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Seismic Performance Analysis of G+10 Multi-Storey commercial Buildings with and without Shear Walls under Wind and Seismic Loads

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Abstract

The main objective of this project is to analyze the seismic and wind load performance of a G+10 multi-storey hotel building. Multi-storey buildings are ideal for accommodating large numbers of people in limited space, but these structures must be designed to be durable, strong, and have sufficient stiffness and structural strength. Buildings in coastal areas are particularly susceptible to various types of loads, including wind and seismic forces. Past events have caused significant damage to both steel and concrete structures, leading to loss of life, property, and livelihoods. These loads, resulting from wind and seismic activity, can severely impact the stability of buildings in such regions.In this study, a G+10 multi-storey hotel building is analyzed under wind and seismic loading using STAAD PRO software. The goal is to design the building to withstand these forces by incorporating shear walls. The primary outputs of the analysis include storey displacement, storey drift, storey stiffness, lateral forces, base shear, and base moment. Different building models, both with and without shear wall locations, are compared to identify the optimal design for enhanced performance under wind and seismic loads.

Keywords: Seismic Load, Wind Load, Shear Walls and Structural Analysis.

Introduction

Multi-storey buildings are essential in urban development due to the increasing demand for space in densely populated areas. As cities grow and land becomes limited, constructing vertically rather than horizontally allows for efficient use of space. Multi-storey buildings enable a higher concentration of residential, commercial, and office spaces in smaller plots, addressing the need for housing, businesses, and amenities while reducing urban sprawl. They play a crucial role in optimizing land use, particularly in metropolitan areas where real estate prices are high and land availability is limited.

Additionally, multi-storey buildings contribute to sustainable development by accommodating more people or businesses with a reduced environmental footprint. By concentrating development in vertical structures, it becomes possible to implement more efficient energy and resource management strategies, such as centralized heating, cooling, and water systems. These buildings often incorporate incorporate modern technologies that enhance energy efficiency and minimize waste, contributing to lower carbon emissions and supporting eco-friendly construction practices. Thus, multi-storey buildings are pivotal for the sustainable growth of urban areas, providing vital infrastructure while promoting environmental responsibility.

Hotel building

A hotel building is a specialized structure designed to accommodate travelers and provide various services, including lodging, food, and amenities. Hotels are crucial components of the hospitality industry, serving as a temporary home for guests who need short-term accommodation. The design of a hotel focuses on providing comfort, convenience, and safety while offering a range of facilities, such as bedrooms, bathrooms, lobbies, dining areas, meeting rooms, and recreational spaces like pools and gyms. Hotels are often strategically located near tourist attractions, business hubs, or transportation centers to cater to the needs of different types of guests, from tourists to business travelers.

The importance of hotel buildings goes beyond providing accommodation; they contribute significantly to the local economy by promoting tourism, creating jobs, and supporting businesses in the surrounding area. Hotels are also essential in fostering cultural exchange, as they bring together people from different regions and backgrounds. In addition to offering basic services, many modern hotel buildings are designed with sustainability in mind, incorporating energy-efficient systems, green technologies, and eco-friendly materials. As travel demand continues to rise, the role of hotel buildings in meeting the diverse needs of global and local travelers is becoming increasingly critical in supporting both economic growth and environmental sustainability.

The structure and architecture of a hotel building are carefully designed to ensure functionality, aesthetics, and comfort while accommodating various services and amenities for guests. The building's structure typically consists of a strong foundation, vertical support systems (such as columns or load-bearing walls), and horizontal elements like floors and ceilings. Hotels can range from low-rise buildings to high-rise towers, depending on the location and the number of rooms required. The building is often designed with reinforced concrete, steel framing, or a combination of both, ensuring stability and the ability to withstand different loads, such as those from guests, furniture, and equipment. For multi-storey hotels, an efficient vertical circulation system, including elevators, staircases, and emergency exits, is essential for easy and safe movement throughout the building.

In terms of architecture, hotel buildings are designed to reflect a balance of functionality and aesthetic appeal to create a welcoming environment. The architectural design incorporates both external and internal elements, often influenced by the hotel's target market, location, and theme. The exterior design may feature a modern, sleek facade with glass, stone, or metal elements, or it may incorporate traditional or cultural design elements

depending on the style of the hotel. Internally, hotels are designed with spaces that cater to various needs, such as guest rooms, lobby areas, dining spaces, meeting rooms, and recreational facilities. Architects focus on creating a sense of luxury, comfort, and space, using smart layouts, efficient lighting, high-quality materials, and soundproofing techniques to enhance the guest experience. Sustainable design features, such as energy-efficient systems, water conservation technologies, and eco-friendly building materials, are increasingly incorporated into hotel architecture to promote environmental responsibility and meet the growing demand for green building practices.

