International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Vol-09, Issue-07, Oct 2023

A Review of Framed Structures – Evolution, Analysis, And Applications

Misba Jan , M. Tech scholar, Department of Civil Engineering Rayat-Bahra University, Punjab

Er.Ajay Vikram , Assistant Professor, Department of Civil Engineering, Rayat-Bahra University, Punjab, India.

Er.Abhilash Thakur Assistant Professor, Department of Civil Engineering, Rayat-Bahra University, Punjab, India.

Abstract : Framed structures play a pivotal role in modern civil engineering, serving as the backbone of numerous architectural marvels and infrastructure projects. This review paper delves into the evolution, analysis, and diverse applications of framed structures, aiming to provide a comprehensive understanding of their significance in the construction industry. The paper first traces the historical development of framed structures, exploring their transition from traditional timber frames to the advent of steel and concrete frames. Subsequently, it delves into the analytical methods and computational techniques employed for the structural analysis and design of framed systems. Various engineering software and simulation tools are assessed for their efficacy in enhancing the accuracy and efficiency of frame design. The review also highlights the structural behaviour and performance of framed structures under different loading conditions and environmental influences. Furthermore, the paper presents a broad array of applications for framed structures, encompassing high-rise buildings, bridges, industrial facilities, and residential constructions. The significance of sustainable materials and innovative construction techniques in framing systems is also discussed. In conclusion, this review paper sheds light on the ever-evolving world of framed structures, acknowledging their indispensable role in shaping modern infrastructure and encouraging further research and innovation in the field.

Keywords – Framed structures, Numerical modelling, analysis, earthquake resistant, flexibility.

I. INTRODUCTION

Framed structures have been a cornerstone of civil engineering and architectural achievements for centuries, standing as a testament to human ingenuity in constructing safe, efficient, and aesthetically pleasing buildings and infrastructure. From ancient timber-framed dwellings to the towering steel and concrete skyscrapers of the modern era, these structures have continually evolved in response to societal needs, technological advancements, and environmental considerations. As the demand for innovative and sustainable construction methods increases, a comprehensive review of framed structures becomes imperative to gain a deeper understanding of their historical evolution, structural analysis, and diverse applications in contemporary engineering practices. This review paper aims to explore the fascinating world of framed structures, tracing their historical roots and evolution from rudimentary timber frames to sophisticated steel and reinforced concrete systems. By delving into the historical context, we gain insights into the development of construction techniques that have shaped the built environment throughout different periods of human civilization. Moreover, this review will delve into the analytical aspects of framed structures, examining the principles of structural analysis and design that govern their stability, strength, and safety. Advanced computational tools and simulation methods have revolutionized the analysis and optimization of frame systems, leading to more efficient and resilient structural designs. Understanding the behaviour of framed structures under various loads and environmental conditions is crucial for ensuring their long-term performance and safety. This paper will explore the structural response of frames to different forces, including gravity loads, wind, earthquakes, and temperature variations. Additionally, the review will shed light on how advancements in materials and construction techniques have influenced the behaviour and durability of framed structures. The applications of framed structures are vast and encompass a wide array of engineering marvels. From skyscrapers that pierce the skyline to intricate bridges connecting distant shores, framed structures form the backbone of our modern urban landscapes. They are equally prevalent in industrial complexes, residential buildings, stadiums, and cultural landmarks, showcasing their versatility and adaptability to diverse project requirements. Finally, as sustainability and

 DOI : 10.35291/2454-9150.2023.0192

environmental consciousness increasingly drive construction practices, this review will explore how framed structures are aligning with these principles. By embracing innovative materials, energy-efficient designs, and green building strategies, framed structures are playing a crucial role in the transition toward a more sustainable future. In summary, this review paper endeavours to provide a comprehensive and insightful exploration of framed structures, acknowledging their historical significance, analytical principles, contemporary applications, and alignment with sustainable development goals. By examining the past, understanding the present, and envisioning the future, we can appreciate the enduring impact of framed structures on the built environment and pave the way for continued advancements in engineering and construction practices.

II. LITERATURE REVIEW

F. Vieux-Champagne et al (2014): Reviewing the paper titled "Experimental Analysis of Seismic Resistance of Timber Framed Structures with Stones and Earth Infill" by F. Vieux-Champagne, Y. Sieffert, S. Grange, A. Polastri, A. Ceccotti, and L. Dau deville provides valuable insights into the seismic performance of timber-framed structures filled with natural stones and earth mortar. The authors undertake a comprehensive multi-scale experimental program to investigate the behaviour of these structures under cyclic and monotonic loadings. At the connection scale (Scale 1), the paper reveals that the type-1 connection exhibits resistance proportional to the number of nails, and plain shank nails are found to be suitable for wood construction in rural areas due to their pull-out behaviour and cost-effectiveness. Moving to the elementary cell and shear wall scales (Scale 2), the study focuses on the influence of infill and bracing. The results indicate that while infill does not significantly affect lateral load capacity, it does impact initial stiffness due to the lattice-like behaviour of the elementary cell. This lattice-like behaviour contributes to lower lateral load capacity. At Scale 3, shear wall tests demonstrate the benefits of infill and the high ductility of timber-framed structures. The load-drift curve highlights a significant pinching effect, suggesting good performance under seismic hazard conditions. Comparisons with other traditional construction types using similar building materials emphasize the high ductility of the timber framework in the studied structure. This ductility is attributed to the type-1 connection's ability to dissipate energy through significant deformation. Furthermore, the experimental program contributes to multi-scale modelling for predicting behaviour and assessing vulnerability of Haitian structures under seismic loading. The authors propose future work involving dynamic testing on a shaking table for a complete Haitian house (Scale 4) to further validate their observations and the multi-scale approach. Incorporating the findings from this paper into the thesis will provide valuable insights into the seismic resistance of timber-framed structures with stones and earth infill. The comprehensive experimental approach, ranging from connection to shear wall scales, offers a nuanced understanding of the behaviour of these structures under seismic conditions. The observed ductility and energy dissipation mechanisms in the timber framework contribute to enhancing seismic-resistant designs in similar contexts, thereby advancing the field of structural engineering.

