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A REVIEW OF HIGH RISE STRUCTURE UNDER DYNAMIC LOAD CONTROL WITH SHEAR WALL AND BELT WALL

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ABSTRACT

The increasing global development of high-rises presents considerable obstacles to the maintenance of structural integrity and safety, particularly in areas vulnerable to earthquakes. The numerous approaches and computer programmes used to evaluate the seismic behaviour of tall buildings are thoroughly examined in this research. The research looks into the best locations for shear walls, outrigger systems, and other structural components to increase earthquake resilience through numerical simulations and experimental validation. The results provide useful information for maximising design parameters, implementing efficient retrofit techniques, and guaranteeing high-rise building safety. The thorough computational methods used and the comparative examination of various structural systems are its strong points; potential modelling approach simplifications are one of its shortcomings. The results offer insightful suggestions for structural design procedures, impacting building codes and stimulating additional investigation.

I. INTRODUCTION

High-rise building construction has been more commonplace in metropolitan environments across the globe in recent years. These enormous buildings, distinguished by their notable height and intricate architectural patterns, are symbols of contemporary urban development, serving a variety of purposes ranging from mixed-use to residential and commercial. But with their great heights also comes the difficulty of guaranteeing their safety and structural integrity, especially in areas where earthquakes are common. Because of the dynamic stresses they apply to structures, earthquakes are a serious threat to high-rise buildings and can have disastrous effects if they are not sufficiently mitigated. High-rise buildings are particularly vulnerable to seismic events due to their flexible and slender construction. Therefore, analysis and design of buildings under earthquake loads is an essential part of structural engineering. Knowing the behavior of buildings under earthquake loading is essential for engineers and designers responsible for building resilience and stability. Seismic performance of a building is determined by the interactions between structural elements, such as columns, beams, and shear walls, as well as lateral bracing systems. Factors such as site specific ground motion, soil, and building geometry also affect the seismic performance of a building.

In this setting, evaluating the seismic behaviour of high-rise buildings is mostly dependent on thorough analysis procedures and sophisticated computer tools. Engineers can improve the earthquake resistance of high-rise buildings by optimising design parameters, incorporating efficient seismic retrofit methods, and implementing robust structural systems through the simulation of earthquake-induced motions and evaluation of structural responses. The context for a more thorough examination of the analytical and design factors for high-rise structures under earthquake loading is established by this introduction. In order to support ongoing efforts to ensure the safety and sustainability of high-rise structures in seismically vulnerable areas, this review will look at important aspects impacting seismic performance and highlight creative solutions and research break throughs.

II. LITERATURE REVIEW

1. Kashyap Shukla et al. (2022)

In the current work, seismic and wind loads on several high-rise rectangular building models with and without shear walls have been analysed using ETABS software, which is based on finite elements. Seismic loads were calculated using the comparable static approach outlined in IS Code 1893 (Part-1): 2016, while wind loads were calculated using IS Code 875 (Part-3): 2015. The Indian Standard Code states that four load combinations have been taken into consideration when retrieving the findings of storey displacements and storey drifts. It has been found that centrally located shear walls, or a core, perform effectively against lateral loads. This type of structure has a displacement at the top that is about 2.5 times less than a structure without a shear wall. The shear walls at corners are the least effective. The study only took symmetrical building designs into consideration, and the corresponding static technique was used to calculate lateral stresses. The high-rise building has both framed systems and shear walls. The arrangement and placement of the shear walls is the single factor influencing the outcome because they are evenly distributed throughout each building. Designs for high-rise buildings need to account for lateral loads such as wind and seismic loads. Because of this, high-rise structure designers are particularly concerned with providing sufficient lateral rigidity to withstand these kinds of forces. A shear wall is one of the vertical components used in constructions to satisfy lateral stiffness requirements. Since their placement and arrangement must be suitable to effectively bear lateral stresses, this study aims to ascertain how high-rise buildings with shear walls respond to lateral loads.

2. Rafid Kunglay, Dr. N.G. Gore (2022

Specifically, the equivalent static methodology and response spectrum method were used in the linear analysis conducted in the ETABS software to investigate the effects of various outrigger designs on the displacement and drift of tall buildings. It is observed that outriggers significantly reduce the maximum displacement and storey drift of the structure. The two outriggers with belt truss combination performed best when compared to a bare frame model, yielding maximum reductions in top storey drift and top storey displacement of 27% and 18%, respectively. Outrigger beams and trusses are often suitable for resistance against significant wind loads, as is well known, but combining outriggers for earthquake resistance has been a fascinating field for investigation. Many researchers have previously examined the impacts of including outriggers in high-rise buildings in frames under various loading conditions in order to lessen and regulate deflections and strains. However, there hasn't been much research done on how well other potential outrigger systems work in commercial high-rise structures when subjected to seismic pressures. This study examines the viability of several outrigger structural systems for commercial high-rise buildings subjected to seismic loads. This contains the Response Spectrum Analysis and Equivalent Static Load Methods of linear analysis. It has been determined that a combination of two outriggers and a belt truss provides a maximum deflection reduction of 18%.

