A Review on Seismic Analysis of a High-Rise RCC Building Provided with The Shear Wall, Bracing System, And Combination of Both.

SURAJ R. DHEKALE[1], PROF. R. D. PATIL[2]

[1] PG student Department of Civil Engineering, Rajarambapu Institute of Technology, Rajaramnagar: Islampur, Maharashtra, India

[2] Department of Civil Engineering, Rajarambapu Institute of Technology, Rajaramnagar: Islampur, Maharashtra, India

Abstract— ***The analysis of an RCC structure with a shear wall, bracing system, and combination for a high-rise, G+30 RCC building in seismic zone III is presented in this manuscript review. The current need for high-rise building development is growing daily as a result of the city's increasing urbanization and land scarcity. A suitable structural system is always required for tall buildings in order to transfer lateral loads. There are various structural techniques that are typically employed to stabilize tall buildings. Outrigger systems, tube systems, bundled tube systems, core shear wall systems, fluid viscous damper systems, bracing systems, etc. are a few of them. Among these, lateral bracing systems are commonly utilized to meet serviceability and design objectives by increasing the lateral strength and stiffness of structures up to thirty to forty stories tall. The building's displacement capability is increased by the bracing system. Although these seismic provisions are frequently employed, this analysis will examine which one is best suited for stabilizing the RCC building based on the seismic zone. Seismic zone III analysis utilizing ETABs software will be done in this assignment. Examine the best location for the bracing system, shear wall, and combination of these effects in the RCC building, and then examine the reactions that resulted (base shear, story drift, and story displacement).***

Index Terms— ***RCC building, Shear wall, Bracing system, ETABs.***

I. INTRODUCTION

One of the catastrophic events that most engineers in the building sector face is earthquakes [2]. It results in fatalities as well as significant financial losses from buildings that are damaged. Structural engineers have been studying the assessment and characterisation of structural damage over the past few decades. The various methods used to characterize damage at the component, element, or structural level, including ductility, drift ratio, maximum deformation, strain softening, and energy dissipation characteristics [5]. Two excellent architectural solutions that can be used to increase seismic enactment are shear walls and bracings. The overall performance of the structure is significantly improved by the shear wall as compared to the bare frame [1]. The number of high-rise structures being constructed is rising daily.

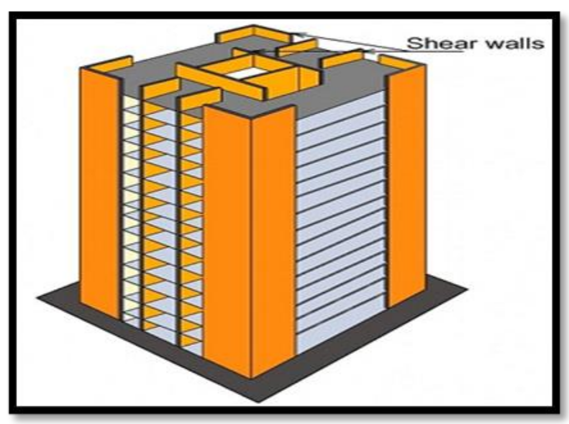

Fig.1 RCC building with shear wall (https://www.designingbuildings.co.uk/wiki/Shear_wall)

In the realm of structural engineering, shear walls play a pivotal role in providing lateral stability to buildings, effectively resisting horizontal forces such as wind and seismic loads. As a fundamental structural element, shear walls contribute significantly to the overall performance and safety of structures in the face of dynamic forces. This review paper delves into the extensive body of research surrounding shear walls, aiming to provide a comprehensive understanding of their design, behavior, and performance. From classical theories to modern advancements, this review synthesizes the key findings and methodologies employed in the analysis and design of shear walls. By exploring a diverse range of studies, the paper aims to contribute insights into the evolving landscape of shear wall engineering, addressing challenges, innovations, and implications for current and future structural design practices. With a focus on both theoretical frameworks and practical applications, this review aims to serve as a valuable resource for researchers, practitioners, and academicians engaged in the field of structural engineering and construction.

