JSRT JOURNAL
JOURNAL OF SCIENTIFIC RESEARCH AND TECHNOLOGY

PAGES: 17-23
12/04/25
VOLUME-3 ISSUE-4 APRIL

Dynamic analysis of RC building with comparison between Shear Wall and Bracing System using STAAD PRO Software

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ABSTRACT

Buildings suffer seismic stresses during an earthquake that may cause lateral and torsional deflections, therefore influencing structural stability as well as occupant comfort. Minimising these impacts and improving general safety in multi-story structures depend on enough lateral stiffness being ensured. Structural performance of reinforced concrete (RC) frame structures is enhanced using many lateral load-resisting techniques. Among them, shear walls and cross bracings are most often used since they withstand seismic stresses very well. While cross bracing increase rigidity by effectively distributing stresses throughout the construction, shear walls provide great strength and stiffness, hence limiting lateral displacements. This work investigates a G+8 residential RC structure with shear walls placed at many points and cross bracings. STAAD PRO program is used for the analysis per IS 1893:2002 recommendations. Different models are created to evaluate the impact of cross bracing positioned at the building's midsections and corners as well as shear walls.

Important structural factors like lateral displacement, base shear, storey drift, frequency, and maximum moment are evaluated by dynamic analysis. This work offers understanding of how well various lateral load-resisting methods improve structural stability and seismic performance.

Keywords: RC building, Response spectrum method, Shear wall, Bracing system, STAAD PRO, Lateral load resisting system.

I. INTRODUCTION

Particularly in places with great earthquake risk, the design of multi-storey reinforced concrete (RC) buildings must provide seismic resistance. Complicated lateral forces produced by seismic occurrences may cause significant structural damage, failure, or even fatalities if not under control. Engineers use several structural techniques to improve resistance to these stresses; among the more successful ones are bracing systems and shear walls. By adding more stiffness, shear walls—vertical structural components—much increase a building's capacity to resist horizontal loads.[1] Likewise, bracing systems—which consist of many kinds of steel or concrete braces—increase the general strength and stability of the construction, therefore reducing too great lateral motions during an earthquake. Over the years, a lot of research has been done to examine how well RC structures with shear walls and bracing systems function under seismic loads. To increase earthquake resistance, researchers have concentrated on finding the best location, arrangement, and design techniques for these structural components. Results highlight the important role shear walls and bracing play in improving general building safety and structural integrity. Moreover, developments in engineering software like ETABS and response spectrum analysis have made exact modelling and simulations possible, therefore enabling engineers to create more resilient and efficient buildings from which to draw earthquakes resistance.[2]

1.1 Shear Wall

To effectively oppose lateral stresses, this structural design blends reinforced concrete (RC) frame with shear walls. The degree of horizontal interaction, which is controlled by the relative stiffness of shear walls and RC frames along with general building height, determines the efficacy of a wall-frame system. Stiffer frame taller buildings show more interplay among these elements. Under this arrangement, the shear wall serves as a cantilever and reacts via bending whereas the RC frame mostly experiences shear distortion. Their contact is guaranteed by structural compatibility with regard to lateral displacement. Whereas shear wall follows a parabolic deformation profile, RC frame sues laterally. This joint action greatly increases the general stiffness of the construction. Whereas the moment frame provides stability from shear wall on the lower levels, on the top floors it supports the shear wall. Thus, the stiffness ratio and special deflection behaviour of these parts define the structural reaction. This interaction improves lateral load resistance, hence increasing the system's efficiency in guaranteeing stability against forces generated by wind and earthquakes.[3]

