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Analysis of High-Rise Buildings with Shear Walls under Dynamic Loads Using STAAD.Pro

Pushpendra Prajapati[1], Murlidhar Chourasia[2], Dr. Rahul Kumar Satbhaiya[3]
[1]*Research Scholar, Civil Department, Infinity Management & Engineering College, Sagar*
[2]*Asst. Prof. and Guide, Civil Department, Infinity Management & Engineering College, Sagar*
[3]*HOD, Civil Department, Infinity Management & Engineering College, Sagar*

Abstract: Rapid population growth and urbanization have intensified the demand for high-rise buildings capable of safely resisting lateral loads induced by earthquakes and wind. In this context, the present study investigates the seismic and wind performance of a reinforced concrete (RC) high-rise building incorporating shear walls as the primary lateral load-resisting system. The building is designed in accordance with Indian Standard IS 1893 (Part 1):2002 for seismic forces and IS 875 (Part III) for a basic wind speed of 39 m/s. The research is based on a live project at the School of Planning and Architecture, Bhouri, Bhopal, Madhya Pradesh. Shear walls are extensively adopted in multi-storey buildings due to their high stiffness, strength, and ability to effectively control lateral displacement and inter-storey drift while also carrying gravity loads. This study evaluates the structural behavior of a G+6 storey building with symmetric and asymmetric shear wall configurations under seismic zone II and medium soil conditions. Both two-dimensional and three-dimensional linear static analyses are performed using STAAD.PRO software. Key response parameters, including lateral displacement, storey drift, natural time period, base shear, torsional effects, and resisting moments, are compared to identify the most efficient shear wall placement. The results reveal that the two-dimensional shear wall model exhibits minimum displacement and storey drift, while achieving maximum base shear and resisting moment, indicating superior lateral performance.

Keyword: Reinforced Concrete, Seismic forces, high raise building , lateral displacement, G+6 storey.

I. INTRODUCTION

A. Overview

Concrete is often regarded as an ideal construction material because of its cost-effectiveness, flexibility in design and construction, and high resistance to fire and long-term deterioration. The raw materials required for concrete production are easily available in most regions, and its manufacturing process is relatively simple and well standardized [1]. Owing to these advantages, concrete has emerged as one of the most widely used construction materials in the present century. Its widespread application is particularly evident in the construction of multi-storey and high-rise buildings, where strength, durability, and economy are essential requirements. High-rise buildings are among the most complex structures to design and construct, as they must satisfy multiple and often conflicting demands related to functionality, safety, economy, and aesthetics. Modern tall buildings are generally more slender than older structures and therefore experience greater lateral movements. Consequently, the influence of wind and seismic forces becomes a governing factor in their structural design. Excessive lateral displacement, storey drift, and torsional effects can lead to structural damage, serviceability issues, and failure of non-structural components. Enhancing the structural systems of tall buildings is therefore crucial to control their dynamic response under lateral loading. With the adoption of improved structural systems such as shear walls, tube systems, and core wall arrangements, along with advancements in material properties, the achievable height of reinforced concrete buildings has increased significantly in recent decades. Buildings incorporating structural walls exhibit higher stiffness compared to conventional framed structures, which substantially reduces lateral deformation and potential damage. Reinforced concrete multi-storey buildings are capable of resisting both vertical and horizontal loads effectively. However, when such buildings are designed without shear walls, beams and columns are required to carry large lateral forces, resulting in uneconomical member sizes. Hence, the inclusion of shear walls becomes essential not only for safety but also for economic design and control of excessive deflection. Lateral forces caused by wind and earthquakes generate shear forces and overturning moments in shear walls. The shear force tends to distort the wall shape, transforming it from a rectangle into a parallelogram, a phenomenon known as racking. In addition, overturning moments create compression at one end of the wall and uplift at the opposite end, enabling the wall to resist overturning through axial force action [2]. These mechanisms allow shear walls to provide significant lateral strength and stiffness to the structural system.

Earthquakes are occurring with increasing frequency, and modern seismic design philosophy emphasizes not only life safety but also damage limitation and performance-based behavior. To mitigate the adverse effects of seismic and wind forces, various lateral load-resisting systems are incorporated in buildings, among which shear walls are one of the most commonly adopted systems. The placement of shear walls is especially critical in asymmetric buildings, where improper configuration may induce torsional effects and uneven force distribution. Therefore, identifying the most effective and optimal location of shear walls is a key aspect of seismic design.

In this study, a comparative analysis is performed to evaluate the influence of shear wall placement in both symmetrical and asymmetrical structures. Two-dimensional frames and three-dimensional reinforced concrete models of a G+6 storey building are analyzed under seismic zone II conditions and a basic wind speed of 39 m/s [3]. All models are subjected to identical gravity loads and analyzed using equivalent static analysis. The structures are modeled with reinforced concrete beams, columns, slabs, and shear walls, and the analysis is carried out using STAAD.Pro V8i software. The comparative assessment focuses on parameters such as lateral displacement, storey drift, base shear, natural time period, torsion, and resisting moments to evaluate the effectiveness of different shear wall configurations [4], [5] .

B. Reinforcement bars in RC Shear Walls

Figure 2 illustrates the arrangement of steel reinforcing bars in RC shear walls, which are organized in evenly spaced vertical and horizontal grids. The reinforcement in these walls can be installed in one or two parallel layers, known as curtains. It is necessary to anchor the horizontal reinforcement at the ends of the RC shear walls. The minimum required area of reinforcing steel is 0.0025 times the cross-sectional area for both the horizontal and vertical directions. The vertical reinforcement should be evenly distributed across the wall's cross section [6].

