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Dynamic Analysis of Retrofitting Multi-Storey Reinforced Concrete Structure Using Jacketing and Steel Wrapping Techniques- A Review

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Abstract: Reinforced concrete (RC) structures are widely used in modern construction due to their strength, durability, and economical advantages. However, many existing RC buildings are vulnerable to earthquake forces because they were designed without considering modern seismic design provisions. Earthquakes can cause severe damage to structural components such as beams, columns, and joints, resulting in structural instability and loss of life. Retrofitting has therefore become an essential technique for improving the seismic performance and safety of existing structures. This review paper presents a detailed study on the dynamic analysis of retrofitting multi-storey reinforced concrete structures using jacketing and steel wrapping techniques. Various retrofitting methods such as RCC jacketing, steel jacketing, CFRP wrapping, steel bracing, and base isolation are reviewed based on previous research studies. The paper also discusses different analysis methods including pushover analysis, nonlinear static analysis, and time-history analysis used for evaluating seismic behavior. The reviewed literature indicates that jacketing and steel wrapping techniques significantly improve stiffness, ductility, strength, and load carrying capacity of RC structures while reducing displacement and structural damage during earthquakes. The paper finally identifies important research gaps and highlights the need for detailed dynamic analysis of retrofitted RC buildings under seismic loading conditions.

Keywords: Reinforced Concrete Structure, Retrofitting, RCC Jacketing, Steel Wrapping, Seismic Analysis, Dynamic Analysis, Earthquake Resistance, Multi-Storey Building, Time History Analysis, Structural Strengthening.

I. INTRODUCTION

Reinforced concrete (RC) structures are among the most commonly used structural systems in the construction industry due to their high compressive strength, durability, and economic feasibility. Rapid urbanization and increasing population have led to the construction of a large number of multi-storey buildings in seismic-prone regions. However, many of the existing buildings were designed according to old design codes without adequate consideration of earthquake-resistant provisions. As a result, these structures become vulnerable to seismic forces and may experience severe damage during earthquakes. Earthquakes generate dynamic forces that produce lateral vibrations in structures, leading to excessive displacement, cracking, stiffness degradation, and even collapse of structural components. Structural failures during past earthquakes have highlighted the necessity of strengthening and retrofitting existing buildings to improve their seismic resistance and ensure public safety. Retrofitting refers to the process of modifying and strengthening existing structures to enhance their load carrying capacity, ductility, stiffness, and overall structural performance under seismic loading conditions.

Several retrofitting techniques have been developed and implemented in civil engineering practice. Among these methods, reinforced concrete (RCC) jacketing and steel wrapping techniques are widely used due to their effectiveness and practical applicability. RCC jacketing involves increasing the cross-sectional area and reinforcement of structural members such as beams and columns, thereby improving strength and stiffness.

Steel wrapping or steel jacketing enhances confinement and ductility of structural elements and reduces the possibility of brittle failure during earthquakes. Dynamic analysis plays an important role in evaluating the seismic behavior of structures under earthquake excitation. Different analysis methods such as response spectrum analysis, pushover analysis, and nonlinear time-history analysis are used to study the response of buildings before and after retrofitting. These methods help in understanding parameters such as displacement, inter-storey drift, base shear, natural time period, and plastic hinge formation. The present review paper aims to study the dynamic analysis of retrofitting multi-storey reinforced concrete structures using jacketing and steel wrapping techniques. The paper reviews previous research work related to seismic retrofitting methods, structural analysis approaches, and the effectiveness of different strengthening techniques in improving seismic performance of RC buildings.

II. LITERATURE REVIEW

[1] Jyoti Subhash Sathe and Prof. A. H. Jamale (2026) studied the seismic behavior of reinforced concrete structures and emphasized the importance of earthquake-resistant design principles. The study focused on parameters such as ductility, stiffness degradation, and energy dissipation under seismic loading. Modern seismic design approaches like performance-based seismic design and base isolation were discussed. The research highlighted that proper reinforcement detailing and advanced structural analysis improve structural safety during earthquakes. Case studies and experimental investigations were analyzed to understand seismic response. The study concluded that retrofitting existing structures is essential for earthquake-resilient infrastructure.