The primary aim of this project is to generate fundamental research data on the seismic performance of hotel building structures, focusing on the comparison of buildings with and without shear walls. By investigating the impact of shear wall placement on a hotel building subjected to wind and seismic loading, the study aims to provide insights into how structural configurations can be optimized for enhanced performance. Using STAAD PRO software, the building is analyzed by varying the locations of shear walls, and the effects on key structural parameters such as storey displacement, storey drift, storey stiffness, lateral forces, base shear, and base moment are thoroughly examined. The objective is to determine the most effective shear wall configuration that minimizes displacement, drift, and stress while maximizing stability under both wind and seismic loads, contributing to the design of safer and more resilient multi-storey hotel buildings.

Literature review

Seismic analysis is a crucial tool in earthquake engineering used to assess and understand how buildings respond to seismic excitations, such as ground motion during an earthquake. Historically, buildings were designed primarily to withstand gravity loads, with little consideration for the forces generated by earthquakes. However, with the increasing frequency and impact of seismic events, seismic analysis has become an essential component of structural design. It enables engineers to predict the behavior of buildings under earthquake-induced forces, helping to design structures that can resist potential damage or failure. This analysis has evolved to become an integral part of both structural analysis and design, particularly in regions prone to earthquakes, ensuring the safety and resilience of buildings in the event of seismic activity.

Mayuri D. Bhagwat et al. [1] conducted a dynamic analysis of a G+12 multistoried RCC building, considering the seismic effects of the Koyna and Bhuj earthquakes. The analysis was performed using time history analysis and response spectrum analysis to study and compare the seismic responses of the building. The seismic responses, such as base shear, storey displacement, and storey drifts, were modeled and evaluated using STAAD PRO software. Two distinct time histories, representing the Koyna and Bhuj earthquakes, were utilized to develop various acceptable criteria for assessing the building's performance under these seismic events. The study aimed to understand the structural behavior of the building under the influence of these significant earthquake scenarios.

Himanshu Bansal et al. [2] conducted a study on the seismic performance of building frames, where they found that the storey shear force was maximum at the first storey and gradually decreased to a minimum at the top storey in all cases. The study also revealed that mass-irregular building frames experience higher base shear compared to regular building frames with similar structural configurations. On the other hand, stiffness-irregular buildings were observed to experience lesser base shear but exhibited larger inter-storey drifts. This indicates that irregularities in mass and stiffness can significantly impact the seismic behavior of buildings, influencing both the distribution of shear forces and the overall deformation of the structure.

Mohit Sharma et al. [3] conducted a study on a G+30 storied regular building, performing both static and dynamic analyses using STAAD-Pro software. The analysis was carried out based on the design parameters outlined in IS 1893-2002 (Part-1) for seismic zones 2 and 3. The study aimed to evaluate the building's structural behavior under seismic loads in these specific zones, ensuring compliance with the relevant design codes for safety and performance under earthquake conditions.

A. B. M. Saiful Islam et al. [4] conducted a study on the effectiveness of isolation systems in reducing earthquake-induced loads on buildings. The analysis results demonstrated that the isolation system significantly decreases the seismic forces acting on the structure. Additionally, the study found that the method of analysis has a notable impact on the seismic response of low to medium-rise buildings. Specifically, time history analysis resulted in considerably lower base shear compared to response spectrum analysis. Furthermore, the time history analysis showed reduced isolator displacement compared to that observed in the response spectrum analysis, highlighting the importance of analysis methods in predicting the behavior of buildings with isolation systems during seismic events.

A. S. Patil et al. [5] conducted a study on the seismic responses of multistoried RCC buildings, showing similar variation patterns in parameters such as base shear and storey displacements across earthquake intensities ranging from V to X. Based on the findings, the study recommends that the Time History method of analysis is crucial for ensuring the safety of multistoried RCC buildings against earthquake forces. This method allows for a more accurate assessment of a building's response under varying seismic conditions, highlighting its importance in the design and evaluation of buildings in earthquake-prone regions.

