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Linear Analysis of Tall Buildings and Tension Cracking of Shear Walls

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Abstract:** This thesis presents a comprehensive study on the linear dynamic analysis of tall buildings and the tension cracking of shear walls, focusing on the structural integrity and seismic performance of high-rise structures. The research addresses the critical role of shear walls in providing lateral stiffness and strength, essential for resisting seismic forces in tall buildings. The study is divided into several key areas: the fundamentals of tall building design, the importance of shear walls, the mechanisms of tension cracking, and advanced methods for linear dynamic analysis. A detailed literature review sets the foundation by exploring historical developments, structural systems in tall buildings, and the significance of shear walls. Previous studies on linear dynamic analysis and tension cracking are critically examined to highlight gaps and establish the need for integrated analysis approaches. The methodology section outlines the selection of case studies, data collection, and the analytical procedures employed. Advanced software tools are used for modeling and simulation, incorporating architectural and design criteria. Linear dynamic analysis procedures, including response spectrum analysis (RSA), and modal analysis, are utilized to evaluate the dynamic response of tall buildings. Additionally, the study investigates tension cracking in shear walls, identifying causes, mechanisms, and influencing factors. The thesis concludes with a summary of findings, contributions to structural engineering, and suggestions for future research to enhance the seismic resilience of tall buildings. This work aims to inform and guide engineers and researchers in developing safer, more reliable tall building structures in earthquake-prone areas.
***Keywords:** Response Spectrum analysis, tall building, shear Wall, linear analysis, lateral stiffness*

I. INTRODUCTION

In recent decades, urbanization has led to a surge in the construction of tall buildings worldwide. Tall buildings, also known as high-rise structures, are emblematic of modern urban landscapes and serve as symbols of economic prosperity, technological advancement, and architectural innovation. The proliferation of tall buildings is driven by various factors, including population growth, land scarcity in urban areas, economic incentives, and advancements in construction technology. The concept of tall buildings has evolved over centuries, with ancient civilizations such as the Egyptians and Romans erecting monumental structures that reached impressive heights. However, it was not until the late 19th and early 20th centuries that tall buildings began to emerge as a distinct architectural typology. The advent of steel and reinforced concrete revolutionized building construction, enabling engineers and architects to design structures that could rise to unprecedented heights. The early 20th century witnessed the construction of iconic tall buildings such as the Empire State Building in New York City and the Chrysler Building, which showcased the architectural and engineering prowess of the time. These early skyscrapers relied on steel frames to support their vertical loads, allowing them to soar above their surroundings. Over the years, tall building design has evolved in response to changing societal needs, technological advancements, and environmental considerations. Structural systems have become more sophisticated, with engineers exploring innovative solutions to maximize efficiency, minimize material usage, and enhance occupant comfort and safety. One of the defining features of tall buildings is the presence of shear walls, which play a crucial role in providing lateral stability and resisting wind and seismic forces. Shear walls are vertical structural elements that are typically constructed from reinforced concrete or steel and are strategically placed throughout the building to distribute lateral loads and minimize sway. As tall buildings continue to proliferate in urban centers around the world, there is a growing need for comprehensive structural analysis and design methodologies to ensure their safety, resilience, and sustainability. The dynamic nature of tall buildings, coupled with the complex interactions between structural components and environmental forces, necessitates advanced analytical techniques and computational tools. In light of these considerations, this study aims to investigate the dynamic behavior of tall buildings and the phenomenon of tension cracking in shear walls. By employing linear dynamic analysis methods and conducting a detailed examination of tension cracking mechanisms, this search seeks to enhance our understanding of tall building performance and inform best practices in structural design and engineering.

A. Problem Statement

Tall buildings stand as remarkable feats of engineering, architecture, and urban development, but they also pose unique challenges in terms of structural design, stability, and safety. As urban populations continue to grow and land becomes increasingly scarce, the construction of tall buildings becomes more prevalent, emphasizing the urgency of addressing the complex issues associated with their design and construction. The problem statement for this study focuses on identifying and elucidating key challenges and concerns pertaining to the dynamic behaviour of tall buildings and the occurrence of tension cracking in shear walls.

1) Challenges in Dynamic Behaviour Analysis

- Complex Structural Response: Tall buildings are subjected to dynamic loads such as wind, seismic forces, and human-induced vibrations, leading to complex structural responses that can affect occupant comfort, safety, and overall building performance.
- Dynamic Interaction Effects: The dynamic interaction between structural components, including floors, columns, and shear walls, can amplify vibration levels and induce resonance phenomena, potentially leading to discomfort or structural damage.
- Performance Assessment: Accurately predicting the dynamic behavior of tall buildings requires sophisticated analytical tools and methodologies, posing challenges in terms of computational complexity, model calibration, and validation against real-world data.

2) Concerns Regarding Tension Cracking in Shear Walls

- Structural Integrity: Shear walls play a critical role in providing lateral stability to tall buildings and resisting wind and seismic forces. However, tension cracking in shear walls can compromise their structural integrity, leading to reduced performance and safety concerns.
- Causes and Mechanisms: Tension cracking in shear walls can arise from various factors, including inadequate reinforcement detailing, differential settlement, material properties, and construction practices. Understanding the underlying causes and mechanisms of tension cracking is essential for developing effective mitigation strategies.
- Predictive Models: Existing analytical models for predicting tension cracking in shear walls may lack accuracy or fail to capture the full range of influencing factors. Improving predictive models and validation against empirical data are necessary steps toward enhancing our ability to anticipate and prevent tension cracking occurrences.

3) To Investigate the Dynamic Behavior of Tall Buildings

- Conduct a comprehensive review of existing literature and empirical data to understand the dynamic behavior of tall buildings under various loading conditions, including wind, seismic forces, and human-induced vibrations.
- Employ advanced analytical techniques, such as linear dynamic analysis and modal analysis, to model and simulate the dynamic response of tall buildings.
- Explore the dynamic interaction effects between structural components, including floors, columns, and shear walls, to assess their impact on building performance and occupant comfort.