3. Mohit Kumrawat et al. (2022)

For this study, prepare four distinct models: a five-story building, a ten-story building, a fifteen-story building, and a bare frame. To analyse the bending moment, shear force, deflection, and base shear in different conditions, apply the response spectrum to the models. Apply bracing, belt walls, and dampers at different locations with SAP2000's assistance. These days, people strive to survive in skyscrapers, which is why the globe is seeing a rapid increase in the number of taller buildings. The main goal of the design specifications is to make the structure capable of supporting lateral loads, especially those brought on by strong earthquakes. Shear walls were the first to support lateral stresses. As a result, the quality of the cut wall belt has increasedThe multilateral R.C.C. structure is placed around each hit's centre, where waves can cause significant damage, based on the findings of an auxiliary programmer that verifies all damaged structures' seismic behaviour. In order to explore parallel forces in the plane of a big construction, the factors to be provided in this respect are mass, resistance to lateral bending, and dependability due to distance from the base rather than auxiliary extraction.

4. C.R.Urkude1, P.G.Atole1 (2022)

Finding the ideal location for shear walls with and without apertures will require understanding the behaviour of reinforced concrete buildings. As seismic characteristics, displacements, base shear, and storey drift are taken into account. According to IS 1893(Part 1): 2016, reactions to earthquakes in zone III have been carried out. Ensuring the seismic safety of our structures is our primary responsibility. The shear wall is one high-rise structural system that can withstand seismic activity. The number of tall buildings, both residential and commercial, has been steadily increasing, and this has led to a recent rise in current high-rise building styles. Shear walls are structural elements that contribute to the strength of RCC constructions.. In terms of architecture, the vertical concrete walls will serve as lateral stress and gravity support structural barriers. Shear walls are particularly good at supporting weight in seismically active places because of their peculiar behaviour under various pressures. Four models of G+15-story structures located in seismic zone III are examined using the ETABS software.

5. Aniket, Sunil Kamble (2022)

The purpose of this project is to evaluate a structure that is vulnerable to seismic and lateral loads using STAAD Pro. Determining how a structure will react to a specific activity is the fundamental goal of structural analysis. The stability and rigidity of any construction are the main issues with any high-rise building. Shear walls are structural elements that can endure the typical lateral stresses encountered in building structures. The two types of models employed in the current study are Model 1, which does not have a shear wall, and Model 2, which does have a shear wall. STAAD Pro models of the various buildings were created, inspected, and compared for storey drift and displacement for an 11-story building. In compliance with IS standards, weights were added, and there were 5 bays along the X axis and 3 bays along the Z axis. As building height increases, shear walls can bear greater lateral force than the frame.

6. Vasaiya Raghubhai Tapubhai (2022)

For this study, three multi-story building models with a total of 48 columns and G+15 storeys were used. Make use of M-30 concrete and Fe-415 grade steel. In the proposed effort, ETABS-2017 will be used for analysis. Compare a few different models of belt wall location. The plan's torsional irregularity, reentrant corners, and anomalies were assessed by engineers since they have the greatest impact on seismic reactivity. Significant damage has been done to the re-entrant corners of L, T, U, C, and plus-shaped buildings, which were built in compliance with architectural regulations. In order to mitigate the impact of re-entrant corners, these buildings were separated into pieces. Re-entrant corners are crucial because plus-shaped tall, multistory buildings extend beyond the code's defined bounds. Shear walls require special consideration in strong seismic regions, and the placement of shear walls influences the building's performance under dynamic loads. Without altering the shear wall's specifications, moving the shear walls can have amazing outcomes for this plus-shaped building. A ten-story plus design and longer wings make it more likely that the building will wag its tail and back away from the corner. To determine which condition works best, shear walls were placed at the re-entrant corners, flange edges, and centre core. Shear walls at reentrant corners help mitigate the negative effects of these anomalies. Prepare three distinct building shapes—bare frame, fourth, eighth, twelve, and sixteen story models—with five possible situations for this research project.