Fig.2 RCC building with bracing system (https://www.designingbuildings.co.uk/bracing)

Bracing systems is crucial for enhancing the stability and resilience of buildings under lateral loads, such as those induced by seismic events or wind forces. Among the various bracing systems, structural steel bracing stands out as a widely adopted and effective solution. This review paper delves into the extensive body of research dedicated to structural steel bracing systems, aiming to offer a comprehensive exploration of their design principles, behavior, and practical applications. From classical approaches to contemporary innovations, this review synthesizes key findings from a diverse range of studies, providing a nuanced understanding of the performance and advantages of structural steel bracing. Through an examination of both theoretical frameworks and practical case studies, the paper endeavors to contribute valuable insights to the evolving landscape of structural engineering. By addressing challenges, highlighting advancements, and elucidating implications for current and future design practices, this review aspires to serve as an informative resource for researchers, engineers, and professionals engaged in the dynamic field of structural engineering and construction.

II. LITERATURE REVIEW

Konstantinos I. Christidis ⇑, Konstantinos G. Trezos (February 2017) “Experimental investigation of existing non-conforming RC shear walls”.
In the present study, the research involved testing four reinforced concrete shear walls under static cyclic loading. The study found that low shear reinforcement ratios did not significantly impact bearing or top deformation capacity but influenced the cracking pattern, leading to inclined cracks without a direct loss of bearing capacity. The interaction between flexure and shear accelerated wall failure, resulting in lower ductility and energy dissipation compared to walls designed to modern seismic standards. The sudden loss of bearing capacity was linked to compressive zone deterioration and buckling of compressive longitudinal reinforcement. Comparison with EC8-3 provisions indicated conservative estimates for ultimate displacement using the empirical equation but closer values with the analytical expression. However, the latter applies only to specimens designed according to modern regulations, and EC8-3's attempt to incorporate shear strength degradation was found to underestimate shear strength capacity in non-conforming shear walls. Safety and importance factors were not considered in the calculations, impacting the conclusion about EC8-3's accuracy in estimating shear strength.

Shaik Akhil Ahamad, K.V. Pratap (August 2020) “Dynamic analysis of G + 20 multi storied building by using shear walls in various locations for different seismic zones by using Etabs”.
In this research the research findings indicate that seismic Zone V exhibits higher maximum displacement and storey drift values compared to Zones II, III, and IV. The study underscores the importance of uniform stiffness in reducing displacement, with the most favorable results observed in Case C, where shear walls are placed at four ends.

Base shear values vary across seismic zones, emphasizing the need for uniform stiffness to distribute lateral loads. Torsional irregularity is noted in Case C, suggesting a requirement for additional stiffness to reduce displacements in all seismic zones in India. Despite discrepancies in time periods, as per IS 1893:2016 (Part-1), the building is deemed safe from resonance effects.

Tulay Aksu Ozkula, Ahmet Kurtbeyoglub, Muzaffer Borekcic, Basak Zengind,

Ali Kocakc (February 2019) " Effect of shear wall on seismic performance of RC frame buildings".
The substantial influence of shear walls on the seismic performance of reinforced concrete buildings is highlighted by this study. Shear barriers affect drift ratios, displacement needs, and first-mode periods, according to ETABS dynamic analysis. The study highligh0ts that stronger and more ductile shear walls lower the amount of damage to structural parts, especially beams and columns. Shear walls with proper design have a significant impact on seismic performance; shear walls with insufficient reinforcement do not improve performance. The study also emphasizes the significance of precise modeling, stressing the necessity of using fictive stiff beams with circular sections and frame elements for shear walls to get trustworthy results in nonlinear analysis. Furthermore, nonlinear time history analysis used in performance-based evaluations closely matches actual building performance.