Md. Arman Chowdhury et al. [6] conducted a study analyzing both regular and irregular buildings, with and without the installation of isolators. The study found that the inclusion of isolators in buildings increases the time period of the structure, which helps reduce the possibility of resonance during seismic events. While the installation of isolators increases the overall cost of the building, it leads to a reduction in the reinforcement requirements and material costs, making it a cost-effective solution in terms of long-term

structural safety and performance. The study emphasizes the benefits of isolators in enhancing the seismic resilience of buildings, particularly in areas prone to earthquakes.

P. P. Chandurkar et al. [7] conducted a study in which shear walls were considered as the primary earthquake-resisting elements in multi-storey buildings. Structural walls provide an effective bracing system, offering significant potential for lateral load resistance during seismic events. The study emphasized the importance of determining the optimal location for shear walls within a building to enhance its seismic response. By strategically positioning shear walls, the building's ability to withstand earthquake-induced forces can be significantly improved, ensuring better safety and stability during seismic events.

Building parameters

In this work, the structural analysis of the hotel building is carried out using STAAD Pro, a powerful and widely used software for designing and analyzing building structures. The building is modeled with an X-shaped configuration, chosen for its ability to efficiently distribute loads in multiple directions, enhancing its stability. The structural elements, including beams, columns, and slabs, are sized to ensure the building can withstand various loading conditions. The beam dimensions are set to 0.4 meters by 0.23 meters to provide adequate strength, while the columns are designed with a 0.7-meter by 0.7-meter cross-section for necessary vertical support. The slab thickness is set at 125 mm to handle both dead and live loads, ensuring the building remains stable under typical load conditions as well as during extreme events such as seismic and wind forces.

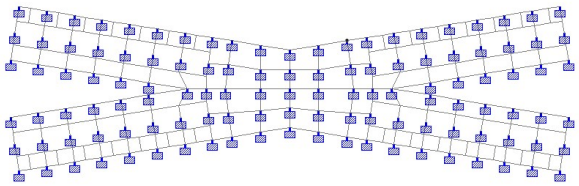


Fig: plan of building.

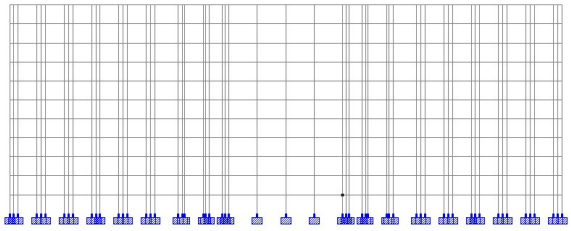


Fig: Elevation view of building.

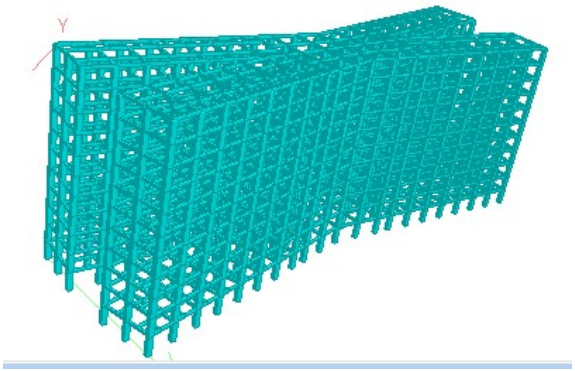


Fig:Render view of building

The analysis of the building considers both seismic and wind loading, following the guidelines established by the Indian Standard IS 1893-2016 for seismic design. The building is situated in Seismic Zone 2, indicating moderate seismic activity. The soil category is classified as "medium," which affects the seismic response of the structure. The response reduction factor is set to 3, reflecting the use of a moment-resisting frame structure that mitigates the effects of seismic forces. Additionally, wind analysis is performed with a wind speed of 5 m/s applied to assess the building's resistance to lateral forces caused by wind. By incorporating these loads, the building's performance under both seismic and wind conditions can be thoroughly evaluated, ensuring its resilience and stability.

To initiate the modeling, AutoCAD is used to create the schematic drawing of the building, which is then saved in DXF file format for compatibility with STAAD Pro. This DXF file is imported into STAAD Pro, where the design is further refined and analyzed. Several critical parameters, such as storey displacement, storey drift, lateral forces, and storey stiffness, are considered in the analysis to assess the building's response under different loading conditions. Storey displacement and drift provide insights into the lateral movement of the building during wind and seismic events, while lateral forces and storey stiffness are crucial in evaluating the overall stability of the building. The combination of these factors ensures that the building is designed to be safe, efficient, and capable of withstanding extreme external forces, offering resilience in the face of natural hazards.