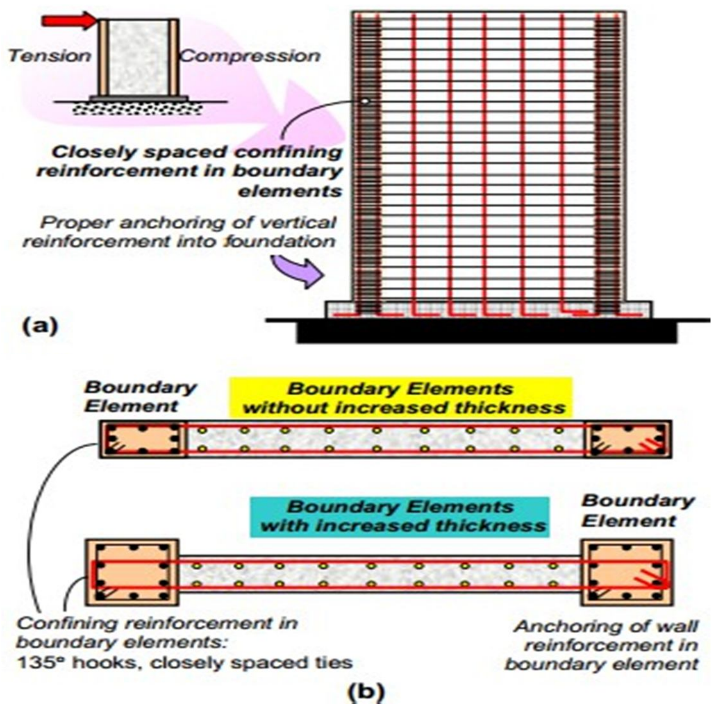


Figure 1 Reinforcement of RCC Shear Wall

C. Shear wall Structures

A structure is classified as a skyscraper when it significantly exceeds the height of its surrounding buildings or appears tall due to its slenderness. The development of shear wall and tall building systems began in Chicago in the late nineteenth century, enabled by innovations such as safety elevators, improved communication systems, and the transition from heavy masonry construction to steel skeletal frames with lighter infill walls. This shift allowed buildings to overcome height limitations imposed by self-weight and facilitated vertical expansion [7]. The evolution of tall buildings is driven primarily by economic factors, supported by advances in structural systems, foundation design, and construction technology. Modern skyscrapers rely on rigid foundations and efficient structural forms to ensure stability, safety, and optimal performance under extreme loading conditions [8][9].

D. Staad.pro

The innovative and forward-thinking STAAD software is a comprehensive structural analysis and design package developed to meet the demands of modern building engineering. Backed by over four decades of continuous research and development, the latest version of STAAD offers advanced three-dimensional object-based modeling, high-quality visualization, and extremely fast linear and nonlinear analysis capabilities. It supports the analysis and design of multi-storey buildings under static and dynamic loading conditions, including seismic and wind effects. Advanced features such as modal analysis, direct integration time-history analysis, P–Δ effects, large displacement behavior, and nonlinear material modeling using plastic or fiber hinges enable realistic simulation of structural response. The software supports a wide range of materials, including steel, reinforced concrete, composite sections, and masonry shear walls. Intelligent graphical displays, customizable reports, and schematic drawings allow clear interpretation of results. Its interoperability with multiple design platforms makes STAAD suitable for applications ranging from simple frames to complex high-rise structures.

1) Objective of Present Study

The aim of this study is to examine the impact of shear walls on buildings that are irregular, asymmetrical, and symmetrical in seismic zone II, with a wind speed of 39 m/s. The modeling and analysis of a G+6 storey high-rise building frame have been conducted using STAAD.Pro V8i software.

2) Specific Objectives of the Present Study are

a) To assess the impact of dynamic forces, such as seismic and wind loads, on a tall building according to Indian Standards.

b) To conduct a comparative analysis of 2D and 3D buildings with both regular and irregular high-rise structures.

c) To determine the effect of shear walls, under dynamic loading on high-rise building.

II. METHODOLOGY

A. General Concept

Advancements in computer processing capabilities have enabled increasingly precise structural calculations while simultaneously encouraging the use of more sophisticated analytical methods. As a result, structural analysis techniques have progressively evolved from conventional elastic static analysis to elastic dynamic analysis, followed by non-linear static procedures and, ultimately, non-linear dynamic analysis. These advanced approaches allow a more realistic representation of structural behavior under complex loading conditions, particularly seismic forces. In the present context, the wide variety of possible building plan configurations has limited the accumulation of comprehensive behavioral understanding. Therefore, there is a clear need to analyze the performance of different reinforced concrete shear wall shapes in unsymmetrical RCC building frames to accurately evaluate their seismic response and improve design reliability.

B. Problem Formulation

This includes comparative study of structural behaviour of 3 dimensional and 2 dimensional geometry RC building frame is prepared using STAAD.Pro software. A comparison in analysis results is done on certain important parameters such as story displacement, storey drift, time period, base shear, torsion, moment etc. Detailed construction progress iswhereas configuration and material specification of the building are shown in Table 1 and Table.2.