1.2 Bracing System

From low-rise to high-rise, bracing systems provide a cheap way to boost the lateral rigidity of structures at various heights with little additional material consumption. Two basic groups usually define these systems: concentric and eccentric. Whereas concentric bracing is directly attached at the beam-column junction, eccentric bracing joins to the beam at a predetermined offset. Moreover, bracing systems may be categorised according to the vertical or horizontal way they distribute lateral stress. By use of diagonal elements placed between columns in vertical planes, vertical bracing effectively channels horizontal stresses down to the base. On the other hand, horizontal bracing is at floor level so that the vertical bracing elements receive equally distributed lateral stresses. In seismic design, steel bracing is very important and helps both newly built and renovated reinforced concrete (RC) structures to improve earthquake protection. Columns are the main load-bearing elements in these systems, therefore providing general structural stability.[1] Bracing systems counteract shear forces by axial tension and compression in the bracing elements, therefore efficiently resisting lateral loads. Although steel bracing has always been connected with steel-framed buildings, it is now usually included into reinforced concrete buildings to increase seismic resistance and general structural performance. This method greatly increases structures' capacity to resist forces from winds and earthquake. The use of double-stage buckling restrained braces in concentric braced frames is one strategy to enhance seismic performance, since conventional steel braces have limited dissipation capacity and CBFs are prone to storey collapses.[4]

II. LITERATURE REVIEW

The present ideas and approaches about high-rise structures with various geometrical forms are investigated in this part. Reviewing pertinent material from books, publications, and conference papers, it investigates their behaviour under many lateral load-resisting approaches.

It has investigated that the height of the structure is the first parameter that affect the fundamental time period of vibration of the models and it approves the most of currently used methods. The ratio of the shear-walls is another most significant parameter built on the bases of the sensitivity analysis, the number of bays and the percentage of the infill walls had nearly the same effects on the fundamental time period of the structure models. The effects of the number of infill-walls and shear-walls on the fundamental time period of buildings is denied by some of the recently used standards, however it has observed that infill walls had effects on the fundamental time period of the models directly after the first fraction of shear-walls and infill walls showed its effects on the fundamental time period that has decreased with the increase of the ratio of infill walls.[5]

It has investigated that If in a high-rise building the distributed belt wall system is provided such that the walls are not connected directly to the core shear walls and acts as real outriggers, are as efficient to reduce lateral drift as the outrigger structures and conventional belt do, However The arrangement and number of belt walls quantify the performance of the distributed belt wall system.[3]

It has investigated that to explore the correlation between outrigger stiffness and the optimal position, a sequence of optimal designs was conducted by modifying the outrigger's cross-sectional area. As the cross-sectional area of the outrigger increases, the optimal location of the outrigger shifts lower in the structure. The variation in the optimal location of the outrigger is diverse within a practical range of the outrigger's cross-sectional area. Specifically, within a two-story range, it is demonstrated that the design variables, encompassing outrigger stiffness and optimal location can be distinctly identified for the optimization of outriggers to meet design limitations, such as permissible lateral displacement. The proposed optimization method utilizing PGI or PLI, is anticipated to be applicable to elastoplastic issues, including seismic pushover analysis, as it yields acceptable results even for analysis models with abrupt changes akin to the Gen model.[6]

It has investigated that the value of story drift and the maximum displacement are higher In high seismic zones that indicates, if a uniform stiffness is provided in a structure, the displacement can be reduced. The building covered by shear wall at all four external corners results good in maximum displacement, story drift and base-shear which means that a building having uniform stiffness has given better result however shear wall at one corner can be subjected to greater lateral load hence the building is required to be provided with uniform stiffness.[7]

It has investigated that the performance of the building is increased with the increase in the number of outriggers and by providing only outriggers, shear band with outriggers and belt trusses is highly effective. In V, inverted V and X type of steel outrigger bracing beams, 4 outriggers combined with Inverted V is more effective but shear walls are the most effective than steel bracing.[8]

The study investigates various structural systems in a G + 16 story RCC building through dynamic analysis. Among the systems studied, the diagrid system emerged as highly effective in handling lateral forces, akin to the shear-walled system. Despite increasing base shear due to added weight, the diagrid system effectively controls displacement, drift and other response parameters. This suggests its potential for enhancing safety and performance in high-rise urban buildings.[9]