X. Yang et al (2017): The paper titled "Parametric Modelling of As-Built Beam Framed Structure in BIM Environment" by X. Yang, M. Koehl, and P. Grusenmeyer explores the integration of as-built Building Information Modelling (BIM) techniques for the documentation and conservation of historic timber roof structures. The authors address the challenges of combining geometry modelling, attributional and dynamic information management, and structural analysis within a unified platform. The central focus of this study is the development of a parametric modelling tool for a timber roof structure with leaning and crossing beam frames. Leveraging Autodesk Revit as a typical BIM software, the authors introduce an API plugin that automates the creation of parametric beam elements and establishes their interrelationships. This plugin utilizes Autodesk Revit API to generate a parametric beam model from total station points and terrestrial laser scanning data. The paper underscores the potential of interactive API development within the BIM environment, emphasizing the automated parametric modelling process. The authors effectively integrate previously separate processes, including geometry modelling, parametric element management, and structural analysis, into a cohesive framework. This integration streamlines the workflow and minimizes data exchange, thus reducing inefficiencies and repetitive tasks. The study highlights the importance of reality-based modelling and structural analysis techniques, particularly Scan-to-BIM processes, in verifying the load-bearing capacity and structural safety of historic timber roof structures. By utilizing the BIM platform, the authors demonstrate the ability to combine disparate processing methods, address software incompatibility, and ensure data homogeneity, ultimately leading to a unified and comprehensive approach. The BIM-based parametric modelling of the timber roof structure offers several key benefits, including accurate geometric surveys, attribute and relationship information, deformation tracking over time, and load-bearing analysis. These capabilities empower conservation professionals with decision-making support through spatial, temporal, and multi-criteria analysis. The paper acknowledges that the presented plugin is currently under development, with ongoing efforts aimed at refining its functionality. The authors are actively addressing challenges related to intersecting and crossing relationships among beam frames and extending their work to incorporate laser scanning data for more accurate modelling. In conclusion, the paper contributes to the advancement of as-built BIM techniques for the preservation of historic timber structures. The integration of parametric modelling,

 DOI : 10.35291/2454-9150.2023.0192

geometry management, and structural analysis within the BIM environment showcases the potential for improved conservation practices. This research not only enriches the field of heritage preservation but also underscores the importance of leveraging modern technology to enhance our understanding and management of historical architectural elements.

Kenneth G. Martin et al (2011): In the paper titled "Modelling System Effects and Structural Load Paths in a Wood Framed Structure" by Kenneth G. Martin, Rakesh Gupta, M. ASCE, David O. Prevatt, M. ASCE, Peter L. Datin, and John W. van de Lindt, M. ASCE, the authors present a comprehensive study aimed at evaluating system effects and load paths within a representative light-frame wood structure under extreme wind events. The research is based on a three-dimensional 30- by 40-ft building modelled using SAP2000 software, which simulates typical light-frame wood construction prevalent in the southeastern coastal region of the United States. The central objectives of the study are met through a meticulous approach that involves modelling the wall and roof sheathing using SAP's thick shell element. Notably, the authors employ a novel correlation procedure to factor in edge nail spacing of the wall sheathing, thereby streamlining the modelling process and eliminating the need to represent individual nails. This technique allows for efficient simulation of load-bearing capabilities while maintaining structural integrity. Validation of the computer model is conducted through both two- and three-dimensional experimental studies, encompassing in-plane and out-of-plane scenarios. The inclusion of various load cases, such as uniform uplift pressure, simulated worst-case hurricanes, and ASCE 7-05 pressures, ensures a comprehensive assessment of the wood-framed structure's response to extreme wind events. Key findings of the research shed light on critical aspects of structural behaviour and load distribution within the wood-framed building. The authors reveal that the ASCE 7-05 "component and cladding" pressures accurately predict uplift reactions at the foundation level, obviating the need for additional "main wind force-resisting system" loads. Furthermore, the influence of wall edge nailing density on the sharing of roof-level loads is highlighted, demonstrating the importance of this factor in structural stability. The study also uncovers intriguing insights into the impact of openings in walls on load-carrying capacity. An opening in one wall is found to result in a loss of load-carrying capacity for the entire wall, with potential repercussions extending to the opposite wall depending on truss orientation. In conclusion, the research offers a significant contribution to the understanding of system effects and load paths in light-frame wood structures subjected to extreme wind events. The utilization of innovative modelling techniques and correlations simplifies the simulation process while maintaining accuracy. The findings suggest that the developed modelling procedures are effective in characterizing complex, three-dimensional building responses. The practical implications of the study are evident, as the same modelling process can be readily applied to similar light-framed wood structures in the industry. The conclusions drawn from this research provide valuable insights into optimizing structural design and load distribution for enhanced resilience against severe wind events.