Table 1 Building Description

S. No.	Building Description	
1.	Plan Area	675m^2
2.	X-Y Direction Grid Spacing	5m x 5m
3.	Storey Height	3.15m
4.	Number of storey	6
5.	Beam Dimension	300mm x 450mm
6.	Column Dimension	500mm x 500mm
7.	Slab Thickness	150mm
8.	Thickness of shear wall	200mm
9.	Thickness of wall	230mm

10.	Bottom Support Condition	Fixed
11.	Seismic Zone	II
12.	Zone Factor	0.10
13.	Soil Type	Medium
14.	Importance Factor	1.5
15.	Response Reduction Factor	5
16.	Eccentricity Ratio	0.05
17.	Wind Speed	39 m/s

Table 2 Material Specification

S. No.	Material Specification	
1.	Grade of Concrete, M-25	f_{ck} = 25N/mm^2
2.	Grade of Steel, Fe-415	f_y = 415N/mm^2
3.	Density of Concrete	ϒ'c = 25KN/m^3
4.	Density of Brick wall considered	ϒ'brick = 18 KN/m^3
5.	Live Load	4KN/m^2
6.	Wall Load	12KN/m^2

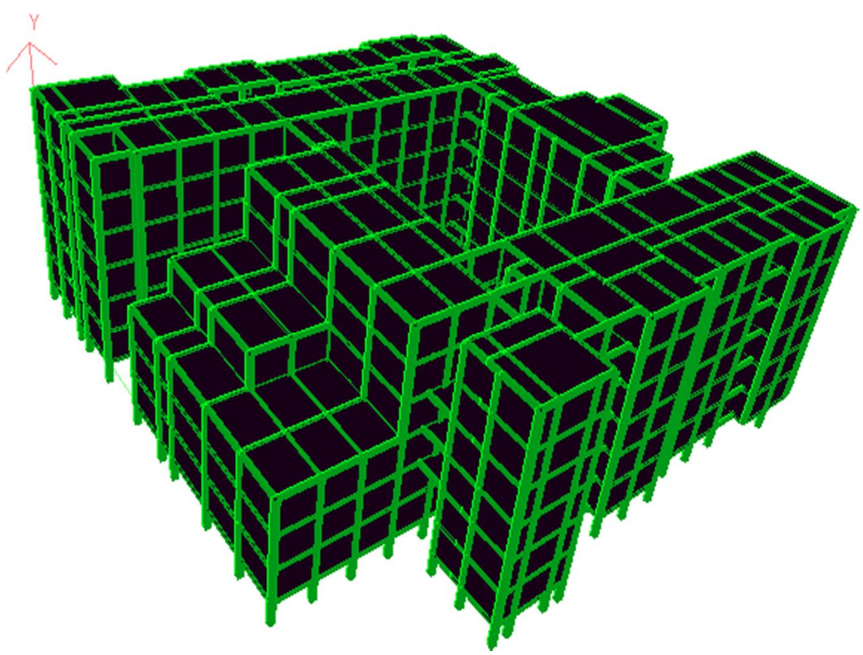
C. General steps required for analysis and design of the High-rise RCC building is given below

1) Step-1Modelling of building frames

An RCC Structure is mainly an assembly of Beams, Columns, Slabs and foundation inter connected to each other as a single unit. Generally the transfer of load in these structures is from slab to beam, from beam to column and finally column to foundation which in turn transfers the entire load to the soil. In this study, I have adopted two unsymmetrical shape of structure and two symmetrical shape of structures both 2- dimensional and 3-dimensional as shown in below figures 2 and 3, modelling and analysis is done using STAAD.PRO software.

Model -1& 2 : 3-dimensional and 2-dimensional boys hostel project of school and planning bhori, Bhopal M.P. considering dynamic loading (seismic & wind).

Model -3 & 4: 3-dimensional and 2-dimensional frame of same symmetrical shape building frame with same loading and geometry.



