Review on The Study of Dynamic Analysis of Retrofitting Multistorey Reinforced Concrete Structure Using Jacketing And Steel Rapping Techniques

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Abstract- *Retrofitting is a crucial approach for enhancing the performance and durability of aging reinforced concrete (RC) structures, especially those subject to seismic forces. This research paper focuses on the dynamic analysis of multistorey RC structures retrofitted using jacketing and steel wrapping techniques. The study synthesizes findings from 15 research papers, covering various methodologies, results, and recommendations on retrofitting techniques in seismic engineering. The literature reveals that both jacketing and steel wrapping improve structural resilience, but they differ in terms of applicability, cost, and performance. This paper presents a critical review of existing research, identifying trends and gaps, and concludes with potential applications, limitations, and the future scope of work in retrofitting multistorey RC structures*

I. INTRODUCTION

The seismic resilience of reinforced concrete (RC) structures is a critical focus for engineers and urban planners, especially in earthquake-prone regions where the structural stability of multi-storey buildings is essential for public safety. Retrofitting has emerged as a viable solution for enhancing the earthquake resistance of existing buildings without the need for complete demolition and rebuilding. Among the diverse retrofitting techniques, concrete jacketing and steel wrapping are widely adopted for their efficiency, accessibility, and effectiveness in improving the seismic performance of RC structures.

Concrete jacketing, a technique that involves encasing structural elements in additional concrete layers, enhances load-bearing capacity and stiffness, providing increased resilience against lateral seismic forces. This approach is particularly beneficial in regions where high lateral strength and rigidity are required. However, concrete jacketing may increase the weight of the structure and requires skilled labor, which can increase costs. Steel wrapping, on the other hand, involves enclosing structural members in a steel layer, which adds flexibility and ductility to the building without significantly altering its weight. This method is adaptable to irregular building shapes, making it suitable for both low-rise and high-rise structures, particularly in high-seismic regions.

This study synthesizes recent findings on the dynamic performance of these techniques, examining how each method responds under seismic stress and how it influences overall structural stability. By understanding the comparative advantages of concrete jacketing and steel wrapping, this study aims to provide practical insights into selecting the most effective retrofitting technique based on factors such as seismic intensity, building type, and regional construction practices. These findings contribute to the development of safer, more resilient infrastructure in vulnerable areas worldwide.

II. LITERATURE SURVEY

The following summarizes key research papers on retrofitting techniques, including jacketing and steel wrapping, for multistorey RC structures. Each summary presents the , year, research focus, methodology, findings, and key contributions.

1. Smith et al. (2018)

Summary This paper explores the effectiveness of RC jacketing on seismic retrofitting of multistorey buildings. Using both analytical models and realworld data, the s found that RC jacketing significantly improves the load carrying capacity and reduces lateral displacement. The research highlights practical challenges in implementation but underscores the overall efficacy of the method.

2. Zhang and Li (2019)

Summary Zhang and Li examined steel wrapping techniques on multistorey buildings in highly seismic areas. Through finite element modeling, they found that steel wrapping provides a notable reduction in inters Torey drift and enhances shear strength. This paper emphasizes the technique's adaptability to various structural layouts and identifies potential areas for improvement.

3. Choudhury et al. (2020)

Summary Investigating both jacketing and steel wrapping, Choudhury et al. conducted comparative analyses to evaluate the effectiveness of each method. The study concluded that while both techniques improve seismic resistance, jacketing is more cost-effective for lower seismic zones, whereas steel wrapping provides superior performance in higher seismic areas.

4. Kaur and Singh (2021)

Summary This study assessed the dynamic response of RC structures retrofitted with steel wrapping. The findings revealed that steel wrapping significantly reduces vibrations and displacement under seismic forces. The s noted the high material costs but highlighted the method's long-term benefits in reducing maintenance costs.

5. Khan et al. (2021)

Summary Khan et al. focused on the benefits of fiber reinforced jacketing on RC frames. Their analysis showed an increase in energy absorption and ductility in the structure. They noted that although this method is more time-consuming, the enhanced durability and life expectancy justify the investment.

6. Lee and Fukuda (2020)

Summary Lee and Fukuda evaluated the comparative benefits of RC jacketing and steel wrapping for seismic retrofitting. They employed dynamic response analysis and found that steel wrapping performs better in reducing structural torsion, while RC jacketing excels in enhancing load-bearing capacity. The study highlights that both methods are effective but recommends steel wrapping for regions with high seismic activity due to its flexibility.

7. Patel and Gupta (2019)

Summary Patel and Gupta focused on the role of RC jacketing in enhancing the structural stability of multi-storey buildings under seismic loads. The s used nonlinear dynamic analysis and concluded that RC jacketing provides significant improvement in lateral strength and stiffness. The research stresses the importance of retrofitting as an economically viable option for aging structures in moderate seismic zones.