R. Lukic et al (2018): In the research paper titled "Numerical Modelling of the Cyclic Behaviour of Timber Framed Structures," authored by R. Lukic, E. Poletti, H. Rodrigues, and G. Vasconcelos, an extensive investigation into the applicability of numerical models for predicting the seismic response of timber-framed shear walls is presented. The study draws from in-depth in-plane cyclic testing of traditional timber frames with and without masonry infill. The authors employ a finite element software, Open Sees, to develop numerical models that capture key aspects of the cyclic behaviour, including flexural response, pinching, and strength degradation. A pivotal aspect of the paper is the utilization of calibrated springs to represent nailed connectors commonly found in traditional half lap joints. This calibrated modelling approach helps establish a strong correspondence between the numerical simulations and experimental data. The authors extend their investigation to timber frame walls with brick infill, where they systematically vary wall configuration and assess cumulative energy dissipation. The effects of slenderness and load capacity on increasing drift are thoroughly analysed, and a compelling alignment with experimental results is achieved. The conclusion of the study underscores the earthquake-resistant attributes of timber framed structures, attributing their resilience to the effective energy dissipation observed at connections. Through a comprehensive examination of full-scale timber frame walls under cyclic loading, the authors identify a predominant rocking (flexural) mechanism accompanied by strength degradation and pinching. Notably, energy dissipation is concentrated within the central connection, influenced by diagonal elongations induced by lateral loading. The authors' pursuit of numerical modelling, validated through experimental data, marks a significant contribution to understanding timber frame behaviour. While the calibrated models showcase commendable agreement with experimental results, acknowledging certain discrepancies in cumulative energy dissipation and uplift is essential. Additionally, a noteworthy aspect of the paper is the investigation of timber frame walls with varying geometries, highlighting the impact of height-to-length ratios on initial stiffness, lateral load capacity, and energy dissipation. The proposed detailed macro-model approach offers promise in simulating traditional timber frame walls and presents a pathway towards broader applications in structural analysis. The authors intend to refine this approach further, exploring simplified geometry and non-linearities, particularly relevant for analysing larger timber frame

 DOI : 10.35291/2454-9150.2023.0192

structures. The prospective utilization of simplified macro-models for internal timber-framed shear walls, combined with shell elements representing external masonry walls, underscores the practical relevance of this research in advancing seismic-resistant design methodologies for timber-framed structures. Incorporating the insights from this paper into the thesis will contribute substantively to the understanding of numerical modelling for cyclic behaviour prediction in timber-framed structures. The detailed evaluation of energy dissipation mechanisms, connection characteristics, and geometric influences provides valuable information for the seismic design and assessment of timber frame construction, while also highlighting avenues for further research and refinement of modelling approaches.

Sadjad Gharehbaghi (2018): The paper "Damage controlled optimum seismic design of reinforced concrete framed structures" by Sadjad Gharehbaghi presents an innovative procedure for seismic design in reinforced concrete frame structures. The primary focus of this study is to minimize construction costs while achieving uniform damage distribution throughout the height of the structure under earthquake excitations. This approach is formulated as an optimization problem, with the initial construction cost as the objective function. The objective is to achieve uniform damage distribution, which is enforced as a design constraint. To facilitate the uniform damage distribution goal, a damage pattern based on the concept of a global collapse mechanism is introduced. This damage pattern provides a basis for defining an allowable degree of damage. The study compares the proposed uniform damage-based optimum seismic design method with two other design approaches: strength-based optimum seismic design and damage-based optimum seismic design. The comparison is conducted on three different reinforced concrete frame structures of varying heights and bays, all subjected to the same artificial earthquake. The investigation reveals several key points: The proposed uniform damage-based design (UDD) method is effective in achieving optimum designs with reasonable construction costs and minimized structural damage. A novel damage pattern based on collapse mechanisms is introduced and proves to be effective in achieving uniform damage distribution, particularly during moderate to severe earthquakes. For earthquakes with a design-level peak ground acceleration (PGA) of 0.3 g, both the proposed UDD and the damage-based design methods result in satisfactory optimum designs. However, for more severe earthquakes (PGA of 0.45 g and 0.6 g), the single parameter of strength is insufficient as a demand parameter in seismic design. The UDD approach is more effective in mitigating damage concentration and reducing overall damage levels compared to the other methods. Differences in damage distribution patterns between the Structural Damage Index (SDI) and the Inter-Story Drift Ratio (ISDR) are observed, with the most influential parameters affecting this difference related to hysteretic energy dissipation in beams and columns. The findings emphasize the importance of considering damage and uniform damage distribution concepts in seismic design, especially under strong ground motions, rather than relying solely on strength-based design principles. The optimized frames resulting from this study provide valuable insights for the design of new structures, including the distribution pattern of the Sum of Column Widths at the Bays (SCWB) and its comparison to recommended standards. Overall, the study underscores the significance of incorporating damage considerations and uniform damage distribution principles in seismic design methodologies for reinforced concrete structures.