[2] Wahab Abdul Ghafar et al. (2025) reviewed modern seismic retrofitting strategies with emphasis on seismic isolation systems for existing buildings. The study explained different isolation systems such as NRB, HDRB, LRB, and friction-based systems. International case studies from countries like Japan, China, Italy, and the USA were examined. The results showed that seismic isolation significantly reduces seismic forces and improves post-earthquake functionality. However, the research also identified limitations such as high installation cost and technical complexity. The study concluded that seismic isolation is an advanced retrofitting method for improving structural resilience.

[3] Prof. Pallavi Bhende and Mr. Sanjay Ghate (2025) evaluated the seismic response of a G+9 reinforced concrete building retrofitted using RCC jacketing and steel wrapping techniques. The structural analysis was performed using SAP2000 software with pushover and time-history analysis. Parameters such as displacement, base shear, and plastic hinge formation were compared between bare and retrofitted structures. The retrofitted structure showed 20–40% reduction in displacement and improved seismic resistance. Steel jacketing at plastic hinge regions enhanced the inelastic capacity of the structure. The study concluded that jacketing and steel wrapping significantly improve structural strength and stiffness.

[4] Weilun Wang et al. (2025) carried out an experimental comparison of RC jacketing, steel jacketing, and base isolation techniques for RC frames. Cyclic loading tests were performed on four frame specimens including one control specimen. The study evaluated hysteretic response, stiffness degradation, and energy dissipation behavior. RC jacketing improved strength and stiffness, while steel jacketing enhanced confinement and load carrying capacity. Base isolation using lead rubber bearings provided the best seismic performance and energy dissipation. The study concluded that base isolation is highly effective, though conventional jacketing techniques also improve seismic resistance.

[5] Furkan Narlitepe et al. (2025) proposed a hybrid thin jacketing technique for strengthening deficient reinforced concrete columns. The method combined CFRP sheets, additional steel reinforcement, and repair mortar. Large-scale RC column specimens were tested under cyclic loading conditions. The retrofitted columns showed significant improvement in strength, ductility, and energy dissipation capacity. Numerical analysis using OpenSees validated the experimental findings. The study concluded that hybrid thin jacketing is a practical and time-efficient retrofitting solution.

[6] Besan Talahmeh et al. (2025) studied the seismic assessment and retrofitting of an existing RC building using RC jacketing and CFRP wrapping techniques. ETABS and SAP2000 software were used for linear and nonlinear analysis. The study identified overstressed columns and plastic hinge formation in the existing structure. Both RC jacketing and CFRP wrapping improved load carrying capacity and seismic performance. CFRP provided better stiffness enhancement, while RC jacketing improved overall structural stability. The research concluded that retrofitting effectively increases structural safety and service life.

[7] Dr. Afolabi and Bolarinwa Faith A. (2025) investigated the retrofitting of a five-storey building using steel bracing and concrete jacketing. ETABS software was used to analyze seismic behavior before and after retrofitting. Parameters such as inter-storey drift, base shear, and lateral displacement were studied. The retrofitted structure showed increased stiffness and improved seismic resistance. The study also highlighted the effect of soil–structure

interaction under seismic loading. The research concluded that combined retrofitting methods provide effective strengthening solutions for existing buildings.

[8] Md Asif and Praveen Ghidode (2025) reviewed the implementation of retrofitting techniques using modern structural analysis software. The study highlighted the role of ETABS software in evaluating seismic behavior and designing strengthening measures. Retrofitting techniques were found to reduce vulnerability of aging structures against earthquakes. The research emphasized that software tools help in accurate structural analysis and efficient retrofit design. The study concluded that advanced software implementation improves the effectiveness of retrofitting projects. It also stressed the importance of upgrading old structures to meet current seismic standards.