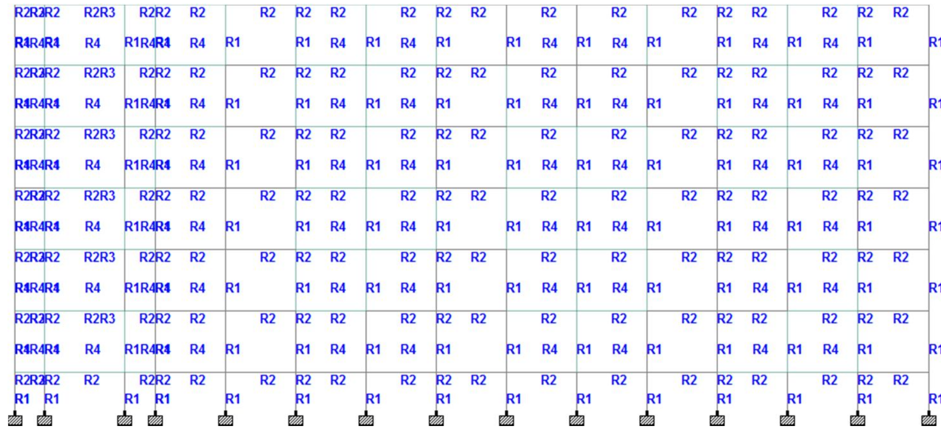


Figure 2 Unsymmetrical structure 2-d and 3-d modelling in staad

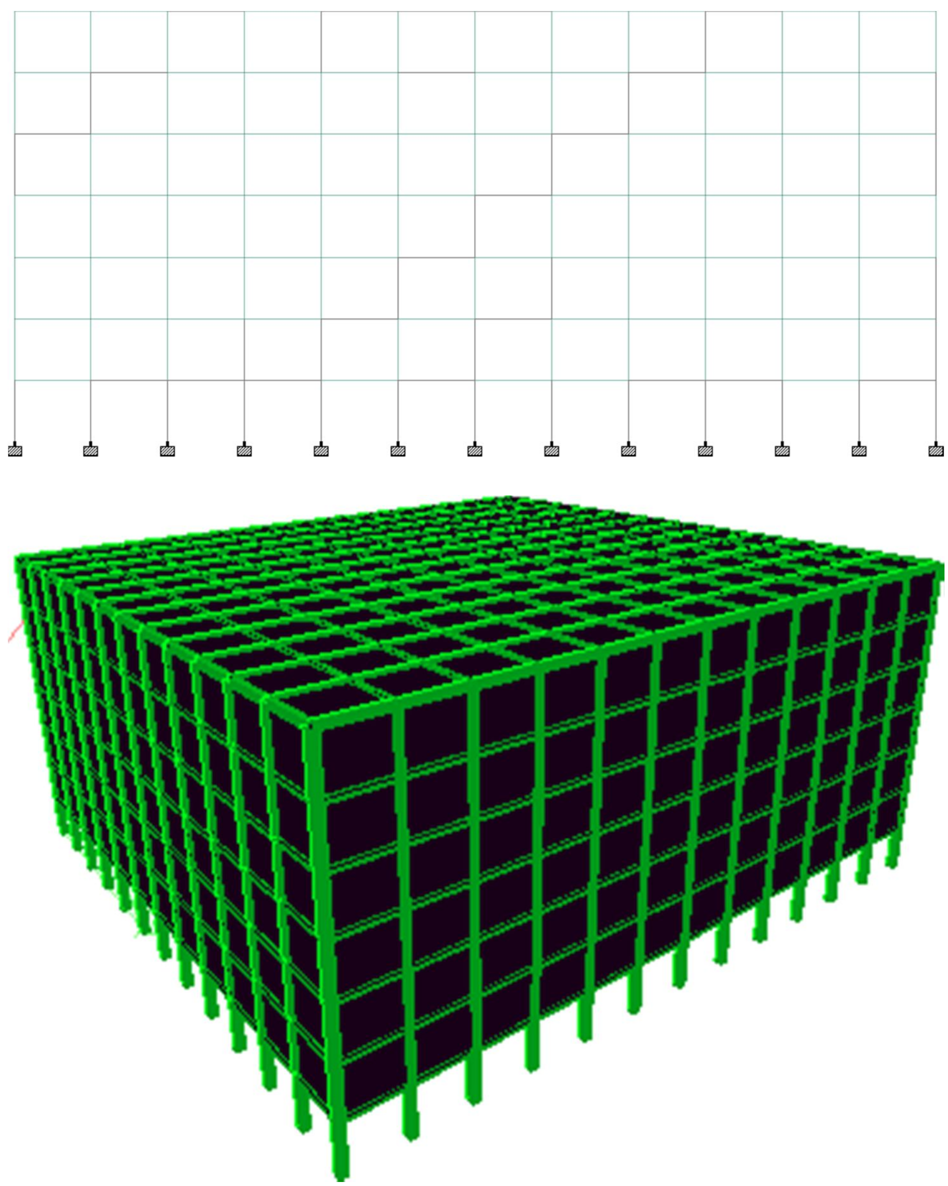


Figure 3 Symmetrical structure 2-d and 3-d modelling in staad. pro

2) Step-2Application of Load

In the structural analysis, all load conditions are applied to the structure. The design load values are determined according to IS-875 Parts I, II, III, and IS-1893 Part I. Dead loads are calculated based on the unit weights of materials specified in IS 875 (Part I), which are determined by considering the materials designated for construction. Figure 4.7 illustrates the distribution of dead load. Imposed load, which is not permanent and can vary, is defined as the load applied to the structure and should be assumed in line with IS 875 (Part II).

3) Step-3Selection of parameters of seismic and wind Definition of given soil condition

a) Selection of Earthquake Zone and wind intensity

The Seismic Zone IIand wind speed 39 m/s is considered in the study. To Design the lateral load resistant structure.

b) Selection of soil for the analysis of structure medium and soil condition is considered.

Various Earthquake parameters such as Zone Factor (Z), Importance Factor (I), Response reduction factor (R), soil condition, damping ratio, eccentricity ratio etc. are defined for different load cases using Staad.Pro analysis software.

4) Step-4Application of Equivalent static analysis

After defining the seismic parameters, static analysis is performed using STAAD software by applying Equivalent static analysis in accordance with IS-1893 (Part I): 2002.

The duration of a building's period is determined using the formulas T = 0.075 x h0.75 for a bare frame and T = 0.09h/√d for an infilled frame, as specified in IS-1893 (Part I): 2002, where h represents the height and d is the base dimension of the building in the direction of vibration. The calculation of lateral loads and their distribution along the building's height is conducted according to IS-1893 (Part I): 2002. The seismic weight is computed by adding the full dead load to 50% of the live load.

$$T_a = 0.09h/\sqrt{d} = 0.85 \text{ sec in x- direction} \quad (1)$$

$$T_a = 0.09h/\sqrt{d} = 0.94 \text{ sec in y- direction} \quad (2)$$

5) Step-5Formation of load combination (9 load combination)

In the analysis and limit state design of reinforced concrete structure, the following load combinations shall be accounted as given in IS-1893 (Part I): 2002 and wind combinations as per 875 part-III (Sec. 6.3.1.2). Load combinations are shown in table 3.