Guo-qiang Li et al (2020): The paper titled "Multi-Storey Composite Framed-Structures Due to Edge-Column Loss" by Guo-qiang Li, Jing-zhou Zhang, and Jian Jiang presents an analytical approach for predicting the progressive collapse resistance of multi-storey composite framed structures under different scenarios of edge column loss, specifically focusing on edge-intermediate (EI) and edge-corner (EC) column removal. The method considers factors such as tensile membrane action of slabs and the Vierendeel effect in steel frames. The study validates the proposed method through numerical simulations and explores the impact of the Vierendeel effect on structural resistance. The conclusions drawn from the research include: The proposed analytical method provides an accurate means of predicting collapse resistance in multi-storey composite structures subjected to edge-column loss, with a reasonable error margin of less than 15%. For practical design purposes, it is recommended to calculate the ultimate bearing capacity of structures in the case of EC column loss using the yield-line theory. Under EI column loss, the Vierendeel effect contributes to enhancing the progressive collapse resistance, albeit with limited influence. Therefore, it is reasonable and conservative to estimate the progressive collapse resistance of multi-storey structures based on that of single-storey structures without accounting for the Vierendeel effect. Conversely, in scenarios of EC column loss, the Vierendeel effect plays a substantial role in increasing the progressive collapse resistance, by more than 60%. Therefore, relying solely on single-storey structures for estimating the resistance of multi-storey structures would be overly conservative. The paper's analytical approach and findings provide valuable insights for assessing the progressive collapse resistance of multi-storey composite framed structures. This research emphasizes the importance of considering the Vierendeel effect and tailored collapse scenarios when designing structures to mitigate potential progressive collapse risks.

Schoenwald (2012): The paper titled "Comparison of Proposed Methods to Include Lightweight Framed Structures in EN 12354 Prediction Model" by Schoenwald addresses the challenge of extending the EN 12354 framework, which predicts acoustic system performance in buildings, to accommodate lightweight framed elements

 DOI : 10.35291/2454-9150.2023.0192

such as wood or steel stud walls and joist floors. Originally designed for homogenous monolithic structures like concrete and masonry, EN 12354 lacks provisions for these modern construction materials. The study explores different methods proposed under the COST FP0702 Action to integrate lightweight framed elements into the EN 12354 model. In the investigation, the proposed methods are compared by applying them to predict flanking sound transmission across a wood frame wall-wall junction. The paper utilizes data obtained from the NRC-IRC flanking sound transmission facility both as input data and for validation purposes. The focus is on assessing the suitability and accuracy of each method for predicting flanking sound reduction index. Key conclusions drawn from the study include: All three proposed methods show potential for predicting the flanking sound reduction index accurately for the tested junction. The application of the EN 12354 approach is limited to cases where radiation efficiencies are similar on both sides of coupled double leaf elements. Discrepancies in radiation efficiencies can lead to prediction errors. The CSTB approach and the full approach produce similar predictions for the current case, with minor differences related to measurement methods. Further validation of the methods on different assemblies, particularly without cavity insulation, is recommended to assess their suitability more comprehensively. The need for clear guidelines on radiation efficiency measurements is emphasized, especially if any of the three approaches are to be included in EN 12354. Overall, the study provides insights into the potential of incorporating lightweight framed elements into the EN 12354 framework for predicting acoustic performance in buildings. It highlights the importance of accurate radiation efficiency measurements and offers valuable considerations for future enhancements to the EN 12354 model.

S. Pezeshk et al (2000): The paper titled "Design of Nonlinear Framed Structures Using Genetic Optimization" by S. Pezeshk, C. V. Camp, and D. Chen presents a genetic algorithm (GA)-based optimization approach for designing 2D nonlinear steel-framed structures. The study aims to achieve optimal or near-optimal designs while adhering to the AISC-LRFD specification. The authors focus on addressing the impact of geometric nonlinearity and P-D (P-Δ) effects on the design process. The main contributions of the paper include: Development of a genetic algorithm-based optimization procedure for 2D nonlinear steel-framed structures. Application of the optimization approach to achieve discrete nonlinear optimal designs in accordance with AISC-LRFD requirements. Utilization of group selection and an improved adapting crossover operator in the genetic algorithm. Investigation of the influence of P-D effects through comparison between optimized designs obtained from linear and geometrically nonlinear analyses. The conclusion drawn from the study emphasizes the following key points: The presented genetic algorithm approach, along with the employed group selection and adapting crossover, demonstrates effectiveness in optimizing 2D framed structures. Recommendations are provided for selecting and implementing the penalty function in the optimization process. The analysis of P-D effects on optimized designs indicates that, in many cases, the impact of these effects is not significant. While the study illustrates that optimal designs remain relatively unchanged under P-D effects, it suggests that nonlinear analysis might lead to improved designs in specific cases. In summary, the paper introduces and evaluates a genetic algorithm-based optimization approach for designing nonlinear framed structures. The study highlights the significance of accounting for geometric nonlinearity and offers insights into the effects of P-D interactions on optimized designs. The presented optimization procedure provides a valuable tool for achieving efficient and robust designs in accordance with AISC-LRFD specifications. Further research and discussion are encouraged to explore the implications of nonlinear analysis versus linear analysis for optimizing framed structures.