The model is analyzed with and without shear walls to compare their effects on the building's performance. Shear walls are strategically placed in different locations to evaluate how their inclusion influences the building's response to seismic and wind loads. The structural analysis results include detailed outputs such as the displacement and deformation of the building, which are used to identify areas of maximum and minimum movement. For example, the maximum deformation is observed at the roof, while the minimum deformation occurs at the base of the structure with shear walls in place. These results highlight the importance of shear wall placement in enhancing

the building's ability to resist lateral forces and maintain stability. By comparing the performance of the building with and without shear walls, this study aims to identify the optimal configuration for improving the building's resistance to seismic and wind loads, ultimately ensuring its safety and longevity.

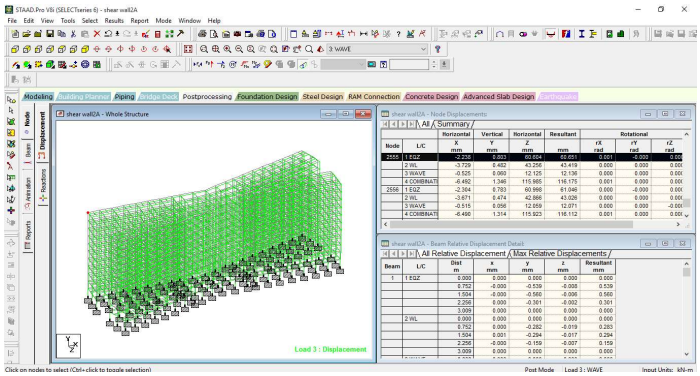


Fig : Displacement of building without shear wall.

In the above image shows the total deformation of RCC frame with Shear wall location 1. Combination load applied on entire structure and Maximum deformation occurs at the roof .Minimum deformation appears at bottom of RCC frame with bracing and Shear wall. And we can clearly able to see in the above image. All together maximum deformation is 115 mm.

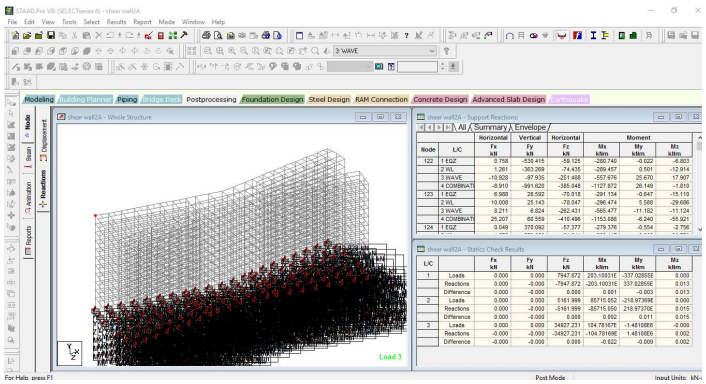


Fig : Base shear of building without shear wall.

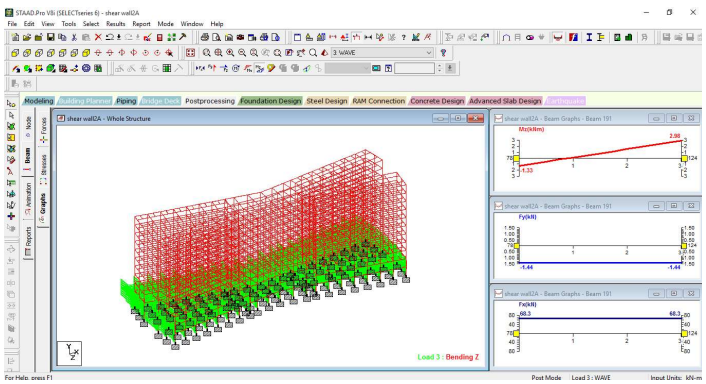


Fig : Bending moment of building without shear wall.

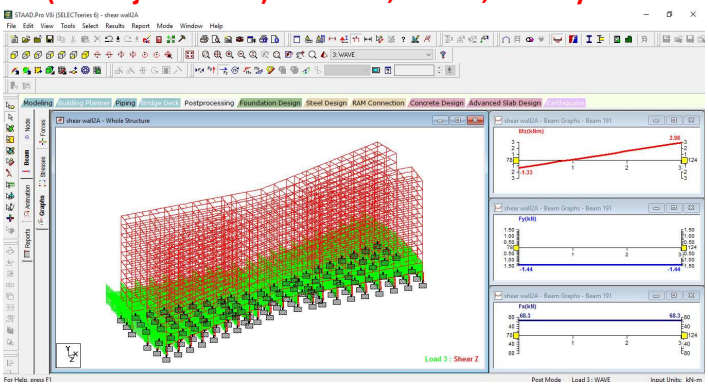


Fig :shear force of building without shear wall.