This study explores T-shaped steel plate reinforced concrete walls under seismic conditions. Experimental tests and simulations showed these walls perform better than rectangular ones. Various parameters like compression ratio and flange width affect their strength and deformation behaviour. The study also highlights ways to mitigate shear lag effects by adjusting parameters like steel plate ratio and shear span ratio in practical engineering applications.[10]

This study tested a scaled double covering composite core wall under biaxial cyclic loads, revealing failure modes and interlinked lateral resistance. It founds energy dissipation impacting hysteresis loops differently in each direction and validated certain structural assumptions. The research supports using these core walls in tall buildings but suggests further exploration of different factors through simulations due to limited experimental models.[11]

III. METHODOLOGY

Modelling Approach

A nine-story reinforced concrete (RCC) skyscraper located in seismic zone 3 is thoroughly structurally analysed in this work. The building's 18 m x 18 m layout calls for consistent bay spacing in both directions.
Two separate structural models are assessed under seismic load conditions.
1. Shear Wall Model
2. Bracing Model
Every structural model uses a different lateral load-resisting mechanism but keeps height, dimensions, material qualities, and loading circumstances constant. This homogeneity makes a direct, exact comparison of their performance possible.

Specification

Table 1. Details of the properties for various types of structure

Kind of building	Residential Building
Plan area	18m x 18m
Storey count	9
Height of every storey	3m
As per IS 1893:2002	
Structure Location	Zone 3
Zone factor	0.16
Column Size	700mm x 350mm

Beam Size	450mm x 300mm
Thickness of Shear wall	300mm
Thickness of Slab	130mm
As per IS 875(part III):1987	
Basic wind speed	40 m/sec
Structure Class	B
Terrain Category	II
Dead Load	
Wall Load	11.96 kN/m
Floor Load	5.25 kN/m^2 for 1st floor to 8th floor lvl.
	6 kN/m^2 for terrace floor
Live Load	2 kN/m^2 for for 1st floor to 8th floor lvl.
Live Load on Roof	0.75 kN/m^2 for Roof
Bracing Steel type	ISHB 400
Response reduction factor	5
Importance factor	1.5
Kind of Soil	Medium Soil
Analysis Tool	STAAD PRO

Code Provisions

The design and analysis adhere to the following Indian Standards:
-IS 1893:2016: Criteria for Earthquake Resistant Design of Structures
-IS 456:2000: Code of Practice for Plain and Reinforced Concrete
-IS 875 (Part 1 & 2): Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures.

Analysis Methodology

-Dynamic Analysis: Response Spectrum Analysis (RSA) is conducted in accordance with IS 1893:2002 to evaluate the building's seismic response.
-STAAD PRO: This software is used for modeling, simulation, and structural analysis to assess performance under seismic loading conditions.

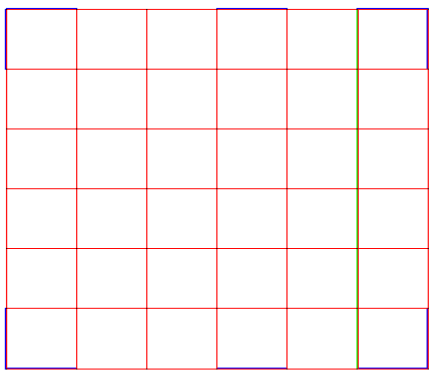

Figure 1: Plan of G+8 story building Shear Wall

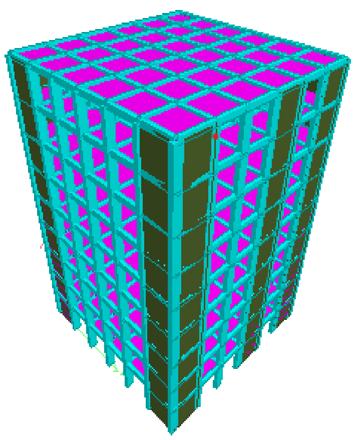

Figure 2: Elevation of G+8 story building for Shear Wall

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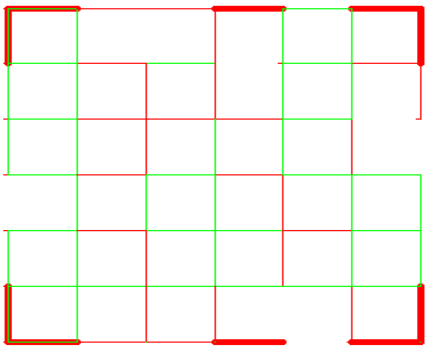


Figure 3: Plan of G+8 story building Bracing.