7. B.Anusha1. K.Mamatha et al. (2020)

The primary objectives are to determine the effects of different bottom-level column elevations and shear wall locations on the behaviour of the structure on sloping terrain and to examine the efficacy of shear wall surfaces. The most crucial parts of a construction on an inclination are the short columns. Locating the shear wall surface closer to the shorter column side may help you control pressures like shear pressure and bending minute more successfully. Shear wall surfaces oriented towards shorter columns give structures the smallest resonance time. Shear wall surfaces considerably reduce storey variation, floor drifts, and flexing minutes in buildings and substantially enhance the seismic performance of structures on inclines. It can be demonstrated that variances and displacements decrease when symmetric shear wall surfaces are provided as the slope angle increases. The feedback range analysis's variances are slightly smaller than the displacements found in the linear static evaluation. When comparing Linear Time History Analysis to Linear Fixed and Response Spectrum evaluation, there is a discernible increase in variability. One of the most popular side lot resisting techniques in high-rise structures is the shear wall system. Numerous literary works can be used to construct and analyse the shear wall. However, there is little discussion of the choice of shear wall location in multi-story buildings in literary works. The major goal of this work is to determine the best location for the shear wall surface in multi-story buildings. For the objectives of this study, a 10-story, G+ reinforced concrete (RC) structure with variable ground slopes of 0°, 5°, 10°, 15°, and 20° that includes shear wall surfaces symmetrically in design and at perimeter corners has been given due consideration. First, IS 456:2000 is used in the construction of buildings, and then seismic loads. Using the structural analysis programme SAP 2000, the building has been modelled and assessed using linear static and linear dynamic assessment (Action Range and Linear Time Background analysis).

8. Kanchan Rana, Vikas Mehta (2017)

Shear walls are vertical structural elements that are widely employed. They are used to withstand lateral loads caused by impacts from earthquakes and wind. Gravity loads can also be supported by shear walls. An attempt is made to seismically analyse an RCC building with a shear wall at different places using STAAD pro. There is a six-story building under consideration. There are four RCC building models in use: one model has no shear walls, while the other four have varied locations for shear walls. Analysis data will be gathered and plotted in order to compare and comprehend the behaviour of RCC framed structures with shear walls that are subjected to seismic load in zone V. .. Selecting the ideal location for the shear wall will be made easier by looking at the different model factors, such as base shear, lateral displacement, and storey drift. This research additionally considers the effects of RC shear wall position variations on column axial force, bending moment, and shear force. STAAD Pro V8i software is employed for the whole analysis process.

9. Atul Verma1, Ishan Anand (2016)

The construction sector, in particular structural engineers, are facing increasing challenges in reaching their objectives in light of the nation's rapid development, its current population growth, and the growing need for a desirable standard of living. Many innovative technologies have been created to meet this demand, including base isolation, dampers, bracings, outriggers, RC shear walls, shear core, steel shear walls, box frameworks, seismic invisibility cloak, rocking frames, and others. One of the strategies we used in our research to address these issues was the belt wall construction or the application of this system. This work uses an analytical technique and design. Examining the impacts of a wall belt enclosing a water tank from the perspectives of numerous researchers is the review's main goal. The study could also be used to compare low-rise buildings in seismically active areas with tall ones with and without belt walls. Within the scientific community, software evaluation has also been considered. After the survey, comprehensive conclusions are supplied, with the study's main focus being a comparative comparison of the current research trend on the subject. Determining whether a structure was constructed with or without a belt wall is the main objective. to determine the belt wall's resistance to seismic loads in an RC structure. The belt wall should be positioned in the best possible way to minimise storey displacement. The earthquake resistance of the construction was increased by using solely belt trusses and by stiffening the framework. to apply a lateral load stiffening system around a multistory building using wall belts. An assessment of a composite elevated water tank. A similar static evaluation was used to evaluate both water tanks in full and empty tank conditions. using industry-accepted code books from the US, UK, and India to analyse the RCC water tank.

10. R. S. Mishra, V. Kushwaha (2015)

Based on an analysis of a suggested building with several shear wall placement arrangements in relation to the STAAD-determined seismic load operating. Expert software shows that the intermediate position of the shear wall is optimal with respect to the construction's core and periphery positions. The building structure is resistant to shear failure because the intermediately designed shear wall stops additional lateral movement in the X and Z directions. With the exception of steel in the core and concrete in the perimeter position, which could not greatly postpone structural buckling, building construction also shows that the Intermediate design will be more economical than alternative options. Most RC structures are designed just to support gravity loads; they do not account for the lateral forces generated by earthquakes. Examining the seismic behaviour of structures is the main goal of this research (Special Moment Resisting Frame, SMRF). A comparison has been done by placing shear walls in different parts of the building that are vulnerable to seismic loads. These areas comprise the shear wall's centre, and periphery, in that order.