Shubham S. Shinde, H. S. Jadhav (July 2023) "Dynamic Analysis of Multistory Building with and Without Shear Wall and Bracing System"
The research compares the effectiveness of Shear Wall Systems and Bracing Systems in seismic-resistant structures. For Shear Wall Systems, the model with shear walls along the periphery outperforms others, showcasing a 53% reduction in displacement and a max story drift about one-fourth that of a normal building without lateral load resistance. In contrast, the Bracing System, particularly the X-type bracing, demonstrates a 30% reduction in displacement and a max story drift half that of a normal building. Overall, the study concludes that the Shear Wall System with periphery placement is more efficient than the Bracing System in enhancing seismic performance.

Krupaben J. Patel, Dhruvkumar h. Patel "Different types of bracing system in multi-story RCC building"
The research highlights the positive impact of steel bracing systems on the displacement capacity, lateral stiffness, and shear strength of reinforced concrete structures. The effectiveness of different bracing configurations varies based on the building shape: Diagonal bracing is more efficient for Square-shaped buildings, X-type for I-shaped, Inverted V-type for T-shaped, and X-type for L-shaped structures. Additionally, the study suggests that introducing bracings can enhance base reaction values in seismic-resistant designs. Overall, the findings emphasize the significance of tailored bracing strategies in improving the seismic performance of diverse building shapes.

O. Esmaili, S. Epackachi, M. Samadzad and S.R. Mirghaderi "Study of Structural RC Shear Wall System in a 56-Story RC Tall Building"
the research underscores the importance of recognizing time-dependent effects in the design of concrete structures. The presence of differential displacements due to concrete time dependency is highlighted, emphasizing the need for designers to account for varying longitudinal stiffness in structural elements. The study suggests that while seismic bracing systems require a level of ductility for energy absorption, the adverse effects of axial loads on their performance should be carefully considered. The use of shear walls for both gravity and bracing systems is deemed unacceptable, as it not only places seismic loads on the main walls but also subjects them to a significant percentage of gravity loads. Confinement of concrete in shear walls is recommended for increased ductility and stable behavior. The research emphasizes the influence of axial load levels on the R factor, design base shear, and moment of inertia, providing insights into the trade-offs between axial load and cross-sectional area. Furthermore, the study highlights the impact of concrete time dependency on the premature cracking of coupling beams and calls for simultaneous consideration of time-dependent concrete behavior and construction sequence loading in analyses. The critical demands are found to occur in the middle height of the structure, between the 25th and 35th stories.

Shubam Sharma, Aditya Kumar Tiwary (May 2021) "Analysis of multi-story buildings with hybrid shear wall: steel bracing structural system".

In this paper the research aimed to optimize the seismic response of structures by examining critical parameters such as story displacement, drift ratio, base shear, and overturning moment. The study involved 50 different building models and found that the hybrid structural system effectively minimized maximum story displacement and drift ratio with only a slight increase in base shear and overturning moment. The results demonstrated the efficiency of the hybrid structural system (type-1) across various building heights, especially for medium to tall structures. While the overturning moments were relatively high for 10-story buildings, other parameters such as story displacement, drift ratio, time period, and base shear remained under control. The recommendation is to prioritize the hybrid structural system (type-1) for medium to tall structures, as the reduction in parameters compared to buildings with shear walls is substantial for tall structures and only marginally significant for low-rise structures. The significance of this new lateral load resisting system lies in achieving significant reductions in maximum story displacement and drift ratio while maintaining minimal increases in base shear and overturning moment.

M.Gopinath, P.Sathishkumar, K.Sakthivelan, R.Venkatesan (2016) "Seismic Analysis of RC Structure with Shear Wall and Bracing"

The research presents a seismic analysis method for a plane reinforced concrete frame with an open soft storey structure, demonstrating its general acceptability and approximate alignment with more accurate methods. The study observes significant lateral displacement in frames with soft storeys, highlighting the efficacy of introducing shear walls in both X and Z directions to minimize corner column displacement. The overstrength in braced reinforced concrete frames is attributed to the added strength from the brace system and the stiffening effects of connections. The number of braced bays is identified as a crucial parameter influencing capacity interaction. Structures without braced frames exhibit weaker seismic performance, with higher ductility values noted for structures with bracing systems. The study utilizes STAAD.Pro software to create models, employing static seismic analysis to calculate displacement and storey drift. Graphical comparisons of displacement vs. storey level and storey drift vs. storey level support the findings, providing valuable insights into the seismic performance of structures with and without bracing systems.