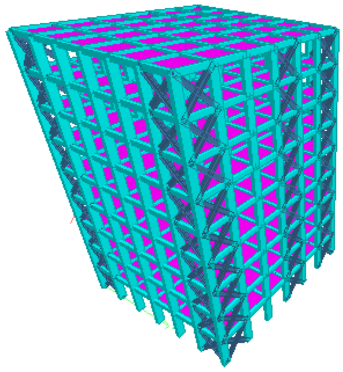


Figure 4: Elevation of G+8 story building for Bracing.

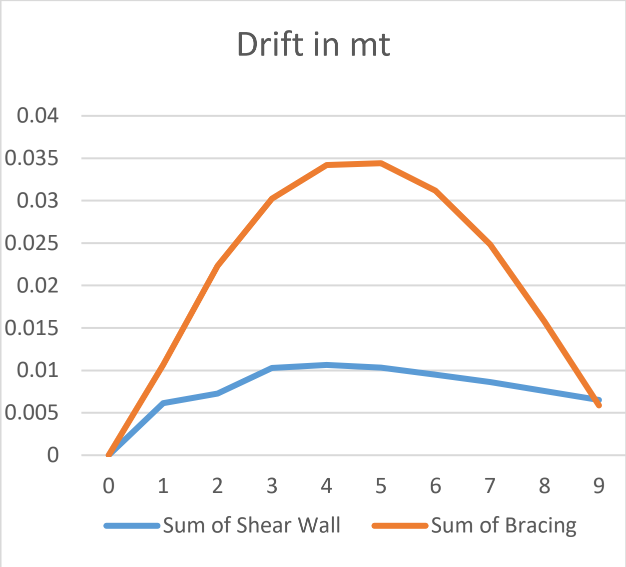
III. RESULT COMPARISON

The performance of each structural model, including the outrigger system, core shear wall, and corner shear wall, is evaluated based on the following criteria:
-Maximum Lateral Displacement: Measures the highest horizontal movement of the structure during seismic activity.
-Storey Drift: Assesses the relative horizontal displacement between consecutive floors, which is crucial for evaluating serviceability.
-Time Frequency: Represents the fundamental natural frequency of the structure, influencing its dynamic behaviour.
-Base Shear: Refers to the total horizontal seismic force acting at the building's base.
-Overturning Moment: The moment that contributes to the potential toppling of the structure during an earthquake.
This comparative study aims to identify the most efficient lateral load-resisting system for high-rise RCC buildings in seismic-prone areas, ensuring both stability and functionality. By analyzing these factors, the research offers valuable insights into the structural behaviour of tall buildings under seismic loads, aiding in more informed design and engineering decisions.

IV. RESULT AND DISCUSSION

Table 2: Max- displacement. Drifts, Overturning moment and Frequency

Items	**Lateral load resisting system**	
	Shear Wall	**Bracing**
Max. Displacement (mm)	16.553	27.978
Max. Story Drifts	1.064	3.442
Base Shear (KN)	2140.46	927.16
Overturning moment (KN- m)	36620	17187.44
Frequencies (Hz)	1.827	5.916