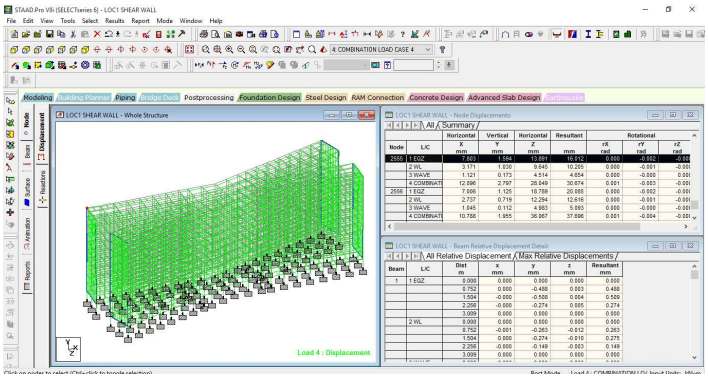


Fig : Displacement of building with shear wall loc1.

In the above image shows the total deformation of RCC frame with Shear wall location 1. Combination load applied on entire structure and Maximum deformation occurs at the roof .Minimum deformation appears at bottom of RCC frame with bracing and Shear wall. And we can clearly able to see in the above image. All together maximum deformation is 28 mm.

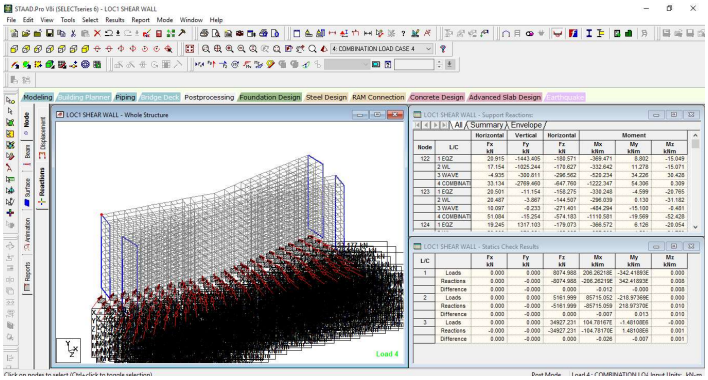


Fig : Base shear of building with shear wall loc1.

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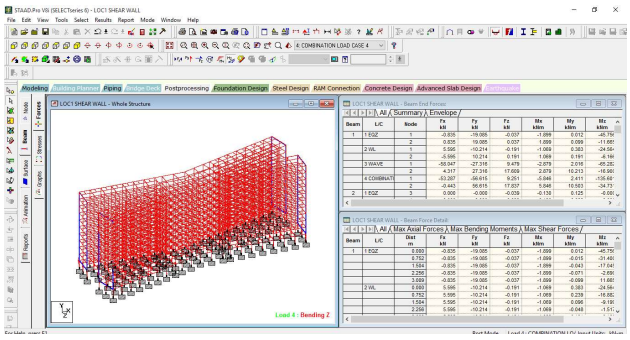


Fig : Base shear of building with shear wall loc1.

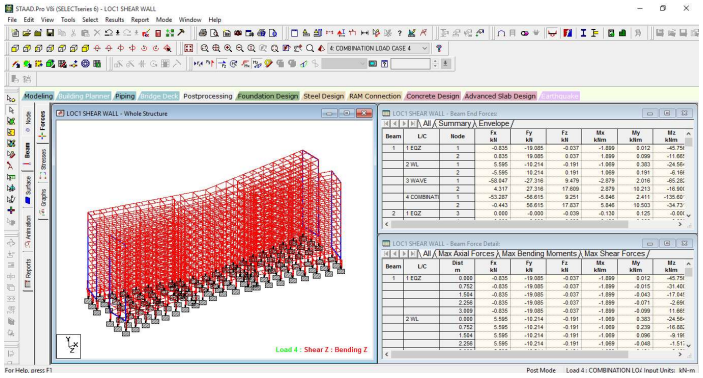
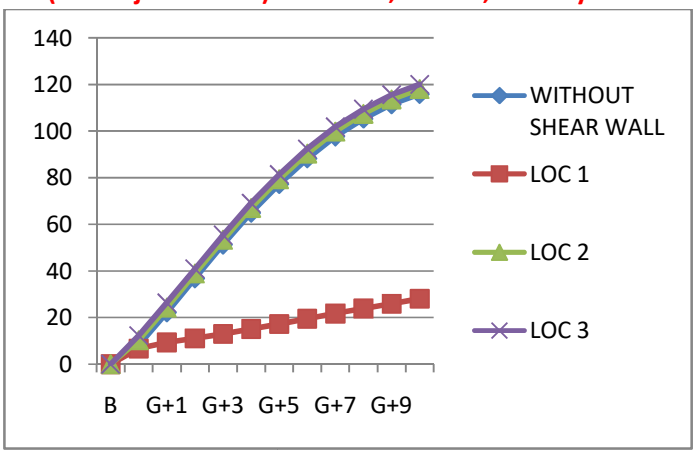