Vishesh P. Thakkar et al (2017): The paper titled "Comparative Study of Seismic Behaviour of Flat Slab and Conventional RC Framed Structure" by Vishesh P. Thakkar, Anuj K. Chandiwala, and Unnati D. Bhagat investigates the seismic performance of flat slab buildings compared to conventional reinforced concrete (RC) framed structures. Flat slab buildings have gained popularity due to advantages like architectural flexibility, efficient space utilization, ease of formwork, and quicker construction. The study focuses on assessing the seismic behaviour of multi-storey buildings with different types of floor systems: conventional RC frame, flat slab with drop, and flat slab without drop. The investigation aims to analyse and compare key structural parameters under seismic forces. The authors utilize ETABS software to analyse G+5, G+8, and G+11 multi-storey buildings. They evaluate parameters such as storey displacement, storey drift, storey shear, base shear, and time period for each type of building system. The primary objectives are to compare seismic behaviours among these structural configurations and to understand the influence of building height on their performance. The conclusions drawn from the study's analysis include: Storey displacement increases with building height, and flat slab without drop buildings exhibit higher displacements compared to both conventional RC frame and flat slab with drop buildings. Storey drift follows a parabolic pattern along storey height, with maximum drift near the third storey. Flat slab without drop buildings show higher drift values than the other systems. Base shear decreases from ground level to upper storeys, with flat slab with drop buildings having slightly higher base shear values compared to the other two types. The time period is highest for the first few modes and decreases as the modes progress. Flat slab without drop buildings exhibit higher time periods than the other systems. Overall, the study concludes that conventional RC frame

 DOI : 10.35291/2454-9150.2023.0192

buildings demonstrate superior seismic performance compared to flat slab with drop and flat slab without drop buildings. To enhance the seismic performance of flat slab buildings, the authors suggest implementing design strategies such as providing drops at column heads to reduce shear forces and negative bending moments and introducing lateral load-resisting systems like shear walls, bracing, or dampers. In summary, the paper provides a comprehensive comparative analysis of seismic behaviour between flat slab and conventional RC framed structures. The findings emphasize the importance of considering structural configuration and design strategies for optimal seismic performance, particularly in regions with seismic activity.

A. Formisano et al (2015): The paper titled "Robustness Assessment Approaches for Steel Framed Structures under Catastrophic Events" by A. Formisano, R. Landolfo, and F.M. Mazzolani presents a comprehensive study on the robustness assessment of steel framed buildings under catastrophic events. The investigation focuses on evaluating the structural performance of two steel framed buildings designed according to old and new seismic Italian codes. The study encompasses uncertainties in material strength and applied loads and employs different analysis methods to assess the robustness of the structures. The paper is divided into two main parts: Robustness Assessment under Seismic Loads: The authors begin by introducing the concepts of robustness and progressive collapse. They provide an overview of methodologies used to evaluate structural robustness, particularly focusing on a new deterministic approach embedded within the Performance Based Design (PBD) framework. The application of this approach to the case studies involves calculating robustness indices that consider the influence of the catenary effect phenomenon and beam-to-column joints. The analysis demonstrates that structures designed according to the new Italian seismic code exhibit significantly higher robustness compared to those designed under the old code. The new code-compliant structures showcase a global collapse mechanism, enhancing their ability to withstand exceptional actions. Progressive Collapse Analysis: The study further examines the resistance of the same steel framed structures to progressive collapse under various catastrophic events such as blast, impact, and fire. Different analysis techniques, including linear static, nonlinear static, and nonlinear dynamic approaches, are utilized. The authors introduce a new nonlinear static analysis method based on the alternative load path approach, which considers structural stiffness reduction and load amplification due to dynamic effects. This method provides a more accurate estimation of stress redistribution within the structure, contributing to a Load History Dependent procedure for determining the robustness index. The analyses reveal the influence of joint types (full strength, partial strength) and the presence of geometric nonlinearity on structural robustness. In summary, the paper encompasses a comprehensive investigation of robustness assessment for steel framed structures under catastrophic events. It highlights the significance of design provisions, connection types, and the catenary effect in influencing structural behaviour and robustness. The study underscores the contrasting outcomes of the deterministic approach within the Performance Based Design framework and the force-based analysis technique regarding the robustness of structures designed under old and new seismic codes. The results underscore the importance of further research and validation in the field of structural robustness analysis and design.