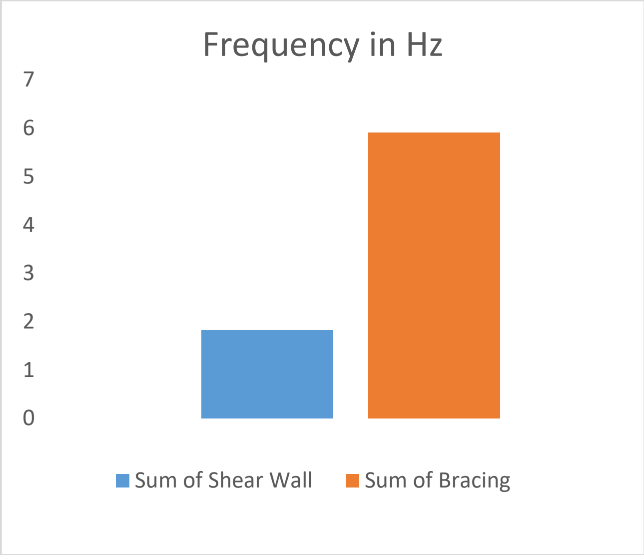
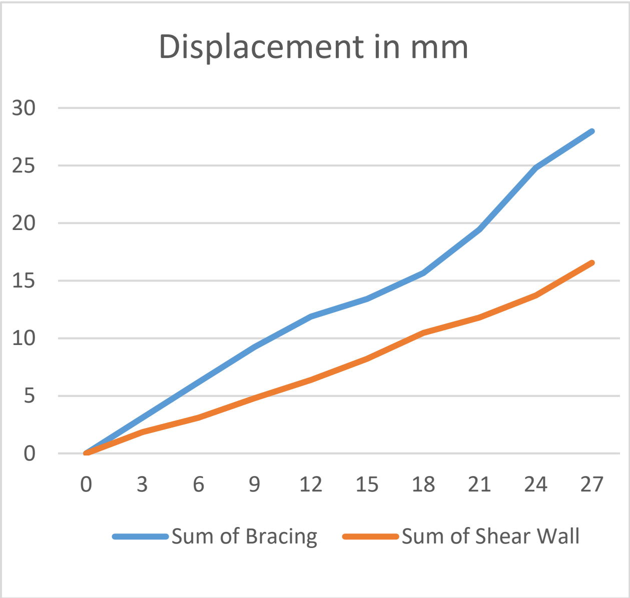


Figure 5: Story Drift of G+8 story building for two model. **Figure 6: Frequency of G+8 story building for two model.**



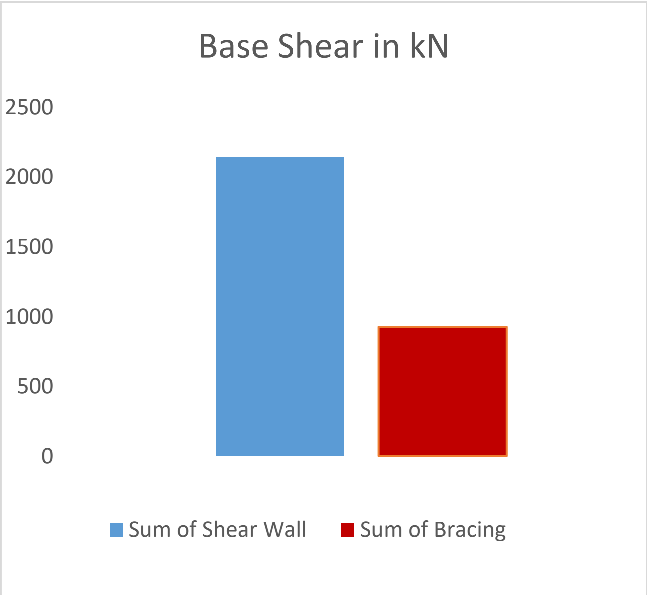


Figure7: Displacement of G+8 story building for two model. **Figure8:Base Shear of G+8 story building for two model.**

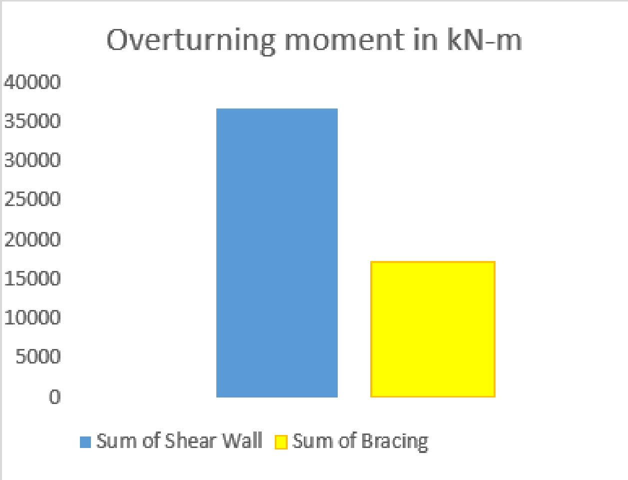


Figure 9: Overturning Moment of G+8 story building for two model.