4) To Examine the Phenomenon of Tension Cracking in Shear Walls

- Investigate the causes and mechanisms of tension cracking in shear walls through a combination of theoretical analysis, empirical observations, and case studies.
- Develop analytical models and computational tools for predicting the occurrence of tension cracking in shear walls based on factors such as material properties, reinforcement detailing, and construction practices.
- Evaluate the reliability and accuracy of existing predictive models for tension cracking and identify areas for improvement and refinement.

5) To Explore the Correlation Between Dynamic Response and Tension Cracking

- Investigate the relationship between the dynamic behavior of tall buildings and the occurrence of tension cracking in shear walls through empirical data analysis and numerical simulations.
- Assess the influence of dynamic loading conditions, including wind and seismic forces, on the initiation and propagation of tension cracking in shear walls.
- Develop integrated analysis methodologies that incorporate dynamic response analysis and tension cracking assessment to provide a holistic understanding of tall building performance.

6) To Provide Practical Recommendations for Mitigating Tension Cracking and Improving Structural Performance

- Synthesize the findings from the investigation into practical recommendations and guidelines for mitigating tension cracking in shear walls and enhancing the structural performance of tall buildings.
- Identify best practices in shear wall design, construction techniques, and material selection to minimize the risk of tension cracking and ensure structural integrity and safety.
- Provide actionable insights for architects, engineers, and construction professionals involved in the design, construction, and maintenance of tall buildings, facilitating informed decision-making and improved building performance.

B. Scope

The scope of this study delineates the boundaries within which the research activities will be conducted and the extent to which the findings can be generalized. Additionally, it acknowledges the limitations inherent in the research approach, methodology, and available resources. The scope and limitations of the study are outlined as follows:

1) Tall Buildings: The study focuses primarily on tall buildings, defined as structures with a height significantly exceeding that of their surrounding built environment. While tall buildings may vary in terms of height, structural systems, and architectural design, the research findings aim to be applicable to a broad range of tall building typologies.
2) Dynamic Behavior Analysis: The study investigates the dynamic behavior of tall buildings under various loading conditions, including wind, seismic forces, and human-induced vibrations. It employs advanced analytical techniques, such as linear dynamic analysis and modal analysis, to model and simulate the dynamic response of tall buildings.
3) Tension Cracking in Shear Walls: The study examines the phenomenon of tension cracking in shear walls, which are critical components in tall building structural systems. It investigates the causes, mechanisms, and predictive models for tension cracking, aiming to provide insights into mitigating this structural concern.
4) Integration of Analysis Approaches: The study explores the correlation between dynamic response and tension cracking in tall buildings, aiming to develop integrated analysis methodologies. By combining dynamic behavior analysis with tension cracking assessment, the study seeks to provide a holistic understanding of tall building performance.

C. Significance of the Study

The significance of this study lies in its potential to advance the understanding of tall building engineering, contribute to the development of safer and more resilient structures, and inform best practices in structural design and construction. The study's significance is articulated in the following aspects:

1) Enhancing Structural Safety and Performance: Tall buildings are iconic structures that shape the modern urban landscape. By investigating the dynamic behavior of tall buildings and the occurrence of tension cracking in shear walls, this study aims to enhance the safety and performance of these structures. Through improved predictive models, design guidelines, and mitigation strategies, the study seeks to mitigate structural risks and ensure the integrity of tall buildings in the face of dynamic loading conditions.
2) Informing Design and Construction Practices: The findings of this study are expected to inform design and construction practices in the tall building industry. Architects, engineers, and construction professionals involved in the planning, design, and construction of tall buildings can benefit from the practical recommendations and guidelines developed through this research. By incorporating insights into shear wall design, reinforcement detailing, and dynamic analysis methodologies, practitioners can enhance the resilience and durability of tall buildings.
3) Advancing Structural Engineering Knowledge: The study contributes to the advancement of structural engineering knowledge by exploring the dynamic behavior of tall buildings and tension cracking in shear walls. By employing advanced analytical techniques and conducting empirical investigations, the study expands our understanding of the complex interactions between structural components and environmental forces. This knowledge can serve as a foundation for future research and innovation in tall building engineering.
4) Addressing Societal Challenges: Tall buildings play a crucial role in addressing urbanization challenges, including population growth, land scarcity, and sustainable development. By improving the safety, resilience, and sustainability of tall buildings, this study contributes to addressing societal challenges related to urbanization. Safe and resilient tall buildings enhance the livability of urban environments, support economic growth, and promote sustainable development practices.

5) Fostering Collaboration and Knowledge Exchange: The study fosters collaboration and knowledge exchange among researchers, practitioners, and stakeholders in the tall building industry. By disseminating research findings through academic publications, conferences, and professional networks, the study facilitates dialogue and collaboration among diverse stakeholders. This collaborative approach promotes the adoption of best practices, facilitates innovation, and fosters a culture of continuous improvement in tall building engineering.

II. LITERATURE SURVEY

J.Y.R. Liew et.al (2019) [1] This article covers the design and construction constraints of present modular construction of high-rise structures and proposes ideas to address these issues. To enhance available headroom, a slim floor system is presented that reduces floor-to-floor depth while ensuring that building services are integrated inside the structural zone. A unique low weight steel-concrete composite equipment is developed to minimize module weight while maintaining strength and stiffness. High strength concrete is used as an infill material for tubular columns to keep the column size consistent and prevent intricate connection details requiring modules with varied column diameters. Inter-module joints are represented as semi-rigid in order to capture realistic joint behavior in global analysis and assure the building's structural integrity and stability. Modular building has significant potential for increasing construction productivity and efficiency. The modular structure is expected to affect the future of the construction industry.