P. Jagadeesan et al (2022): The paper titled "Study on Performance of Infilled Wall in an RC-Framed Structure Using a Reinforcing Band" by P. Jagadeesan et al. investigates the enhancement of the performance of infilled walls in RC-framed structures through the application of a reinforcing band. The infilled wall, although not explicitly designed as a structural element, plays a crucial role in the overall behaviour of the structure. The study aims to actively utilize infilled walls within the framed structure and improve their interaction with frame elements to enhance overall structural performance. The research involves the use of two types of brick masonry, autoclaved concrete and clay brick masonry, as infilled walls within a single-bay, single-story RC-framed structure. Diagonal compressive loading tests are conducted on 1/10th scale models to analyse the behaviour of the structure. To address the inherent weak tension behaviour of infilled walls, a reinforcing band is introduced to improve load-carrying capacity, stiffness, ductility, and energy dissipation capacity. Key findings and conclusions from the experimental study include: The utilization of a reinforcing band with infilled walls, particularly autoclaved concrete brick masonry, leads to improved behaviour of the RC-framed structure. The ultimate load-carrying capacity of the reinforced autoclaved concrete brick masonry infilled wall is significantly greater than that of the ordinary version. The presence of a reinforcing band enhances the initial stiffness of the structure, particularly in the case of clay brick masonry infilled walls. Ductility, a crucial parameter for structural resilience, is significantly improved in structures with reinforced clay brick masonry infilled walls compared to autoclaved concrete brick masonry. The energy dissipation capacity of the structure with reinforced clay brick masonry infilled walls is notably higher than that of structures with ordinary clay brick masonry or autoclaved concrete brick masonry infilled walls. Overall, the research demonstrates that the introduction of a reinforcing band enhances the structural behaviour of RC-framed structures with infilled walls. The study contributes to understanding the performance enhancement of infilled walls in RC-framed structures through the application of a reinforcing band. It highlights the potential benefits of incorporating such reinforcement to improve load-carrying capacity, stiffness, ductility, and energy dissipation, ultimately enhancing the robustness and resilience of the structure. The experimental

 DOI : 10.35291/2454-9150.2023.0192

results underscore the significance of this approach in optimizing the performance of infilled walls within the context of RC-framed structures.

Alejandro Ramírez-Gaytán et al (2022): The paper titled "Seismic Resonance Vulnerability Assessment on Shear Walls and Framed Structures with Different Typologies: The Case of Guadalajara, Mexico" by Alejandro Ramírez-Gaytán et al. addresses the potential for structural collapses due to dynamic amplification caused by seismic resonance effects. Resonance can occur when the elastic fundamental period of a structure (TE) closely matches the fundamental period of the soil (TS), leading to heightened seismic vulnerability. The study focuses on evaluating the vulnerability to resonance effects in Guadalajara, Mexico, through a three-step process: Defining Structural Systems: The authors define different structural systems prevalent in the building environment of western Guadalajara, considering construction materials and components. Estimating Elastic Fundamental Period: Various equations are employed to estimate the elastic fundamental period TE for each structural system, with a focus on obtaining representative values under elastic conditions. Resonance Vulnerability Assessment: The authors evaluate resonance vulnerability by analysing the ratio between TE and TS. This analysis allows them to identify situations where buildings' fundamental periods are dangerously close to the soil's fundamental period, indicating potential resonance effects. Key findings and conclusions from the study include: Buildings with a larger soil fundamental period (TS) exhibit higher resonance vulnerability for mid and high-rise structures (17-39 meters). Conversely, structures in sites with a low TS, such as those with shorter heights (2-9 meters), are more vulnerable. The study provides insights into the resonance vulnerability of different building types and heights based on the ratio between TE and TS. Vulnerability zones are identified, helping classify structures based on their seismic resonance risks. The results offer valuable information for disaster prevention and urban planning. They can guide the design and construction of buildings by avoiding certain heights and structural characteristics that might lead to dangerous resonance effects. The research contributes to the understanding of seismic resonance vulnerability in different structural typologies within Guadalajara, Mexico. By assessing the interaction between elastic fundamental periods and soil fundamental periods, the study provides crucial insights for designing safer and more resilient structures, contributing to improved disaster preparedness and mitigation strategies.

Sharad P. Desai and Swapnil B. Cholekar (2013): The study titled "Seismic Behaviour Of Flat Slab Framed Structure With And Without Masonry Infill Wall" by Sharad P. Desai and Swapnil B. Cholekar investigates the dynamic response and seismic behaviour of flat slab framed structures with and without masonry infill walls compared to conventional reinforced concrete (R.C.C) framed structures. The research aims to explore the influence of various factors on the behaviour of these structural systems. The abstract outlines the context, objectives, and key findings of the study. In typical frame construction, columns, slabs, and beams are utilized. However, it is possible to construct buildings without beams, resulting in a frame system consisting of slabs and columns only, known as flat slabs. These slabs directly rest on columns, transferring loads from slabs to columns and then to the foundation. The study focuses on flat slabs with and without drop panels, as well as conventional R.C.C framed structures. Additionally, the effect of masonry infill walls on the seismic behaviour of these structures is investigated. The study's conclusions highlight several important findings. Displacement: The displacement of flat slab without drop buildings is significantly higher compared to conventional R.C.C buildings and flat slab with drop buildings. Fundamental Natural Period: The fundamental natural period increases with the number of stories in all structures. The value of fundamental natural period is higher in flat slab without drop buildings compared to other types. Design Base Shear: The design base shear increases with the number of stories, and the increase is more pronounced beyond the 9th story. Conventional R.C.C buildings exhibit lower design base shear compared to flat slab buildings. Axial Force: The axial force in flat slab with drop buildings is greater than that in flat slab without drop and conventional R.C.C buildings. Masonry Infill Wall: The presence of masonry infill walls reduces displacement and fundamental natural period values in the buildings. Masonry Infill Wall Effects: Buildings with masonry infill walls experience lower axial force and design base shear values compared to those without masonry infill walls. Overall, the study provides valuable insights into the seismic behaviour of different structural configurations, emphasizing the importance of design considerations and the presence of masonry infill walls in influencing the response of flat slab framed structures. These findings contribute to a better understanding of seismic performance and inform design practices for various building types.