Table 3 Load Combination

S. No.	*Load Combination*	*Primary Load*	Factor
1.	Load Combination 1	Dead Load	1.5
		Live Load	1.5
2.	Load Combination 2	Dead Load	1.5
		Earthquake Load and wind -X	1.5
3.	Load Combination 3	Dead Load	1.5
		Earthquake Load and wind -X	-1.5
4.	Load Combination 4	Dead Load	1.5

6) Step-6 Design of RCC structure

Design of RCC structure is done on STAAD.Pro software using IS-456:2000. During the design of RCC framework components such as Beams, Columns, Slabs, Shear wall various design parameters are selected as given below:-

Grade of concrete = M-25 Grade of main steel = Fe415

Grade of secondary steel = Fe250 Clear Cover = 20mm, 25mm & 40 mm

Max. Size of main reinforcement = 40 mm Min. Size of main reinforcement = 20 mm

Max. Size of secondary reinforcement = 12 mm Min. Size of secondary reinforcement = 8 mm

7) Step-7 Comparative studies of results in terms of displacement, moment, shear force and storey displacement.

III. RESULTS

A. *Parameters Selected for Analysis*

This result contains comparative study of G+6 storey structure of three dimensional building with two dimensional building considering shear walls with region in seismic zone II &wind zone 39 m/s. RCC building frames are designed for same loading condition and rigid diaphragm is considered in all cases. Column, beam and shear wall sections are made of reinforced concrete. STAAD.prosoftware is used to compare the result obtained during the analysis and design of structure.

Linear static analysis method is used to analyse the structures in this study height of the building taken as 22.05 m, so it comes under high rise structure. The parameters which has been compared in this study

- Lateral displacement
- Max. Shear Force
- Maximum Bending moment
- Axial Force

B. *Axial Force*

When a load is exerted on a structure through the center of gravity of its cross section, it is referred to as an axial load, meaning the force is applied along the object's longitudinal centerline. Axial force pertains to the compression or tension experienced by the member.

C. *Shear Force*

Shearing forces occur when unaligned forces push one section of an object in a particular direction while another section is pushed in the opposite direction. In contrast, when forces are directed towards each other, they are referred to as compression forces.

D. *Bending Moment*

When a structural element is subjected to an external force or moment, it leads to bending, creating a bending moment. Beams are the simplest and most common structural elements that undergo bending moments. The example shows a beam that is supported at both ends.

IV. RESULTS AND INFERENCES

A. *Maximum Storey Displacement*

Table 4 Material Specification

storey	Storey Displacement in mm			
	2d unsymmetric	3d unsymmetric	2d symmetric	3d symmetric
terrace	0.24	0.589	0.366	1.3
6	0.205	0.55	0.358	1.28
5	0.17	0.504	0.351	1.258
4	0.135	0.453	0.343	1.232
3	0.102	0.398	0.334	1.204
2	0.074	0.34	0.324	1.173
1	0.05	0.276	0.311	1.13
G.F.	0	0	0	0

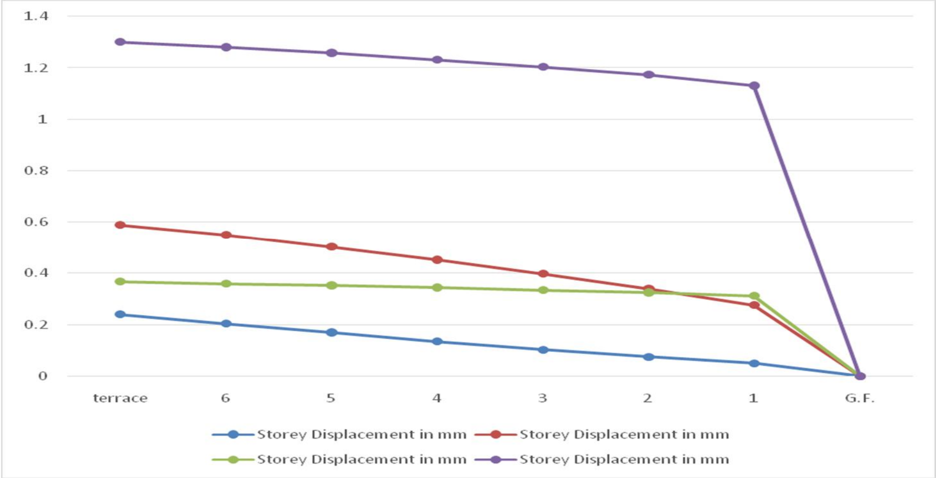


Figure 4 Storey displacement

Inferences:

- The figure above clearly shows that the minimum story displacement occurs in a two-dimensional unsymmetrical frame.
- In contrast, a three-dimensional frame exhibits more displacement compared to the two-dimensional unsymmetrical frame. Additionally,
- the figure indicates that a two-dimensional symmetrical frame experiences significantly greater displacement than a three-dimensional symmetrical frame.