Fig : Base shear of building with shear wall loc1.

Results And Discussion

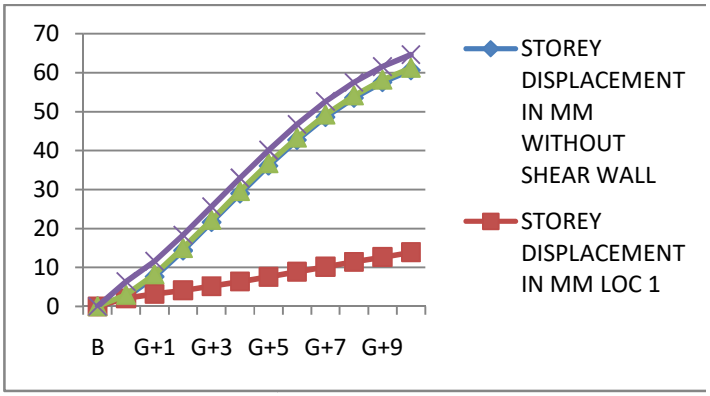
In this work, seismic and wind load analysis is conducted on four types of reinforced cement concrete (RCC) structures, with a focus on seismic Zone II, which indicates moderate seismic activity. Initially, an RCC frame structure is created using STAAD Pro, and seismic and wind loads are applied according to the relevant standards. Shear walls are strategically placed at different locations within the RCC structure to evaluate their impact on the building's performance under seismic forces. The analysis is then repeated for each configuration, and the results, including parameters such as storey displacement, storey drift, and base shear, are compared to identify the optimal frame design that can best resist seismic effects. The outcomes of these analyses are plotted to provide a clear visualization of the performance variations between the different RCC frame configurations, ultimately helping to determine the most effective shear wall placement for enhancing structural stability and resilience against seismic and wind loads.



Graph: Storey displacement for combined load.

The graph above represents the storey displacement on G+10 RCC frame with and without shear wall. The x axis represents number of storey and y axis represents storey displacement. Three types of locations and without shear wall used in this analysis.. The storey displacement increases when there is increase in storey. From the graph it is seen that the shear wall location 1 has minimum storey displacement compared to others.

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Graph: storey displacement for EQ load.

The graph above represents the storey displacement on G+10 RCC frame with and without shear wall. The x axis represents number of storey and y axis represents storey displacement. Three types of locations and without shear wall used in this analysis.. The storey displacement increases when there is increase in storey. From the graph it is seen that the shear wall location 1 has minimum storey displacement compared to others.