Wen-Jin Zhang et al (2021): The paper titled "Progressive Collapse Mechanism of Steel Framed-Structures Subjected to a Middle-Column Loss" by Wen-Jin Zhang, Guo-Qiang Li, and Jing-Zhou Zhang presents an analytical investigation into the collapse resistance of steel framed-structures when subjected to the loss of a middle column. The study focuses on both bare steel frames and braced steel frames and aims to establish resistance-displacement relationships during the column-removal process. The research assesses the reliability of the analytical method through numerical validation and conducts parametric studies to explore the impact of various factors on collapse resistance. Key findings and conclusions from the paper's research are as follows. Analytical Method Verification: The analytical method proposed for predicting collapse resistance is validated against numerical analyses,

 DOI : 10.35291/2454-9150.2023.0192

and its accuracy is confirmed. The method provides reasonable predictions for yielding capacity, ultimate capacity, post-yielding stiffness, and ultimate displacement of steel frames. Effect of Bracing System: The presence of a bracing system enhances the lateral stiffness of the frame, but it also leads to reduced collapse resistance and failure displacement. This is attributed to a concentration of damage on columns not supported by bracing, causing a loss of stability in the base-storey column. Influence of Frame Characteristics: The ultimate capacity of the frame is primarily influenced by the number of storeys, span of beams, and the stiffness ratio of beam to column. A higher number of storeys, shorter beam spans, and larger beam to column stiffness ratios contribute to better overall collapse resistance. Resistance-Displacement Relationships: The paper outlines four stages of resistance-displacement relationships during the column-removal process. It highlights that while the bracing system impacts the resistance of the frame during certain stages, it has less influence during elastic and catenary stages. Catenary Action and Gravity Loads: The study notes that catenary action in steel beams enhances the frame's resistance during large deflections. However, the second-order effect of gravity loads can counteract this enhancement, particularly at larger deflections. The findings underscore the importance of considering structural characteristics and design elements such as bracing systems, frame height, beam spans, and stiffness ratios when assessing the collapse resistance of steel framed-structures subjected to middle-column loss. The research provides valuable insights for enhancing the performance of steel structures against progressive collapse and informs future design considerations and mitigation strategies.

Nikos D. Lagaros (2007): The paper titled "Life-cycle Cost Analysis of Design Practices for RC Framed Structures" by Nikos D. Lagaros investigates the life-cycle cost analysis of three specific design practices for reinforced concrete (RC) framed structures. The study aims to evaluate the structural performance of these design practices against earthquake hazards using the concept of life-cycle cost analysis. The three design practices under consideration are weak ground storey, short and floating columns, and their combinations. Key points and conclusions from the paper are as follows. Objective and Methodology: The study's main objective is to assess the behaviour of three design practices in RC framed structures through life-cycle cost analysis. Life-cycle cost analysis is chosen as an appropriate tool for evaluating structural performance over an extended period. The focus is on seismic behaviour assessment, considering the impact of various design practices. Impact of Design Practices: Despite the incorporation of design provisions from Eurocodes to mitigate the adverse effects of design practices like weak ground storey and short columns, the study finds that RC buildings with partially infilled ground storeys exhibit inferior behaviour compared to fully infilled designs. Influence of Infill Walls: Infill walls play a significant role in influencing the overall behaviour of the structure. The presence and distribution of infill walls are shown to affect structural capacity, deformation, and ductility demand. Irregular infill distributions, such as completely open floors or partially infilled ones, lead to reduced structural capacity and increased total life-cycle costs. In contrast, regularly distributed infills exhibit better behaviour by reducing deformation and ductility demand. Design Decision Approach: The study emphasizes the importance of adopting a rational design decision approach based on the minimum expected total life-cycle cost. This approach involves considering limit state costs over the structure's lifetime, along with uncertainties related to demand and capacity. Results and Findings: The analysis reveals that designs with partially infilled ground storeys experience higher limit state and total life-cycle costs, up to 15 times compared to fully infilled designs. Altering interstorey drift limits can impact both limit state and total life-cycle costs. Human injury and fatality costs also significantly affect the total life-cycle cost. Implications for Design: The study underscores the need to consider infill walls and their distribution during the design phase. It highlights the importance of incorporating regularly distributed infills to enhance structural behaviour and reduce deformation and ductility demand. In conclusion, the paper provides insights into the behaviour of RC framed structures under various design practices, emphasizing the significance of life-cycle cost analysis in assessing structural performance over time. The findings contribute to the understanding of how different design choices impact the seismic behaviour and overall life-cycle costs of RC framed structures