B. Axial Force

Table 5 Axial Forces

Max. Axial Force in KN			
2d unsymmetric	3d unsymmetric	2d symmetric	3d symmetric
1675	1789	2751	2527

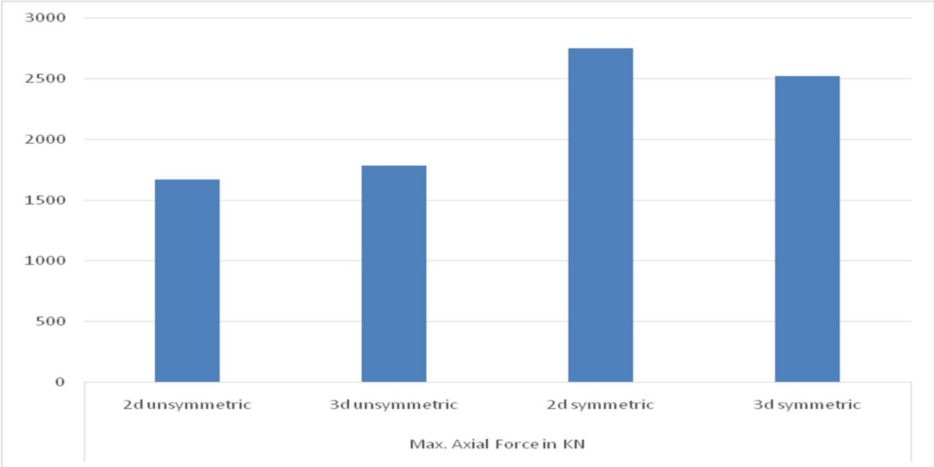


Figure 5 Axial Force

Inferences:

- As shown in above figure Axial force in 2-dimensional symmetric structure is more than 3-dimensional. Whereas 2-dimensional in un-symmetric is less than 3- dimensional.

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C. *Maximum Bending Moment*

Table 5.3: Maximum bending moment

Max. Bending moment in KN-m			
2d unsymmetric	3d unsymmetric	2d symmetric	3d symmetric
223	287	121.54	117.229

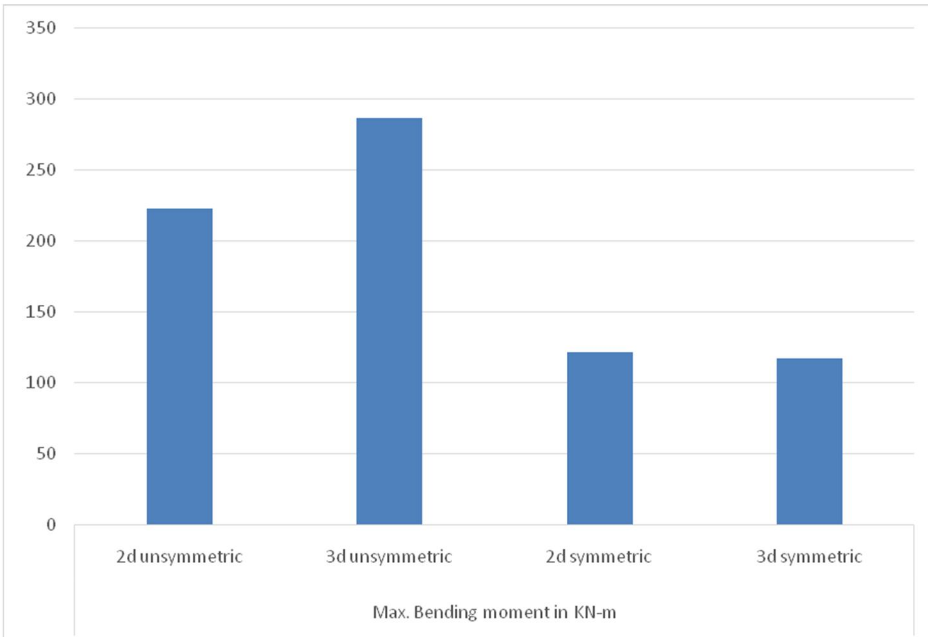


Figure 6 bending moment

Inferences:

- Here results shows that 3-dimensional symmetric is comparatively more economical as compared to 2-dimensional, whereas in un-symmetrical case 3-dimensional shows more bending moments.

D. *Shear Force*

Table 6 Shear force KN

Max. Shear Force in KN			
2d unsymmetric	3d unsymmetric	2d symmetric	3d symmetric
398	435	74.87	72.345