Baoyin Sun et.al (2019) [2] This paper establishes the multi-cross line model (MCLM) for reinforced concrete (RC) shear walls, which integrates micro- and macro-shear wall models. The model simulates stress-strain relationships at the material level using concrete or steel bars and determines the resultant stresses. The suggested model was verified using three RC shear wall specimens under cyclic stress conditions. Additionally, this approach has significant practical applications. In this study, MCLM was used to two planar shear walls and one 3D T-shaped shear wall. It effectively captured local and global responses such as stiffness degradation, plastic displacements, and pinching behaviors. Shear walls are in either linear or moderate nonlinear stages. In conclusion, the MCLM is a reasonably accurate, efficient, stable, and practically easy to use theoretical tool that can be used to simulate the nonlinear behaviors of RC shear walls in high-rise buildings during cyclic loadings, such as earthquakes.

Mehrnoosh Ramezani et.al (2019) [3] This article examines free vibration analysis for tall buildings with non-uniform cross-section structures. A novel and easy approach is proposed to address natural frequencies of free vibration in cantilevered tall buildings with varying flexural rigidity and mass density. A cantilever Timoshenko beam with different cross-sections could be used instead of existing systems. The governing partial differential equation for vibration of a nonuniform Timoshenko beam under various axial stresses is translated with varying coefficients to its weak form of integral equations. A novel method for resolving the free vibration of tall building structures with continuously fluctuating axial forces, mass density, and flexural rigidity is proposed. Additionally, it has been demonstrated how to use the weak form integral equations to find the natural frequencies of tall structures undergoing shear flexural deformation. The method's efficiency was proven by comparing numerical results to those available for framed tube, tube-in-tube, and frame tube with belt truss and outrigger structures, including uniform and nonuniform cross-sections under varying axial loads.

K. Wijesooriya et.al (2020) [4] This paper presents an innovative and efficient numerical approach for predicting wind induced dynamic responses of a tall building. The method uses an uncoupled fluid structure interaction (FSI) approach, where wind flow data obtained from a validated Computational Fluid Dynamics (CFD) analysis was used to obtain structural responses of the 184 m tall CAARC (Commonwealth Advisory Aeronautical Research Council) building with a typical facade. This innovative pressure-to-load conversion approach allows for an implicit modal time history analysis to forecast the structure's dynamic behavior. A comprehensive transient structural study was conducted to test this new technology. The proposed mapping and implicit analysis technique performed in 45 seconds and achieved comparable numerical precision to a thorough transient analysis that took 2 clock hours. To showcase the methodology, the proposed method was applied to the standard CAARC building where building responses were predicted.

Xin Nie et.al (2020) [5] In this Study Four shear-critical RC shear walls were tested with a tension-bending-shear load to simulate seismic behavior in high-rise buildings. Each specimen showed a shear compression failure mode, with an inclined crack at 45° and direct strut action. Shear displacement was the primary deformation component during the loading process. In addition, this work presents a unique experimental method for determining transverse reinforcement shear resistance (Vs) using plasticity theory and strain measurements. A database of RC shear walls with combined tension-bending-shear loads was created to assess shear strength calculations in design codes. The Chinese code predicted higher tension-shear capacity than the US code, indicating a potential bias.

Najah Assainar and Sujit Kumar Dalui (2020) [6] This research aims to evaluate the effectiveness of aerodynamic modifications on a pentagonal-shaped model by computational fluid dynamics (CFD) simulation using ANSYS CFX software. The study found that the chamfered model is the most effective corner modification for reducing wind loads in terms of pressure and force coefficients, while also demonstrating outstanding dynamic performance. The study found that the tapered model reduced pressure and force coefficients during static analysis, outperforming other aerodynamic shapes. The investigation could lead to the following conclusions. The chamfered model was found to be best effective aerodynamic modification in reducing both pressure and force coefficient's, Aerodynamic models like setback and tapering showed more steady reduction in both pressure and force coefficients than corner modifications.

Fangwei Hou and Mohammad Jafari (2020) [7] This paper analyzes previous studies on wind response in tall buildings, offering detailed information on the mechanism and identification methodologies. Understanding wind-induced reaction can improve urban sustainability by designing taller buildings that are less subject to wind loads, resulting in more energy-efficient and occupant-friendly communities. Quantifying wind-induced loads and responses on high-rise buildings is crucial, using both traditional and modern methods. This paper provides a comprehensive assessment of current methodologies for studying wind-induced responses in tall buildings. Three commonly utilized methodologies, wind tunnel testing, numerical simulation, and field measurement, are thoroughly addressed. Each methodology has advantages and disadvantages when assessing wind-induced responses in tall buildings.

Han-Soo Kim et.al (2020) [8] This work utilizes a gradient-based nonlinear programming approach to determine the best outrigger positions for minimizing top drift in tall buildings. The proposed optimization method utilizes finite element analysis to assess the objective function for structures with arbitrary configurations. Design factors, such as outrigger placements, are addressed by piecewise linear and quadratic interpolation functions. A series of optimum designs for three analysis models with varying vertical profiles were undertaken to study the relationship between outrigger stiffness and optimal position by adjusting the cross-sectional area of outriggers. The design results show a minor link between outrigger stiffness in a practical range and its ideal placement. Therefore, variables related to outrigger optimum location and stiffness can be addressed separately for design reasons.