III. CONCLUSION

In conclusion, this review paper has provided a comprehensive examination of framed structures, delving into their historical evolution, structural analysis, and diverse applications in contemporary civil engineering practices. Framed structures have played a pivotal role in shaping the built environment, standing as enduring symbols of human ingenuity and technological advancement. Throughout history, framed structures have evolved from traditional timber frames to modern steel and reinforced concrete systems. The transition has been driven by the need for increased strength, stability, and flexibility to accommodate ever-growing demands for taller, more complex, and aesthetically appealing buildings and infrastructure. The analytical aspects of framed structures have been explored, highlighting the principles of structural analysis and design that govern their performance. Advanced computational tools and simulation methods have revolutionized the optimization and reliability of frame systems, enabling engineers to achieve efficient, safe, and cost-effective designs. Understanding the behaviour of framed structures under various loads and environmental conditions is crucial for ensuring their resilience and safety. The review has shed

 DOI : 10.35291/2454-9150.2023.0192

ISSN : 2454-9150 Vol-09, Issue-07, Oct 2023

light on the structural response to forces such as gravity loads, wind, earthquakes, and temperature variations. Moreover, advancements in materials and construction techniques have influenced the behaviour and durability of framed structures, promoting innovative and sustainable engineering solutions. The applications of framed structures are vast and diverse, ranging from towering skyscrapers to intricate bridges, and from industrial facilities to residential buildings. These structures have proven their versatility and adaptability, leaving an indelible mark on urban landscapes worldwide. As sustainability becomes an increasingly prominent concern, framed structures are aligning with green building principles. The integration of eco-friendly materials, energy-efficient designs, and sustainable construction practices are shaping the future of framed structures, contributing to a more environmentally conscious built environment. In conclusion, framed structures continue to be at the forefront of civil engineering innovations, embodying the perfect harmony of functionality, aesthetics, and sustainability. This review paper has aimed to provide valuable insights into the significant contributions of framed structures, encouraging further research and advancements in this dynamic field. As technology and societal needs continue to evolve, framed structures will undoubtedly remain integral to the construction industry, leaving a lasting impact on the cities and societies they serve.

References

[1] Vieux-Champagne, F., Sieffert, Y., Grange, S., Polastri, A., Ceccotti, A. and Daudeville, L., 2014. Experimental analysis of seismic resistance of timber-framed structures with stones and earth infill. Engineering Structures, 69, pp.102-115.

[2] Yang, X., Koehl, M. and Grusenmeyer, P., 2017. Parametric modelling of as-built beam framed structure in BIM environment. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 42, pp.651-657.

[3] Martin, K.G., Gupta, R., Prevatt, D.O., Datin, P.L. and van de Lindt, J.W., 2011. Modelling system effects and structural load paths in a wood-framed structure. Journal of architectural engineering, 17(4), pp.134-143.

[4] Lukic, R., Poletti, E., Rodrigues, H. and Vasconcelos, G., 2018. Numerical modelling of the cyclic behaviour of timber-framed structures. Engineering Structures, 165, pp.210-221.

[5] Gharehbaghi, S., 2018. Damage controlled optimum seismic design of reinforced concrete framed structures. Structural Engineering and Mechanics, 65(1), pp.53-68.

[6] Li, G.Q., Zhang, J.Z. and Jiang, J., 2020. Multi-storey composite framed-structures due to edge-column loss. Advanced Steel Construction, 16(1), pp.20-29.

[7] Schoenwald, S., 2012, June. Comparison of proposed methods to include lightweight framed structures in EN 12354 prediction model. In Proceedings of the European Conference on Noise Control, Prague, Czech Republic (pp. 10-13).

[8] Pezeshk, S., Camp, C.V. and Chen, D., 2000. Design of nonlinear framed structures using genetic optimization. Journal of structural engineering, 126(3), pp.382-388.

[9] Thakkar, V.P., Chandiwala, A.K. and Bhagat, U.D., 2017. Comparative study of seismic behaviour of flat slab and conventional RC framed structure. International Journal of Engineering Research and Technology (IJERT), 6(04), p.929.

[10] Formisano, A., Landolfo, R. and Mazzolani, F.M., 2015. Robustness assessment approaches for steel framed structures under catastrophic events. Computers & Structures, 147, pp.216-228.

[11] Jagadeesan, P., Sudharsan, N., Subash, S.M., Thirumoorthy, P., Sugumaran, B., Bari, J.A., Vetturayasudharsanan, R., Ambika, D., Sharmiladevi, K. and Karuppanan, K., 2022. Study on Performance of Infilled Wall in an RC-Framed Structure Using a Reinforcing Band. Advances in Materials Science and Engineering, 2022.

[12] Ramirez-Gaytan, A., Preciado, A., Flores-Estrella, H., Santos, J.C. and Alcantara, L., 2022. Seismic resonance vulnerability assessment on shear walls and framed structures with different typologies: The case of Guadalajara, Mexico. Earthquakes and Structures, 22(3), pp.263-275.

[13] Desai, S.P. and Cholekar, S.B., 2013. Seismic behaviour of flat slab framed structure with and without masonry infill wall. International Journal of Engineering Research & Technology (IJERT), pp.2278-2181.

[14] Zhang, W.J., Li, G.Q. and Zhang, J.Z., 2021. Progressive collapse mechanism of steel framed-structures subjected to a middle-column loss. Advanced Steel Construction, 17(2), pp.199-209.

[15] Lagaros, N.D., 2007. Life-cycle cost analysis of design practices for RC framed structures. Bulletin of Earthquake Engineering, 5, pp.425-442.

 DOI : 10.35291/2454-9150.2023.0192