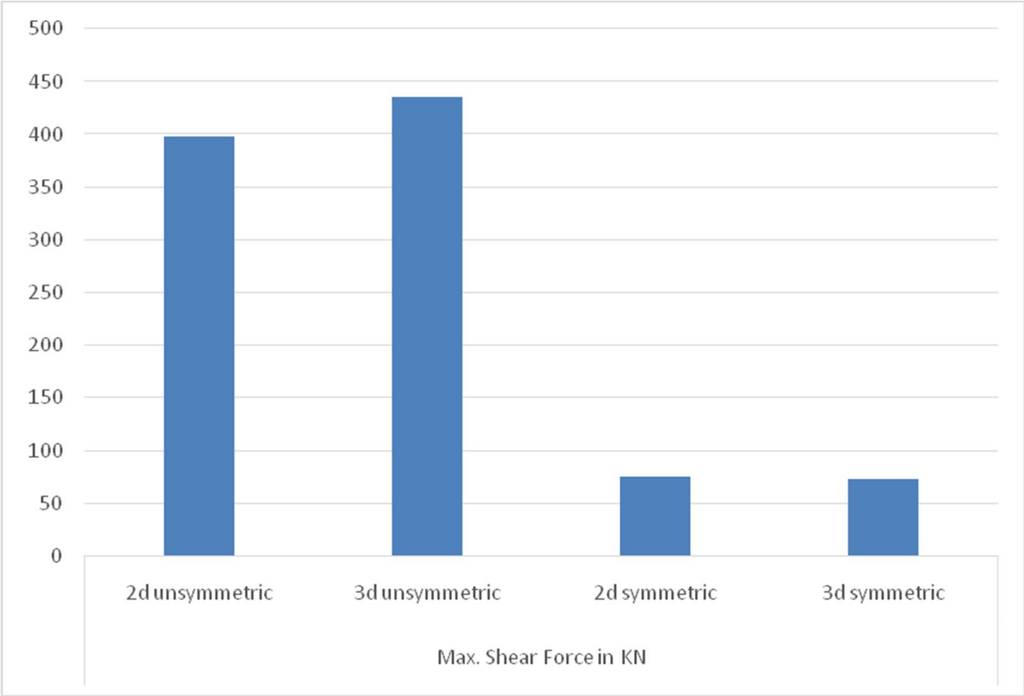


Figure 7 Shear force

Inferences:
As shown in figure above in Symmetric frame 2-dimensional shows more force than 3- dimensional, whereas in unsymmetrical structure result is opposite showing least in 2- dimensional and more in 3-dimensional.

V. CONCLUSION

This chapter presents the findings of the research work on dynamic loading response of a high-rise reinforced concrete building with shear walls.
The main outcome from results obtained from the previous chapters on analysis by dynamic analysis are discussed here. The results are discussed in relation to the previous research results in the literature and existing code recommendations, and presents new information and suggestions for further improvement of structures with shear walls when subjected to lateral forces. It also presents the comparative analysis of 2-dimensional and 3-dimensional building frame with symmetric and unsymmetric shape and their significance for application to general engineering practices of such types.

A. *Maximum Bending Moment*

Bending moment is directly proportional to reinforcement requirement hence as the bending moment increases a gradual increase in reinforcement requirement can be observe,
In our study in unsymmetrical case maximum bending moment of 287 KN/m is observed in 3-dimensional case on beam number 117 whereas 223 KN/m is obtained in 2-dimensional condition on beam number 07. In case of symmetrical structures maximum bending moment is observed in 2-dimensional condition of 221.8 KN/m on beam number 09 whereas in 3-dimensional case its value is obtained 217 KN/m on beam number 109 which shows that geometrical design of a structure can vary the value of bending moment.

B. *Maximum Shear Force*

Shear force is the unbalance forces develops on a beam at the corners or ends which is balanced by providing stirrups, In our study it is found that in condition of unsymmetrical frame 435 KN is observed on 3-dimensional condition on a beam number 104 whereas 398 KN is observed on 2-dimensional frame on beam number 7. In case of symmetrical frame maximum is observed in 2-dimensional frame at beam number 08 of 74.87 KN whereas 72.35 KN is observed on 3- dimensional frame on beam number 105.

C. Storey Displacement

It is total displacement of all storey with respect to ground. It is clearly observed that minimum story displacement is in two dimensional unsymmetrical whereas maximum in 3-dimensional condition.

It is observed that in symmetrical frame building 2-dimensional frame shows much more displacement than 3- dimensional frame.

D. Axial force

Axial loading occurs when an object is loaded so that the force is normal to the axis that is fixed. Taking statics into consideration the force at the wall should be equal to the force that is applied to the part. In our study it is observed that in unsymmetrical 3-dimensional condition maximum axial force of 1798 KN is available on beam number 121 whereas 1675 KN is observed on 2-dimensional frame on beam number 11. In case of symmetrical maximum value 2751 KN is observed on 2-dimensional frame on beam number 12 whereas 2527 KN on 3-dimensional frame on beam number 113.

E. Future Scope

1) We can also study different shape irregular type of geometries such as T- Shape, V- shape, I-shape, Y-shape, channel-shape, etc. on RCC frame with RC shear wall using Linear static analysis as well as Response spectrum method.
2) The effect of combined irregularity in plan as well as in elevation can be studied.
3) We can also study different types of soil conditions as well as different types of seismic zones also effect of wind load can be consider.

REFERENCES

[1] R. Grover and B. K. Daharwal, "Study of Seismic Effect on High Rise Building in Two Different Position of Shear Wall using Staad Pro," International Journal for Research in Applied Science and Engineering Technology , vol. 11, no. 4, p. 4168, Apr. 2023, doi: 10.22214/ijraset.2023.51191.

[2] Mr. A. Ansari, "Comparative Study of Response of Staad.Pro Model with and Without Modeling Plate Element Considering Plan Irregularity: A Review," International Journal for Research in Applied Science and Engineering Technology , vol. 12, no. 5. International Journal for Research in Applied Science and Engineering Technology (IJRASET), p. 4090, May 25, 2024. doi: 10.22214/ijraset.2024.62506.

[3] K. Nanchari, "Linear Analysis of Tall Buildings and Tension Cracking of Shear Walls," International Journal for Research in Applied Science and Engineering Technology , vol. 12, no. 6, p. 1327, Jun. 2024, doi: 10.22214/ijraset.2024.63316.

[4] N. Govind, "Design and Analysis of General Hospital Building Using STAAD Pro," International Journal for Research in Applied Science and Engineering Technology , vol. 12, no. 5, p. 4765, May 2024, doi: 10.22214/ijraset.2024.62680.

[5] S. Koul and S. Lalotra, "Analysis and Design of Highrise Building G+12 With Swimming Pool at Top and Shaer Wall by Using Staad-Pro with Seismic Loading in All Zones," International Journal for Research in Applied Science and Engineering Technology , vol. 11, no. 2, p. 122, Feb. 2023, doi: 10.22214/ijraset.2023.48983.