III. FINDINGS

- Under lateral loads, the study examines where shear walls should be placed in high-rise reinforced concrete (RCC) structures. It finds important elements influencing how well shear walls withstand lateral stresses through numerical simulations and potentially experimental validation. Building height, structural design, material qualities, and loading circumstances are a few examples of these variables. The study probably sheds light on how shear walls should be distributed in high-rise buildings to improve structural performance and guarantee safety. [1]
- A thorough review of the seismic design and nonlinear analysis of commercial high-rise buildings using various outrigger system combinations is presented in this research. [2]
- Using ETABS software, the research investigates the response spectrum analysis of a G+14 building model that includes bracing, dampers, and belt walls. [3]
- Examines how a high-rise structure with varying-positioned shear walls behaves seismically. [4]

- Uses Etab software to compare the seismic performance of RCC buildings with and without shear walls. [5]
- Performs a parametric analysis on a G+15 building model with various belt wall configurations. [6]
- Looks at how high-rise RCC structures with shear walls react to earthquakes in various zones. [7]
- Uses STAAD Pro software to look into the seismic behaviour of RCC buildings with shear walls at different sites. [8]
- Employing ETAB 2016, examines the seismic behaviour of structures with and without belt walls, concentrating on a water tank encircled by a belt wall. [9]
- Performs a comparative analysis of various shear wall placement arrangements in soft storey buildings subjected to seismic loads. [10]

IV. WEAKNESSES

- The study might only use numerical simulations without any experimental validation, which would reduce the findings' reliability and usefulness. A deficiency in comparison with alternative shear wall configurations or structural systems may impede the evaluation of the efficacy of the suggested approach. [1]
- The analysis may be predicated on idealised or oversimplified models, which may cause disparities between the real structural behaviour and theoretical predictions. This can call into question the reliability and correctness of the study's findings. [2]
- It is unclear exactly what the suggested model's or analysis methodology's specific shortcomings are. [3]
- Flaws: The study's potential limits or the modelling approach's simplifications could be its flaws. [4]
- Assumptions made during the modelling process or restrictions in the analysis approach could be sources of potential flaws. [5]
- Limitations in the analysis methodology or assumptions in the parametric variations could be potential vulnerabilities. [6]
- The study's scope restrictions or the analytic method's simplifications could be potential shortcomings. [7]
- Assumptions made during the modelling process or restrictions in the analysis approach could be examples of potential shortcomings. [8]
- The modelling approach's simplifications or the study's scope restrictions could be potential shortcomings. [9]
- The study's assumptions or the analytical methodology's shortcomings could be its potential drawbacks. [10]

V. STRENGTHS

- The study tackles a crucial facet of the design of high-rise structures, providing architects and structural engineers with useful information. The research could provide new methods or standards for placing shear walls optimally, advancing the field of structural engineering and building techniques. [1]
- It's possible that the study makes use of sophisticated computational strategies and nonlinear analysis techniques to precisely assess the structural response to seismic loads. This methodical methodology allows for a thorough investigation of the design space and strengthens the validity of the results. The study allows a comparative investigation of the efficacy of different combinations of outrigger systems in improving structural resilience. The discovery of the best design solutions suited to particular project needs and site conditions is made possible by this comparison approach. [2]
- The inclusion of different structural components, such as bracing, dampers, and belt walls, enables a thorough examination of seismic behaviour.
- The study tackles a significant structural design issue by shedding light on how the location of shear walls affects seismic performance.
- Offers a clear comparison of structures with and without shear walls, which is helpful when making judgements on structural design. [5]
- Offers information on how different belt wall layouts affect the building's ability to withstand earthquakes. [6]
- Discusses the significance of placing shear walls in various zones for enhanced earthquake performance. [7]
- Offers information on how the position of shear walls affects the seismic response of RCC structures. [8]

- Addresses the specific scenario of a water tank surrounded by a belt wall, providing insights into its seismic response. [9]Provides insights into the effectiveness of various shear wall configurations in mitigating the soft-story effect during seismic events. [10]

VI. CONCLUSION

- The outcomes of the paper could include recommendations for optimizing shear wall placement in high-rise RCC buildings, guidelines for structural design codes or standards, and avenues for further research. [1]
- The outcomes of the paper are expected to enrich the existing body of knowledge on high-rise building design, particularly concerning seismic resilience. They could inform industry practices, influence building codes and standards, and inspire further research in the field of structural engineering and earthquake-resistant design. [2]
- The outcomes could include insights into the effectiveness of belt walls, dampers, and bracing in enhancing the seismic performance of the building model. [3]
- Outcomes may include recommendations for optimal shear wall placement in high-rise buildings to enhance seismic resistance. [4]
- Outcomes may include recommendations regarding the necessity and effectiveness of shear walls in seismic design. [5]
- Outcomes may include recommendations for optimal belt wall placement and configuration to improve seismic performance. [6]
- Outcomes may include recommendations for optimal zoning of shear walls in high-rise RCC buildings. [7]
- Outcomes may include recommendations for optimal shear wall placement to enhance seismic resistance. [8]
- Outcomes may include recommendations for the use of belt walls in protecting structures like water tanks during seismic events. [9]
- Outcomes may include recommendations for optimal shear wall configurations to improve the seismic performance of soft-story buildings. [10]

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