David Ugalde and Diego Lopez-Garcia (2020) [9] This observation shows that the earthquake capacity of these buildings exceeds the seismic design code requirements. Three building structures with 5, 17, and 26 stories survived the 2010 Chile earthquake with little visible damage, providing insight into the issue. In initial analyses, nominal approaches are employed to determine seismic demands and member capacities. The second round of analyses involves calculating earthquake demands using reaction history analysis and evaluating member capacities using cutting-edge technologies. Nominal calculations do not support the reported lack of damage in 17- and 26-story buildings. Response history analysis yields consistent results, but only after accounting for foundation uplift. The structures evaluated in this study are indicative of Santiago's enormous building portfolio. While foundation uplift is feasible, it was not documented following the 2010 earthquake. Although foundation uplift may have occurred in a few buildings, it is unlikely to explain why the 17- and 26-story buildings analyzed in this study, as well as many other similar buildings, remained unharmed after the 2010 Chile earthquake.

M.A. Cando et.al (2020) [10] This study examines how stiffness affects seismic performance in residential shear wall buildings according to Chilean requirements, such as DS60 and DS61. The research examines the impact of stiffness on building overstrength, displacement ductility, fragility for Life Safety (LS), and collapse limit states, as well as the likelihood of hitting these limits within 50 years. This study examines the seismic performance of four 20-story residential shear wall buildings in Santiago. A probabilistic seismic hazard analysis was conducted, taking into account the seismicity of Chile's central zone, to predict the likelihood of reaching the two limitations in 50 years. Increasing stiffness decreases the likelihood of surpassing the LS and collapse limit states at the same intensity level. Probabilistic seismic hazard analysis indicates that increasing stiffness reduces the likelihood of reaching the LS limit state within 50 years.

Zhen Wang et.al (2020) [11] This article proposes incorporating precast shear walls with high-rise modules to create a new lateral force-resisting system. A finite element (FE) model was created to simulate the structural performance of precast concrete shear walls and validated by cyclic loading testing. The FE model successfully replicates the structural performance of precast concrete shear walls, and the suggested system is strong enough to withstand wind and seismic loads. These module walls replace traditional cast-in-situ cores or shear walls. The structural performance of the precast concrete shear walls was simulated using a developed finite element (FE) model. Conclusions of the paper are the developed FE model successfully reproduces the structural performance of precast concrete shear walls. First, it is confirmed that the FE model that was constructed can accurately replicate the precast concrete shear walls' structural performance. Second, it is discovered that the suggested lateral force resisting system has sufficient stiffness and strength to withstand wind loading as required by the HK wind code.

Shubhangi Jha et.al (2020) [12] The purpose of this research is to analyze and study how tall, plus-shaped buildings that have bracing systems oriented differently respond to wind loads. When the height of large buildings increases, the impact of wind load on the building becomes increasingly significant. Bentley STAAD Pro software v8i module was used to carry out response study The prototype building had a ground floor height of 4.5 meters and subsequent floor heights of 3.3 meters, following the G+35 design. Less axial force values were represented by the single diagonal bracing system. The axial force readings indicate a relatively gradual decline from the building's base to its thirty percent height, followed by a sharp decline to its summit. With the exception of the inverted V-bracing system for column B (Leeward position) at a 60-degree angle of attack, all systems were found to have very little twisting moment.

M.A. Bezabeh et.al (2020) [13] In this paper, we present a thorough analysis of the research gaps in this topic and lay the groundwork for future investigations. First, the anatomy of the Wind Loading Chain is explained, with special attention to Alan G. Davenport's early publications. After that, the constraints of the current practice of designing tall structures for wind are discussed. After that, we looked at the nonlinear response of simple yielding systems under long-duration turbulent wind loads in two phases to provide the groundwork for further research. In the first stage, the problem of damage accumulation in traditional structural systems which are defined by bilinear, elastic-plastic, decaying, pinching, and deteriorating hysteretic models was examined. In the second phase, novel techniques for creating PBWD performance objectives based on joint peak and residual deformation needs are presented. The usefulness of multi-variate demand modeling with kernel density estimation and copulas is discussed in this context. Using a case study example, the function of and necessity for explicit modeling of uncertainties in PBWD are also covered. A summary and a suggestion for more study round out this report.

Shazim Ali Memon et.al (2020) [14] This study provides a thorough analysis of six case studies of contemporary tall structures with difficult architectural designs and convoluted structural elements to handle lateral loads and gravity. Six exemplary tall buildings with unique structural systems that are indicative of the global architecture have been selected. The basic features of these tall structures around the world are covered in this paper, along with the difficulties encountered in the modeling, analysis, design, and construction of these skyscrapers. A summary of the approaches that were eventually used to address these difficulties is also provided. The paper focused on the latest developments in structural systems for tall structures and the difficulties brought about by sophisticated design techniques in the contemporary environment.

A. Research Gap

While significant research has been conducted on various aspects of tall building design and analysis, there remains a gap in our understanding of the dynamic behavior of tall buildings and the occurrence of tension cracking in shear walls. Existing studies often focus on static analysis or simplified models, overlooking the dynamic nature of tall buildings and the potential implications of tension cracking on structural performance. Addressing this research gap is essential for advancing the state-of-the-art in tall building engineering and ensuring the safety and resilience of future structures.

1) Overview of Tall Buildings

Tall buildings, often referred to as skyscrapers, represent architectural marvels that symbolize human ingenuity, technological advancement, and urban progress. These towering structures have become iconic features of modern cityscapes around the world, reshaping skylines and reflecting the aspirations of societies. An overview of tall buildings encompasses their historical evolution, defining characteristics, functional considerations, and societal impact.

Historical Evolution: The concept of tall buildings dates back to ancient civilizations, with historical examples such as the pyramids of Egypt and the ziggurats of Mesopotamia demonstrating early attempts to build vertically. However, it was during the late 19th and early 20th centuries, with the advent of steel frame and reinforced concrete construction techniques, that tall buildings began to rise to unprecedented heights. Landmark structures such as the Eiffel Tower, completed in 1889, and the Woolworth Building, completed in 1913, marked significant milestones in the evolution of tall building design and construction.