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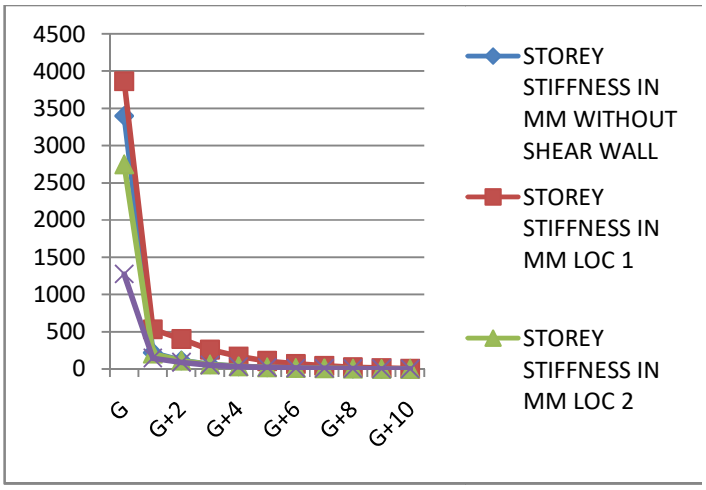
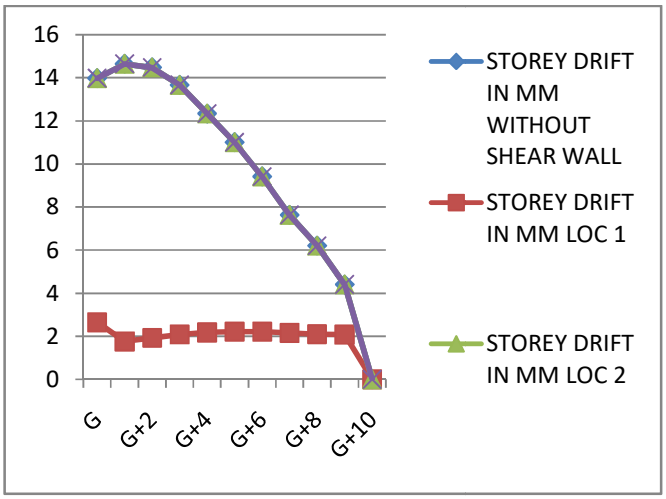


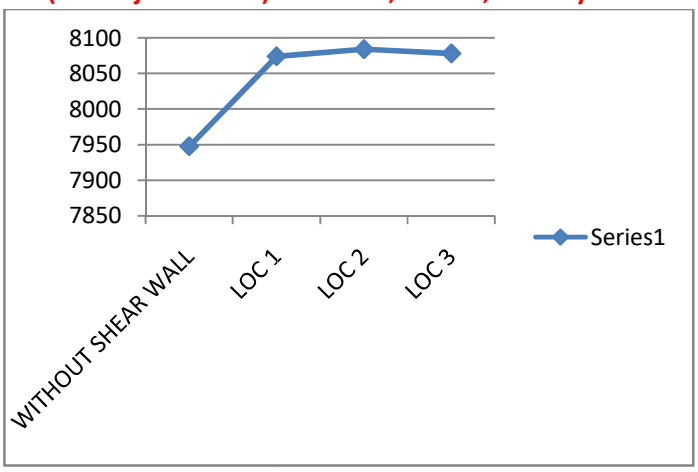
Fig: Storey stiffness for G+10 building.

The graph above represents the storey stiffness on G+10 RCC frame with and without shear wall. The x axis represents number of storey and y axis represents storey displacement. Three types of locations and without shear wall used in this analysis.. The storey displacement increases when there is increase in storey. From the graph it is seen that the shear wall location 1 has minimum storey Stiffness compared to others.



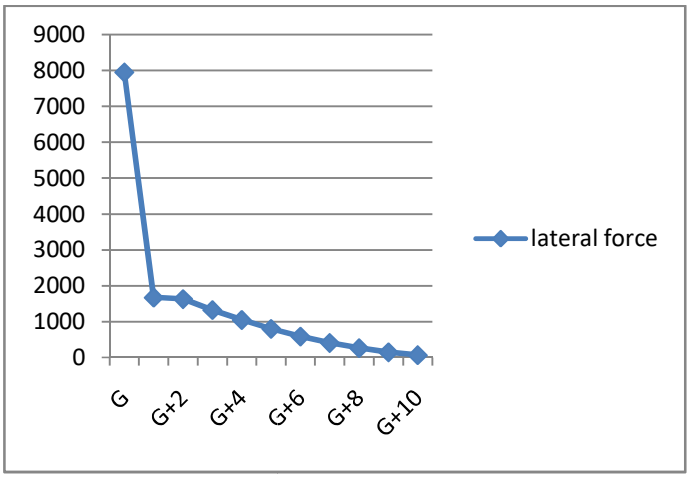
Graph: Storey drift in mm.

The graph above represents the storey Drift on G+10 RCC frame with and without shear wall. The x axis represents number of storey and y axis represents storey displacement. Three types of locations and without shear wall used in this analysis. The storey drift decreases when there is increase in storey. From the graph it is seen that the shear wall location 1 has minimum storey drift compared to others.



Graph: Base shear of building.

The graph above represents the base Shear on G+10 RCC frame without shear wall. The x axis represents number of zones and y axis represents base moment. Shear wall at location at 12 having maximum base shear.



Graph: Lateral force on building.

The graph above represents the lateral force on G+10 RCC frame without shear wall. The x axis represents number of storey and y axis represents lateral force. The lateral force will slowly decreases and when it reaches g+1 it gradually decreases downwards.