[9] Abdul Ahad and Mohammed Moiz (2024) conducted a comparative study on different retrofit techniques for seismic performance improvement in RC buildings. ETABS software was used to analyze structural response under earthquake loading. Parameters such as displacement, vibration frequency, and ductility were studied. The results showed significant reduction in displacement after retrofitting. Retrofitting techniques improved the strength and stiffness of buildings. The study concluded that suitable retrofit methods increase structural stability and seismic resistance.

[10] Michele Fabio Granata (2024) presented a case study on retrofitting corrosion-damaged RC buildings in Southern Italy. Linear dynamic analysis and pushover analysis were performed using finite element modeling. The retrofitting techniques included RC jacketing, steel jacketing, FRP wrapping, and steel-concrete composite floors. The strengthened structure showed improved seismic capacity and structural integrity. Steel jacketing effectively confined beam-column joints, while FRP improved flexural strength. The study concluded that integrated retrofitting methods successfully restore damaged structures.

[11] Mr. Sanjay Ghate and Prof. Pallavi Deotale (2024) reviewed retrofitting techniques for multistorey RC structures under seismic loading. The study focused mainly on concrete jacketing and steel wrapping techniques. Concrete jacketing improved stiffness and load carrying capacity, while steel wrapping enhanced ductility and confinement. Various research findings were compared to understand the dynamic response of retrofitted structures. The study emphasized that retrofitting increases seismic performance and structural stability. It concluded that jacketing and steel wrapping are reliable strengthening techniques for earthquake-prone regions.

[12] Vaishnavi N. Pawar et al. (2023) studied the seismic strengthening of an existing G+1 RC building in Akola, India. Equivalent static analysis was carried out to evaluate structural safety under seismic loads. The study found that the existing columns were inadequate for additional floor loads. RC jacketing was suggested to improve column strength and load carrying capacity. After retrofitting, the building safely supported additional storeys. The research concluded that RC jacketing is an economical and effective retrofitting technique.

[13] Turgay Cosgun et al. (2022) investigated seismic retrofitting techniques for multi-rise RC buildings according to Turkish earthquake codes. Finite element analysis and laboratory investigations were conducted on two similar structures. One building was strengthened using RC shear walls while the other remained unretrofitted for comparison. The retrofitted building showed reduced lateral displacement and improved stiffness. However, the study also observed shear-critical behavior in some cases. The research concluded that detailed assessment and analysis are necessary for selecting effective retrofitting methods.

[14] Diksha Kumari and Chandra Pal Gautam (2022) reviewed different seismic retrofitting techniques such as jacketing, steel bracing, dampers, and base isolation. ETABS software was used for static and dynamic analysis of buildings. Parameters including story drift, stiffness, and displacement were evaluated. The study found that retrofitting significantly improves structural stiffness and reduces displacement. Different techniques were compared based on their seismic performance. The research concluded that appropriate retrofitting methods enhance structural safety and durability.

[15] Sarth Khunt (2022) presented a comprehensive review on retrofitting of concrete structures. The study discussed causes of structural deterioration such as earthquakes, aging, corrosion, and overloading. Different retrofitting techniques including FRP composites, grouting, and section enlargement were reviewed. The research classified retrofitting into local and global strengthening approaches. Retrofitting was found to improve load carrying capacity and service life of structures. The study concluded that retrofitting is a practical alternative to demolition and reconstruction.

[16] Sachin Motghare et al. (2021) studied the seismic behavior of RC structures retrofitted using RCC jacketing and steel jacketing. SAP2000 software was used for pushover and time-history analysis. Parameters such as displacement, base shear, and plastic hinge formation were analyzed. The retrofitted structure showed better seismic performance than the bare frame structure. Plastic hinge formation was significantly reduced after retrofitting. The study concluded that jacketing techniques improve ductility, strength, and structural stability.