Defining Characteristics: Tall buildings are characterized by their exceptional height relative to their surroundings, often exceeding typical building heights by several orders of magnitude. While there is no universally accepted threshold for what constitutes a tall building, various classifications categorize buildings based on their height, form, and structural systems. Common features of tall buildings include slender profiles, vertical circulation cores, and innovative structural systems designed to withstand lateral and vertical loads.

Functional Considerations: Tall buildings serve diverse functions, ranging from commercial and residential use to hospitality, cultural, and mixed-use developments.

Their verticality allows for efficient land use in dense urban environments, maximizing floor area while minimizing ground footprint. Tall buildings may house office spaces, residential units, retail establishments, hotels, restaurants, observation decks, and other amenities, catering to the needs of occupants and visitors alike.

Societal Impact: Tall buildings have profound societal impacts, influencing urban development patterns, economic growth, and cultural identity. They serve as symbols of prosperity, innovation, and urban vitality, attracting investment, tourism, and talent to cities. However, their construction and operation also raise important considerations related to sustainability, environmental impact, and social equity. Issues such as energy consumption, carbon emissions, urban heat island effects, and access to amenities and public spaces require careful planning and management in the context of tall building development.

B. Historical Notes and Structural Models of Tall Buildings

The evolution of tall buildings is intricately woven into the fabric of architectural history, reflecting the changing needs, technological advancements, and societal aspirations of different eras. This section delves into the historical development of tall buildings, tracing their evolution from ancient structures to modern skyscrapers, and explores the various structural models that have shaped their design and construction.

1) Ancient Origins

The roots of tall buildings can be traced back to ancient civilizations, where monumental structures were erected as symbols of power, religion, and cultural identity. Ancient wonders such as the pyramids of Egypt, the ziggurats of Mesopotamia, and the temples of Greece and Rome stand as enduring testament to human ingenuity and engineering prowess. These early structures, though lacking the height and scale of modern skyscrapers, laid the foundation for vertical construction techniques and architectural innovation.

2) Early Innovations

The medieval period saw advancements in building technology and construction methods, leading to the emergence of tall structures such as cathedrals, castles, and towers. Gothic cathedrals, with their soaring spires and intricate stone vaults, pushed the boundaries of verticality and structural expression, showcasing the capabilities of medieval craftsmanship and engineering.

3) Industrial Revolution and the Rise of Steel

The 19th century witnessed the dawn of the industrial revolution, ushering in an era of unprecedented technological innovation and economic growth. The development of new materials, most notably steel and iron, revolutionized building construction, enabling architects and engineers to design taller and more robust structures. The advent of the steel frame structural system, pioneered by architects such as William Le Baron Jenney and Louis Sullivan, laid the groundwork for the modern skyscraper.

4) Skyscraper Boom of the 20th Century

The early 20th century witnessed a proliferation of tall buildings in cities around the world, fueled by rapid urbanization, population growth, and economic prosperity. Landmark structures such as the Empire State Building, the Chrysler Building, and the Woolworth Building in New York City became iconic symbols of American modernity and progress. These early skyscrapers, characterized by their steel frame construction, Art Deco styling, and sheer height, captivated the public imagination and set new benchmarks for architectural achievement.

5) Structural Models of Tall Buildings

Tall buildings employ a variety of structural models and systems to support their vertical loads and resist lateral forces such as wind and seismic activity. Common structural models include:

a) Steel Frame Construction: Steel frame structures consist of vertical columns and horizontal beams fabricated from steel, providing strength, durability, and flexibility. Steel frame construction allows for open floor plans, slender profiles, and rapid assembly, making it a popular choice for tall buildings.

b) Reinforced Concrete Construction: Reinforced concrete structures utilize concrete as the primary structural material, reinforced with steel bars or mesh to enhance tensile strength and ductility. Reinforced concrete offers versatility in design, enabling architects to create innovative forms and shapes while providing robust structural support.

c) Composite Construction: Composite structures combine the benefits of steel and concrete, utilizing steel beams encased in concrete to achieve optimal strength-to-weight ratios and structural efficiency. Composite construction is commonly used in tall buildings to capitalize on the strengths of both materials.

C. Structural Systems in Tall Buildings

Tall buildings require robust structural systems capable of supporting their vertical loads, resisting lateral forces, and ensuring stability and safety. The choice of structural system depends on various factors, including building height, form, function, architectural design, environmental conditions, and construction materials. This section examines the common structural systems employed in tall buildings and their characteristics, advantages, and limitations.

1) Steel Frame Construction

Steel frame construction is a versatile and widely used structural system in tall buildings. It consists of vertical steel columns and horizontal steel beams interconnected to form a rigid frame that supports the building's vertical and lateral loads. Steel frame structures offer flexibility in design, allowing for open floor plans, large spans, and slender profiles. The inherent strength and ductility of steel make it well-suited for tall building construction, enabling architects to achieve dramatic heights and architectural expression. However, steel frame construction may be more susceptible to fire damage and corrosion compared to other structural systems, necessitating fireproofing and protective coatings.

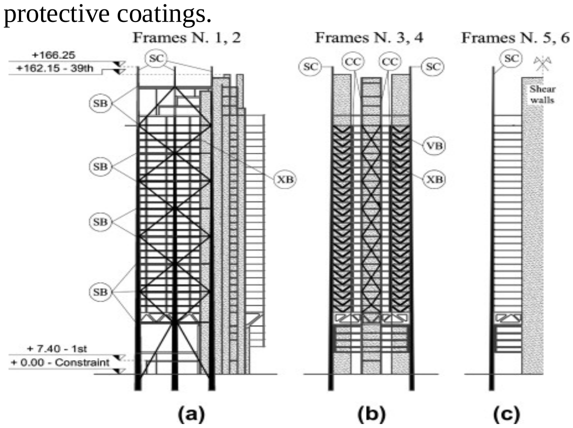

Figure E.1 Steel Frame Construction

2) Reinforced Concrete Construction

Reinforced concrete construction utilizes concrete as the primary structural material, reinforced with steel bars or mesh to enhance tensile strength and ductility. Reinforced concrete structures offer durability, fire resistance, and thermal mass, making them suitable for tall building construction. Concrete's moldability allows for a wide range of architectural forms and shapes, while the inherent mass and stiffness of concrete provide stability and vibration damping. Reinforced concrete buildings can be constructed quickly and cost-effectively, particularly in regions with abundant locally available materials. However, reinforced concrete structures may be heavier and require deeper floor plates compared to steel frame buildings, potentially impacting floor-tofloor heights and overall building height.