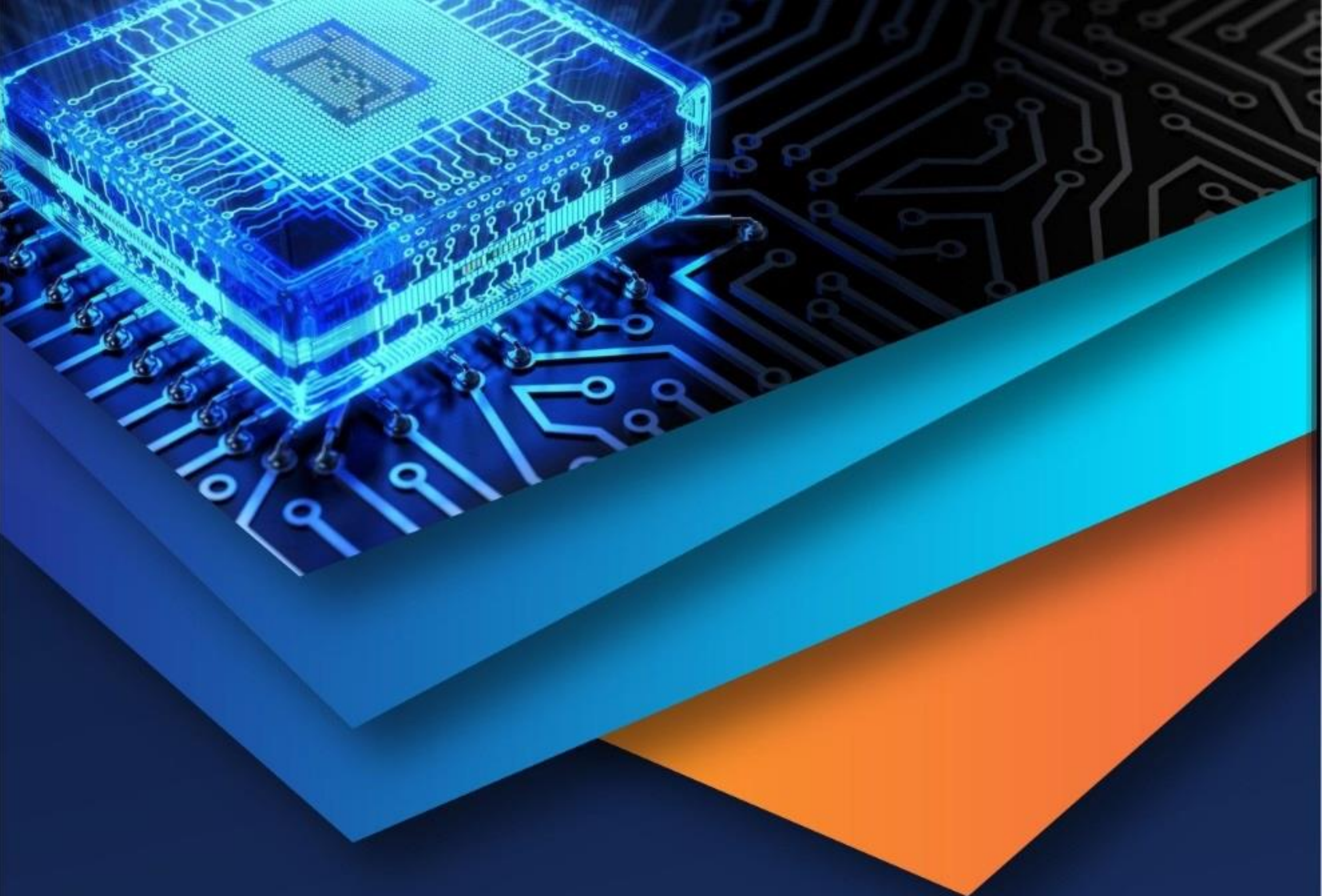
[6] S. N. Khadake, "An Attempt to Design of High-Rise Structures Using ETABS," International Journal for Research in Applied Science and Engineering Technology , vol. 12, no. 1, p. 708, Jan. 2024, doi: 10.22214/ijraset.2024.58029.

[7] A. Kumar and P. Malviya, "A Review Paper on Sloping Ground Building Structures under Seismic and Wind Load Conditions," International Journal of Trend in Scientific Research and Development . Rekha Patel, p. 783, Oct. 31, 2018. doi: 10.31142/ijtsrd18753.

[8] N. Saravanan, "Study on Optimum Location of R.C. Shear Wall in a High Rise Soft Storey Structure Subjected to Seismic Force," International Journal for Research in Applied Science and Engineering Technology , vol. 8, no. 6, p. 38, Jun. 2020, doi: 10.22214/ijraset.2020.6007.

[9] Kum. K. Navyasri, "Analysis and Design of Shear Wall with Openings and Bracings in Multi-Storey Irregular Building," International Journal for Research in Applied Science and Engineering Technology , vol. 13, no. 8, p. 1802, Aug. 2025, doi: 10.22214/ijraset.2025.73868.

[10] K. Nallasivam and K. Shukla, "Dynamic Response of High-Rise Buildings with Shear walls due to Seismic forces," Research Square (Research Square) , Apr. 2023, doi: 10.21203/rs.3.rs-2815496/v1.



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