V. CONCLUSIONS

1. Shear wall and bracing are good structural solutions for reduction of lateral displacement and story drift.
2. Shear wall seems to be more effective than the braces for control of deflection
3. The maximum displacement was found on brace and values in case of brace and shear wall are 27.978 mm and 16.553 mm in Zone III in Response spectrum Method for G+8
4. The maximum storey drift was found on brace and values in case of brace and in shear wall which are 3.442 mm and 1.064 mm in Zone III in Response spectrum Method for G+8.
5. The maximum base shear was found on shear wall i.e. 2140.46 kN. Which is 43.31% higher than brace model base shear value.
6. Conclusion: The shear wall system is the most effective for high-rise RCC buildings, enhancing safety and serviceability.

REFERENCES

[1] S. N. R. Anwar, F. Ernanda, M. Sulton, S. A. Anwar, and M. S. Anwar, “A comparative study of dynamic performance the shear-wall and bracing shapes on the tall building in seismic area,” Sep. 06, 2024. doi: 10.55214/25768484.v8i4.1394.
[2] V. Jain, “Seismic Analysis of different Shaped Building Structures using ETABS,” Mar. 31, 2019, International Journal for Research in Applied Science and Engineering Technology (IJRASET). doi: 10.22214/ijraset.2019.3471.
[3] A. Joseph, A. Dhruvan, K. S. Anandh, M. Adamu, and Y. E. Ibrahim, “Behavior of Double Skin Composite Shear Wall with Different Faceplate Configuration towards Cyclic Loading,” Dec. 24, 2024, University of Indonesia. doi: 10.14716/ijtech.v15i6.7324.
[4] V. Kushwaha and N. Mishra, “A Review on Dynamic Analysis of Outrigger Systems in High Rise Building against Lateral Loading,” International Journal for Research in Applied Science and Engineering Technology, vol. 10, no. 4. International Journal for Research in Applied Science and Engineering Technology (IJRASET), p. 564, Apr. 12, 2022. doi: 10.22214/ijraset.2022.41317.
[5] H. A. Hasrat, W. Qazi, and N. Momand, “Evaluation of Lateral Load Resisting Systems in High-Rise Buildings,” Jun. 11, 2024. doi: 10.47191/ijcsrr/v7-i6-28.
[6] D. K. Sahu and B. K. Jha, “Dynamic Analysis of G + 20 Multi Storied Building by Using Shear Walls and Tune Mass Damper for Different Seismic Zones by Using ETABS.” Apr. 2021.
[7] V. singh tanwar and A. K. Dwivedi, “A Study of the Influence of Various Lateral Load Resisting System in Steel Building.” Jun. 2021.
[8] S. Nigdikar and V. S. Shingade, “A seismic behavior of RCC high rise structure with and without outrigger and belt truss system for different earthquake zones and type of soil,” Jun. 05, 2023. doi: 10.30574/wjaets.2023.9.1.0156.
[9] I. Dabbaghchian, S. R. Mirghaderi, and S. Sayadi, “Comparison of seismic behavior of the eccentric and conventional diagrid systems,” Nov. 20, 2020, Wiley. doi: 10.1002/tal.1824.
[10] A. Agrawal, K. Divya, and L. Singh, “Analysis of Lateral Load Resisting Systems for High Rise Building Frame Considering Utilization of Analysis Tool A Review.” Nov. 2020.
[11] S. Khan, “An Assessment on an Important Element In Building: Shear Wall Vs Brace.” 2020.