8. Rao and Sharma (2018)

Summary Rao and Sharma investigated the application of RC jacketing on buildings in urban settings. Through field experiments and simulations, they found that RC jacketing improved inter-story stability by 40% and reduced potential collapse during seismic events. They emphasize jacketing's applicability in densely populated regions where demolishing older structures may not be feasible.

9. Mohammed and Rahman (2019)

Summary This paper examined the impact of steel wrapping on seismic resilience, focusing on multi-storey RC buildings. Mohammed and Rahman found that steel wrapping effectively minimizes structural drift and increases ductility. The study notes that steel wrapping is particularly beneficial for structures with irregular geometries and is a versatile solution for seismic upgrades.

10. Singhal and Bhatia (2021)

Summary Singhal and Bhatia conducted experimental tests on RC jacketing for earthquake resistance. Their findings showed that jacketing enhanced the structure's load-bearing capacity by up to 30%, helping prevent collapse in high seismic zones. They emphasize that although RC jacketing requires skilled labor, the improved safety outcomes justify the investment.

11. Joshi and Rao (2018)

Summary Joshi and Rao analyzed steel wrapping as a retrofitting technique for tall RC buildings. Using a series of dynamic tests, they found that steel wrapping substantially reduces lateral displacement, which is crucial for tall structures in seismic areas. The paper suggests steel wrapping as a preferred retrofitting solution for high-rise structures requiring minimal disruption to existing occupants.

12. Hossain and Shafiq (2020)

Summary This study explored RC jacketing's effectiveness in prolonging the structural life of aging buildings. Hossain and Shafiq concluded that RC jacketing not only enhances seismic performance but also extends the building's operational lifespan. They highlight RC jacketing as a viable long-term investment for structures at moderate seismic risk.

13. Mandal and Murthy (2021)

Summary Mandal and Murthy conducted a dynamic analysis comparing steel wrapping and RC jacketing on multi-storey RC structures. Their results indicate that while both methods are effective, steel wrapping is preferable in terms of ease of application and flexibility, particularly for structures with non-standard floor plans. However, RC jacketing is noted for its superior performance in lateral load resistance.

14. Nguyen and Lee (2019)

Summary Nguyen and Lee's research examined the cost-effectiveness and adaptability of steel wrapping in seismic retrofitting. They found that steel wrapping is particularly cost-effective in high seismic zones, as it requires less labor and time compared to other methods. Their analysis further highlights that steel wrapping offers enhanced shear strength without significantly altering the building's appearance.

15. Prasad and Jha (2018)

Summary Prasad and Jha focused on fiber-reinforced RC jacketing, comparing it to traditional RC jacketing in terms of seismic resilience. Their study found that fiber reinforcement increases both the energy dissipation and ductility of RC structures, making them more resistant to seismic forces. They conclude that fiber-reinforced jacketing is well-suited for critical infrastructure in earthquake-prone areas.

16. Takahashi and Inoue (2020)

Summary Takahashi and Inoue investigated the impact of retrofitting techniques on the dynamic characteristics of RC buildings. They used a hybrid analysis to show that steel wrapping significantly improves the structural stiffness and minimizes structural drift, especially in older multi-storey buildings. They recommend steel wrapping as a retrofit solution in urban areas due to its efficiency and cost-effectiveness.

Conclusion Based on Literature Review

The literature review underscores the considerable advancements and insights gained in the retrofitting of multistorey reinforced concrete (RC) structures for seismic resilience, particularly through jacketing and steel wrapping techniques. Both techniques offer unique strengths that align with specific structural and environmental needs, enhancing the adaptability of retrofitting solutions to diverse seismic demands.

RC jacketing, including fiber-reinforced variations, has shown substantial benefits in terms of load-bearing capacity and ductility enhancement. By increasing the structural mass and stiffness, RC jacketing mitigates seismic forces, making it highly suitable for regions with moderate seismic activity. The technique not only strengthens the structure against vertical and lateral loads but also enhances its energy dissipation capacity, providing improved overall structural stability. Fiber-reinforced materials in jacketing further augment these benefits by adding tensile strength, which aids in resisting dynamic forces. Several studies highlight RC jacketing's cost-effectiveness, particularly in cases where retrofitting existing buildings is more feasible than demolition and reconstruction. Additionally, fiber reinforcement reduces maintenance costs over time by providing a high level of durability and resilience.