Conclusion

Shear walls are among the most effective structural elements for resisting lateral forces during earthquakes and high winds. By incorporating shear walls, the damage caused by these lateral forces can be minimized. Shear walls provide significant stiffness to buildings, which reduces structural damage and protects both the building and its contents. Additionally, shear walls help accommodate large populations in limited spaces, making tall structures with shear walls an ideal solution for densely populated urban areas. In this work, a G+10 multi-storey building is analyzed, initially without shear walls, and then with various shear wall configurations. The seismic analysis evaluates key parameters such as base shear, storey displacement, lateral forces, and storey stiffness for each shear wall location. Among all models,

the shear wall location 1 exhibits the highest performance, with base shear, moment, lateral forces, and storey displacement values increased fivefold compared to the RCC frame model. The combination of shear walls and RCC frames offers improved stiffness and helps reduce structural damage. Therefore, in developing nations like India, shear wall construction is considered a critical component for the growth of the construction industry, ensuring safer and more resilient buildings.

References

IS codes for reference

Earthquake Resistance: IS 1893 (Part 1): 2016.

Wind Load: IS 875 (Part 3): 2015.

Dead Load: IS 875 (Part 1): 1987.

Live Load: IS 875 (Part 2): 1987.

Concrete Design: IS 456: 2000.

1. Mayuri D. Bhagwat, Dr. P.S. Patil, "Comparative Study of Performance of RCC Multistory Building For Koyna and Bhuj Earthquakes", *International Journal of Advanced Technology in Engineering and Science*, Volume 02, Issue 07, July 2014, ISSN (online): 2348-7550.

2. Himanshu Bansal, Gagandeep, "Seismic Analysis and Design of Vertically Irregular RC Building Frames", *International Journal of Science and Research (IJSR)*, ISSN (Online): 2319-7064, Impact Factor (2012): 3.358.

3. Mohit Sharma, Dr. Savita Maru, "Dynamic Analysis of Multistoried Regular Building", *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)*, eISSN: 2278-1684, p-ISSN: 2320-334X, Volume 11, Issue 1 Ver. II (Jan. 2014), PP 37-42, www.iosrjournals.org.

4. A. B. M. Saiful Islam*, Mohammed Jameel, and Mohd Zamin Jummat, "Study on Optimal Isolation System and Dynamic Structural Responses in Multistorey Buildings", *International Journal of the Physical Sciences*, Vol. 6(9), pp. 2219-2228, 4 May 2011, ISSN 1992-1950, DOI: 10.5897/IJPS10.441.

5. A. S. Patil and P. D. Kumbhar, "Time History Analysis of Multistoried RCC Buildings for Different Seismic Intensities", ISSN 2319-6009, *www.ijscer.com*, Vol. 2, No. 3, August 2013, © 2013 IJSCER.

6. Md. Arman Chowdhury, Wahid Hassan, "Comparative Study of the Dynamic Analysis of Multi-storey Irregular Building with or without Base Isolator", *International Journal of Scientific Engineering and Technology (ISSN: 2277-1581)*, Volume 2, Issue 9, pp. 909-912, 1 Sept. 2013.

7. P. P. Chandurkar, Dr. P. S. Pajgade, "Seismic Analysis of RCC Building with and Without Shear Wall", *International Journal of Modern Engineering Research (IJMER)*, www.ijmer.com, Vol. 3, Issue 3, May June 2013, pp. 1805-1810, ISSN: 2249-6645.

8. Prof. S.S. Patil, Miss. S.A. Ghadge, Prof. C.G. Konapure, Prof. Mrs. C.A. Ghadge, "Seismic Analysis of High-Rise Building by Response Spectrum Method", *International Journal Of Computational Engineering Research (Ijceronline.Com)*, Vol. 3, Issue 3.

[9] Kirtan. T, N. Jayaramappa, "Comparative Study of Multi-Storey RC Frame With Shear Wall and Hexagrid System" ParipexIndian Journal of Research, Volume: 06, Issue: 01, pp. 814-817, ISSN 2250-1991, January 2017

[10] Jayesh Venkolath, Rahul Krishnan K, "Optimal Diagrid Angle of High-Rise Buildings Subjected to Lateral Loads" International Research Journal of Engineering and Technology (IRJET), Volume: 03 Issue: 09, pp. 841-846, e-ISSN: 2395 -0056 p-ISSN: 2395-0072, September 2016