Figure E.2 Reinforced Concrete Construction

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3) Composite Construction

Composite construction combines the benefits of steel and concrete, utilizing steel beams encased in concrete to achieve optimal strength-to-weight ratios and structural efficiency. Composite structures offer the advantages of both materials, including high strength, durability, and fire resistance. By combining steel's flexibility and concrete's compressive strength, composite construction allows for long spans, reduced column sizes, and efficient use of materials. Composite buildings are often lighter and more slender than their steel or concrete counterparts, enabling architects to achieve taller and more aesthetically pleasing designs. However, composite construction may require specialized detailing and construction techniques to ensure proper integration of steel and concrete elements.

Figure E.3 Composite Construction

4) Tubular Systems

Tubular structural systems consist of a grid of perimeter columns interconnected by spandrel beams, forming a rigid tube that resists lateral loads. Tubular systems offer inherent stability, efficient use of materials, and flexibility in architectural design. By distributing lateral forces across the building's perimeter, tubular structures minimize column sizes and maximize usable floor space. Tubular systems are particularly well-suited for tall buildings located in seismic-prone regions, where lateral stability is paramount. However, tubular structures may be more challenging to adapt to irregular or asymmetrical architectural layouts, potentially limiting design flexibility.

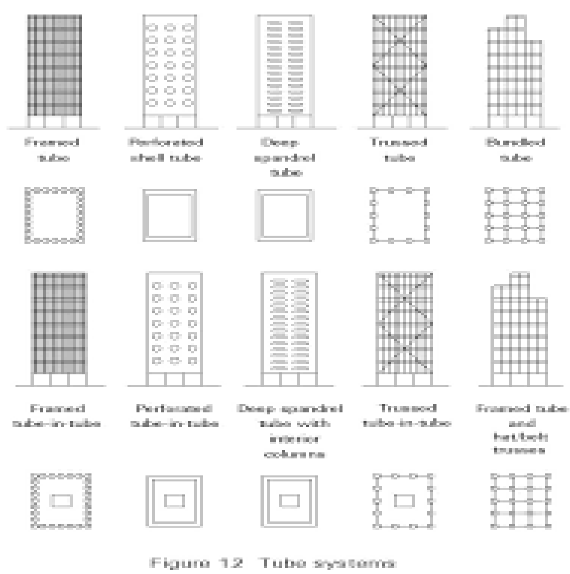

Figure E.4 Tubular Systems

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5) Diagrid Systems

Diagrid structures employ diagonal bracing elements to form a triangulated lattice, providing both structural support and architectural expression. Diagrid systems offer efficiency, aesthetic appeal, and structural redundancy, making them popular choices for tall building design. By distributing loads along diagonal members, diagrid structures minimize the need for interior columns, allowing for open and flexible floor plans. Diagrid systems are renowned for their iconic appearance, which often becomes a defining feature of the building's identity. However, diagrid structures may require specialized fabrication and construction techniques, adding complexity and cost to the project.

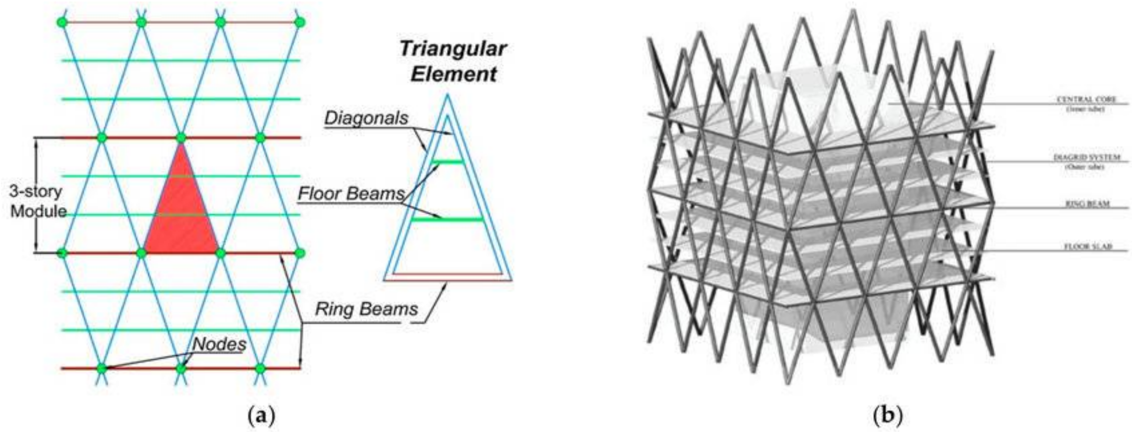

Figure E.5 Diagrid Systems

D. Tension Cracking of Shear Walls: Causes and Effects

Tension cracking in shear walls represents a significant structural concern in tall buildings, potentially compromising their integrity, performance, and safety. This section explores the causes, mechanisms, and effects of tension cracking in shear walls, shedding light on the factors contributing to this phenomenon and its implications for structural engineering practice.