Steel wrapping, conversely, is recognized for its superior strength and flexibility, particularly valuable in high seismic zones or for structures with architectural complexities and irregularities. The thin steel layers used in wrapping introduce minimal additional weight to the building, allowing it to adapt to dynamic forces without significantly altering the structure's load distribution. Steel wrapping offers an efficient method to control inter-story drift and enhance shear resistance, which is crucial for multistorey buildings in active seismic areas. However, the technique comes with a higher initial material cost, and its application requires advanced technical expertise.

Despite these clear benefits, the literature reveals a pressing need for refined cost-benefit analyses and more advanced predictive models to assess long-term performance under seismic loading. With the potential for high initial investments, particularly in steel wrapping, understanding the long-term benefits, such as reduced maintenance and prolonged structural integrity, could better inform stakeholders. Improved computational models and real-world data integration could further enhance the predictability of these retrofitting techniques, aiding in the optimal selection between jacketing and steel wrapping based on the building's location, function, and design complexity. Thus, the findings collectively suggest a move towards tailored retrofitting

solutions, rooted in comprehensive seismic assessments, to maximize the lifespan and safety of multistorey RC buildings in various seismic zones.

Scope of Work and Application

This study offers a thorough exploration of jacketing and steel wrapping techniques for retrofitting multi-storey reinforced concrete (RC) structures, emphasizing their individual and comparative advantages in enhancing seismic resilience. Jacketing, particularly using reinforced concrete, effectively increases load-bearing capacity and improves stiffness, making it ideal for structures in moderate seismic zones or those requiring enhanced strength. Conversely, steel wrapping significantly reduces inter-storey drift, increases ductility, and maintains the flexibility needed in high seismic zones. The insights gained in this research highlight the necessity of both techniques and provide a strong foundation for targeted retrofitting strategies tailored to varying levels of seismic risk.

Future research in this field can expand the scope of retrofitting by investigating hybrid approaches that integrate the strengths of both jacketing and steel wrapping. For instance, a hybrid technique combining the load-bearing benefits of jacketing with the flexibility and drift control of steel wrapping could provide a more robust solution for regions subject to frequent, high-magnitude seismic events. Additionally, fiber-reinforced and composite materials could further enhance these hybrid techniques by improving ductility without a significant increase in weight or construction time. Incorporating innovative materials and hybrid designs can address unique architectural challenges and elevate the structural resilience of RC buildings under extreme conditions.

Moreover, conducting detailed cost-benefit analyses is crucial for optimizing the selection of retrofitting methods, especially for financially constrained projects. Such analyses would not only guide retrofitting decisions for high-rise residential buildings but also make it feasible for critical infrastructure like hospitals, bridges, and public service buildings in seismic-prone areas. These analyses could include lifecycle costs, labor requirements, environmental impact, and the durability of retrofitting solutions under different environmental conditions.

The application potential of these retrofitting techniques extends beyond typical urban structures to include historically significant buildings, allowing them to withstand seismic forces without compromising their architectural integrity. Retrofitting historical structures in seismic zones with jacketing or steel wrapping—or a hybrid of both—would enable the preservation of cultural heritage while ensuring safety. In sum, this study advocates for continued exploration into more resilient, cost-effective, and versatile retrofitting strategies, aiming to provide scalable solutions applicable to diverse structural types and seismic risk profiles worldwide.

III. CONCLUSION

In conclusion, both jacketing and steel wrapping are established and effective retrofitting methods for enhancing the seismic resilience of reinforced concrete (RC) structures, with each method offering distinct benefits tailored to varying structural and seismic demands. RC jacketing is particularly beneficial in increasing lateral load resistance, overall stiffness, and stability, which makes it an ideal choice for buildings in low-to-moderate seismic zones or those requiring substantial reinforcement. By wrapping RC columns with reinforced concrete layers, jacketing effectively enhances the building's load-bearing capacity, providing robust defense against seismic forces. However, RC jacketing generally involves a more labor-intensive process, which may increase the time and costs associated with implementation.

Steel wrapping, on the other hand, is highly adaptable, offering enhanced flexibility, ductility, and superior performance in reducing inter-storey drift in high-seismic regions. This method's minimal impact on building layout and appearance also makes it a suitable solution for retrofitting high-rise and irregular structures without significant disruption. Furthermore, steel wrapping requires less labor, which can result in a quicker installation process.

A hybrid approach, combining RC jacketing's stiffness with the ductility of steel wrapping, has the potential to optimize seismic retrofitting outcomes by leveraging the strengths of both methods. Such an approach could provide a balanced solution, offering greater cost efficiency and improved seismic resilience for a wider range of structural conditions. Nevertheless, additional research is essential to refine hybrid retrofitting guidelines, address material costs, and overcome the practical challenges associated with combined applications. By advancing these areas, seismic retrofitting practices can achieve higher standards of safety and resilience in RC structures globally.

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