Vineeth Vijayan, M Helen Santhi, Romy Mohan (2020) "Seismic Performance of High Rise Buildings with Different Types of Shear Wall"

The research concludes that replacing normal RCC shear walls with steel-silica fume concrete composite shear walls in aesthetic tall buildings enhances seismic resistance and provides attractive structural properties. The advantages of the composite shear wall include a significant reduction in storey drift, especially as the number of storeys increases. Compared to normal shear walls, the composite shear wall demonstrates a substantial reduction of nearly 60% in displacement, highlighting its effectiveness in minimizing seismic effects. Additionally, the study underscores the significant role of the composite shear wall in reducing storey shear, emphasizing its positive impact on the overall seismic performance of aesthetic tall buildings.

III. SUMMARY OF LITERATURE AND GAP

Literature is carried out on In literature survey it's seen that, the different researchers have studied the on different types of problems and parameters related to the seismic loads acting on multi-storeyed buildings. The models are created on different analysis software such as ETAB's, and STAAD Pro. The different conditions have also been applied as in the shear wall system, the shear wall at different locations to find minimum storey drift and displacement. In the bracing system, the research is also developed on the provision of different cross sections, the comparison in between types of bracing according to the shape of the building, the angle between the bracing is made The further scope of study is to compare these two lateral load resisting system in according with parameters as location, types by considering the certain method of analysis. Results and Discussion

Authors analyzed buildings independently with either Bracings or Shear walls. Authors used different types of bracings independently to check the seismic parameters of the structure. Most of the authors concluded that results of X type bracing are more effective than the other type of bracing. Authors used different types of Shear wall independently to check the seismic parameters of the structure. Most of the researchers used a single type, for placement of shear wall that is either I shape, T shape or L shape. When using combination of shear wall and bracing system, shear wall at core and bracing system at corner is been used.

CONCLUSION

Structure with shear wall at appropriate location is more important while considering displacement and base shear. Shear walls with openings experienced a decrease in terms of strength. A diagonal shear wall was found to be effective for structures located in earthquake-prone areas.

Raising of shear wall up to the entire height of the building is not necessary and it is sufficient to raise the shear wall up to mid-height of the building

Among the four models, (structure without shear wall, structure with L type shear wall, structure with shear wall along periphery, structure with cross-type shear wall) shear wall provided along the periphery of the structure is found to be more efficient.

The bracing system decreases 62 % the maximum story displacement as compared to a plain RCC-framed structure. Story drift is reduced by 77.5% due to the use of LRB against the preliminary RCC framed structure. So, it is clear that for the reduction of story drift, the use of LRB is useful. Since drifting of the story with the relative story during events of earthquakes is reduced in RCC framed structure with LRB. Storey shear is reduced by 83% due to the use of LRB when compared with plain RCC framed structure. Whether it is increased by 67% by using RCC bracing. structure stable during earthquakes due to Lesser story shear keeping the structure safe from sway since lesser lateral forces act during earthquakes. Story stiffness is reduced by 35% due to the use of LRB and is increased by 390% due to the use of bracing when it is compared with preliminary RCC framed structure hence, story stiffness is more, the resistance against lateral deflection while earthquake is more (4).

FUTURE SCOPE

Advanced Material Investigation:
Explore and incorporate innovative materials, such as high-performance concrete and advanced composites, in the construction of RCC buildings. Investigate their seismic performance to enhance the overall structural integrity and resilience.

Dynamic Interaction Studies:
Conduct comprehensive studies on the dynamic interaction between different structural elements, including shear walls, bracing systems, and the main structure. Investigate the impact of these interactions on the seismic response of the building.

Nonlinear Analysis Techniques:
Develop and refine nonlinear analysis techniques to better capture the complex behavior of RCC buildings during seismic events. Incorporate advanced modeling methods, such as fiber element modeling, to simulate the actual response of materials under varying loading conditions.

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