1) Causes of Tension Cracking

Tension cracking in shear walls can result from various factors, including:

- Flexural Loading: Excessive bending moments induced by lateral loads, such as wind or seismic forces, can lead to tensile stresses in shear walls. If the tensile stresses exceed the capacity of the concrete or reinforcement, tension cracking may occur along the length of the shear wall.
- Construction Deficiencies: Inadequate construction practices, such as improper concrete placement, curing, or consolidation, can introduce weak zones or discontinuities in shear walls, making them susceptible to cracking under load.
- Material Properties: Variations in material properties, such as concrete strength, aggregate distribution, or reinforcement detailing, can affect the structural performance of shear walls and contribute to cracking phenomena.
- Foundation Movements: Differential settlement or lateral movements of the building foundation can impose additional stresses on shear walls, leading to cracking due to differential displacements or rotations.
- Temperature and Shrinkage Effects: Thermal gradients, moisture fluctuations, and drying shrinkage of concrete can induce internal stresses in shear walls, resulting in cracking over time.

2) Mechanisms of Tension Cracking

Tension cracking in shear walls typically occurs along regions subjected to high tensile stresses, such as the corners or edges of openings, reentrant corners, or zones of abrupt changes in wall thickness or geometry. Cracks may initiate at these stress concentrations and propagate gradually under cyclic loading or sustained stress conditions, leading to progressive deterioration of the structural integrity.

3) Effects of Tension Cracking

Tension cracking in shear walls can have several adverse effects on tall building performance and safety, including:

- Reduced Structural Capacity: Cracks in shear walls can compromise their load-carrying capacity and stiffness, leading to increased deflections, drift, and deformation under lateral loads.

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- Water and Moisture Intrusion: Open cracks in shear walls provide pathways for water infiltration, moisture migration, and corrosion of reinforcement, potentially accelerating degradation and reducing the durability of the structure.
- Aesthetic Concerns: Visible cracks in shear walls can detract from the aesthetic appearance of the building, affecting its perceived quality and market value.
- Serviceability Issues: Cracks in shear walls may result in occupant discomfort, noise transmission, or operational disturbances, impacting the usability and functionality of the building.

4) Mitigation Strategies

To mitigate tension cracking in shear walls, engineers may implement various design and construction measures, including:

- Optimized Reinforcement Detailing: Proper detailing of reinforcement, including the use of adequate reinforcement spacing, bar size, and development lengths, can enhance the ductility and crack resistance of shear walls.
- Controlled Concrete Placement: Careful attention to concrete mix design, placement techniques, and curing practices can minimize the risk of shrinkage cracking and ensure the quality and integrity of shear wall elements.
- Proper Structural Analysis: Accurate prediction of loading conditions, structural behavior, and performance through advanced analytical techniques, such as finite element analysis and nonlinear modeling, can help identify potential cracking mechanisms and optimize design solutions.
- Monitoring and Maintenance: Regular inspection, monitoring, and maintenance of shear walls throughout the building's lifecycle can identify early signs of cracking and deterioration, allowing for timely repairs or retrofitting measures to mitigate further damage

III.METHODOLOGY

A. Selection of Case Studies

The selection of case studies is a critical aspect of conducting research on linear dynamic analysis for tall buildings and tension cracking of shear walls. This section outlines the criteria and considerations used to identify and select appropriate case studies for the research investigation.

B. Linear Dynamic Analysis Procedures

Linear dynamic analysis procedures are essential for evaluating the dynamic response of tall buildings under various loading conditions. This section outlines the step-by-step procedures involved in conducting linear dynamic analysis for tall buildings, focusing on the methodologies, techniques, and software tools utilized in the analysis process.

1) Model Development

- Geometric Modeling: Develop a detailed geometric model of the tall building structure using structural analysis software. Define the building geometry, including floor plans, elevations, and structural elements such as columns, beams, and shear walls.
- Material Properties: Specify material properties for structural elements, including concrete, steel, and reinforcement. Define material characteristics such as modulus of elasticity, Poisson's ratio, density, and damping ratios based on design specifications and material test data.
- Boundary Conditions: Apply appropriate boundary conditions to the structural model to represent the support conditions and constraints. Define fixed supports, roller supports, and other boundary conditions based on the building's foundation type and structural connectivity.

2) Load Definition

- Dynamic Loads: Define dynamic loads representing wind, seismic, or other dynamic loading scenarios based on relevant design codes and standards. Specify load combinations, duration, and time histories for dynamic loading conditions to simulate realistic environmental effects.
- Load Cases: Define multiple load cases corresponding to different loading scenarios, including wind directionality, seismic hazard levels, and occupant activities. Consider transient loads, such as wind gusts, seismic ground motions, and human-induced vibrations, to capture dynamic response characteristics accurately.

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3) Analysis Setup

- Analysis Type: Select the appropriate type of linear dynamic analysis, such as modal analysis, response spectrum analysis, or time history analysis, based on the research objectives and loading conditions. Choose analysis techniques that best represent the dynamic behavior of tall buildings under varying excitation sources.
- Solver Settings: Configure solver settings, convergence criteria, and numerical integration methods for the dynamic analysis. Specify solution algorithms, time-stepping schemes, and damping models to ensure accurate and stable simulation of dynamic response phenomena.
- Output Requests: Define output requests to capture relevant response quantities, including displacements, velocities, accelerations, modal participation factors, and internal forces. Specify output formats, frequencies, and data sampling rates for post-processing and analysis.

4) Analysis Execution

- Numerical Solution: Execute the linear dynamic analysis using the selected structural analysis software. Run the analysis solver to solve the dynamic equilibrium equations and compute the structural response to prescribed loading conditions.
- Convergence Monitoring: Monitor the convergence of the analysis solution to ensure numerical stability and accuracy. Verify convergence criteria, error tolerances, and solution convergence for each load case and analysis step.
- Output Generation: Generate output files containing analysis results, including time histories of displacements, accelerations, and internal forces. Store output data in designated directories or databases for further processing and visualization.