[17] Geetha M and Chaitra D. M. (2021) analyzed the seismic retrofitting of an existing G+6 building using steel jacketing, RC jacketing, and steel bracing techniques. ETABS software and linear static analysis were used for

structural evaluation. Parameters such as story drift and story displacement were compared under different soil conditions. The retrofitted building showed improved seismic resistance and reduced displacement. The study highlighted that retrofitting is economical for strengthening existing structures. It concluded that appropriate retrofit techniques enhance safety and allow vertical expansion of buildings.

[18] D. R. Daniel and A. H. Sinaga (2020) investigated the seismic response of retrofitted low-rise RC structures using nonlinear time-history analysis. Different retrofitting techniques including CFRP strengthening, steel cage jacketing, and base isolation were evaluated. Earthquake records such as Northridge and Sylmar were used for analysis. The retrofitted structures showed reduced story drift, roof acceleration, and base shear. Nonlinear analysis demonstrated improved stability under strong earthquake excitation. The study concluded that retrofitting significantly enhances seismic resistance and reduces structural damage.

[19] Prashant Sunagar et al. (2019) studied sustainable retrofitting techniques for RC buildings using nonlinear static analysis. Different strengthening methods such as RC jacketing, steel jacketing, and FRP jacketing were compared. Response spectrum analysis and pushover analysis were performed. The results indicated reduction in displacement and inter-storey drift after retrofitting. Structural stiffness and load carrying capacity also improved significantly. The study concluded that jacketing techniques provide sustainable and effective seismic strengthening solutions.

[20] Gopika S. Kumar and Suji P. (2019) carried out a comparative study on retrofitting RC columns using concrete, steel, CFRP, and GFRP jacketing. ETABS and ANSYS software were used for structural analysis. The deformation behavior of columns before and after retrofitting was evaluated. Concrete jacketing showed the maximum reduction in deformation among all methods. The study found that jacketing improves confinement and load carrying capacity. The research concluded that jacketing techniques are effective for strengthening damaged columns.

III. RESEARCH GAP

From the detailed review of previous literature, it is observed that many researchers have studied different seismic retrofitting techniques such as RCC jacketing, steel jacketing, CFRP wrapping, steel bracing, base isolation, and FRP strengthening methods for reinforced concrete structures. Most of the studies focused on individual retrofitting techniques or experimental investigations on isolated structural elements like beams and columns. Several researchers performed static analysis, pushover analysis, or limited nonlinear analysis, but comparatively fewer studies addressed detailed dynamic analysis of multi-storey reinforced concrete buildings under actual earthquake loading conditions. It is also observed that limited research has been carried out on the combined application of RCC jacketing and steel wrapping techniques for improving the seismic performance of multi-storey reinforced concrete structures. Very few studies have compared the behavior of bare frame and retrofitted structures using nonlinear time-history analysis considering parameters such as displacement, storey drift, base shear, stiffness, ductility, and plastic hinge formation. In addition, the effect of retrofitting on dynamic characteristics such as natural time period and mode shape behavior has not been extensively investigated. Furthermore, most existing studies are based on conventional retrofitting methods, while limited attention has been given to optimization of retrofitting techniques considering cost, structural efficiency, and seismic performance together. Therefore, there is a need for comprehensive dynamic analysis of retrofitted multi-storey reinforced concrete structures using RCC jacketing and steel wrapping techniques to evaluate their effectiveness in improving structural stability, seismic resistance, and overall performance under earthquake loading conditions.

CONCLUSION

The literature review indicates that retrofitting techniques play an important role in improving the seismic performance of reinforced concrete buildings. Techniques such as RCC jacketing, steel wrapping, CFRP strengthening, steel bracing, and base isolation significantly enhance strength, stiffness, ductility, and load carrying capacity of structures. Among these methods, jacketing and steel wrapping are widely adopted due to their effectiveness and practical applicability in strengthening existing buildings. Previous studies showed considerable reduction in displacement, story drift, and plastic hinge formation after retrofitting. However, more detailed dynamic analysis is still required to evaluate the combined effect of jacketing and steel wrapping techniques on multi-storey RC structures under seismic loading. Therefore, the present review highlights the importance of further research in this area for developing safer and earthquake-resistant structures.

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