5) Results Interpretation

- Post-Processing: Post-process analysis results to extract relevant information and evaluate dynamic response characteristics. Plot time histories, frequency spectra, and modal shapes to visualize the structural behavior under dynamic loading.
- Response Assessment: Assess the dynamic response of tall buildings in terms of displacement amplifications, modal frequencies, mode shapes, and inter-story drift ratios. Compare analysis results across different load cases and loading scenarios to identify critical response patterns and trends.
- Sensitivity Analysis: Perform sensitivity analyses to evaluate the influence of key parameters, such as building height, structural stiffness, damping ratios, and loading magnitudes, on dynamic response characteristics. Investigate the sensitivity of analysis results to variations in model assumptions and input parameters.

6) Validation and Verification

- Comparison with Experimental Data: Validate analysis results against experimental data from field measurements, structural tests, or previous studies. Compare predicted dynamic responses with observed behavior to assess the accuracy and reliability of the analysis.
- Verification of Modeling Assumptions: Verify the validity of modeling assumptions, boundary conditions, and material properties used in the analysis. Conduct sensitivity analyses and parametric studies to assess the robustness of the structural model and its ability to represent real-world behavior accurately.
-

C. *Architectural Modelling*

Structural Members Details

1) Columns Details

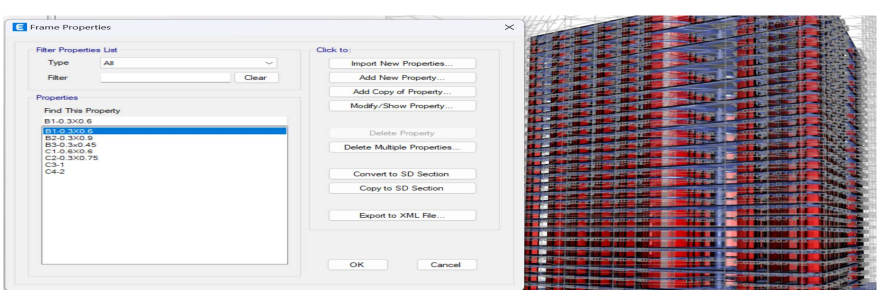

Figure E.6 Columns And Beams Sizes

2) Beams Details

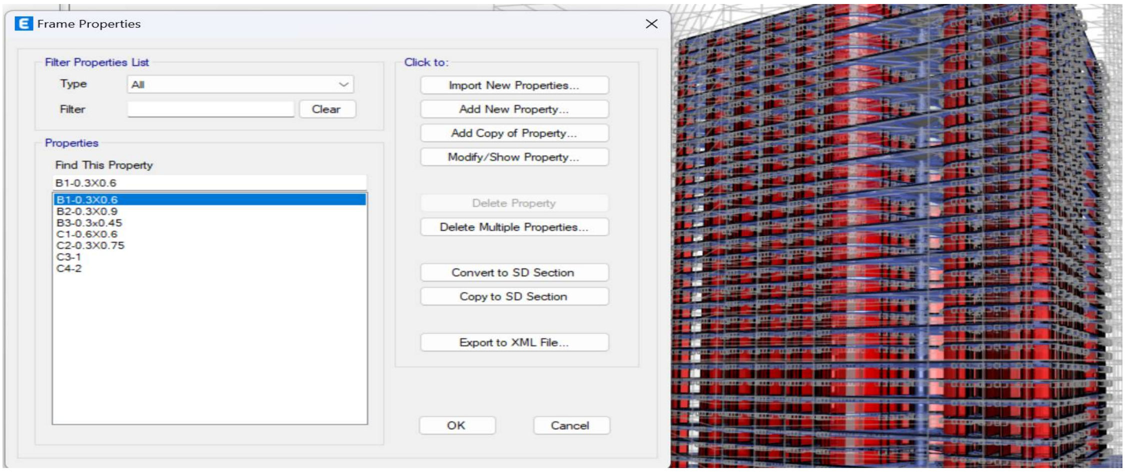

Figure E.7 BEAMS DETAILS

3) Shear Wall Details

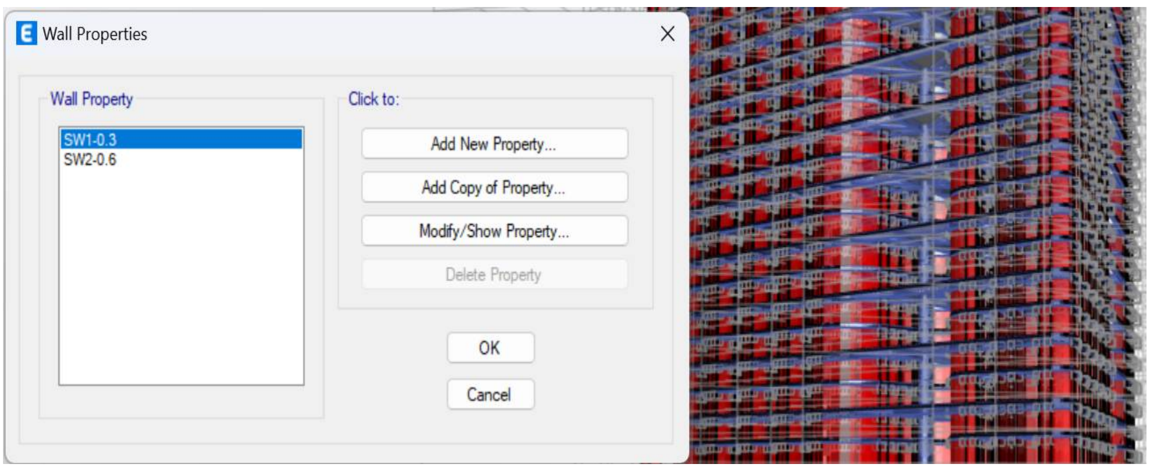

Figure E.8 SHEAR WALL SIZES

4) Slab Details

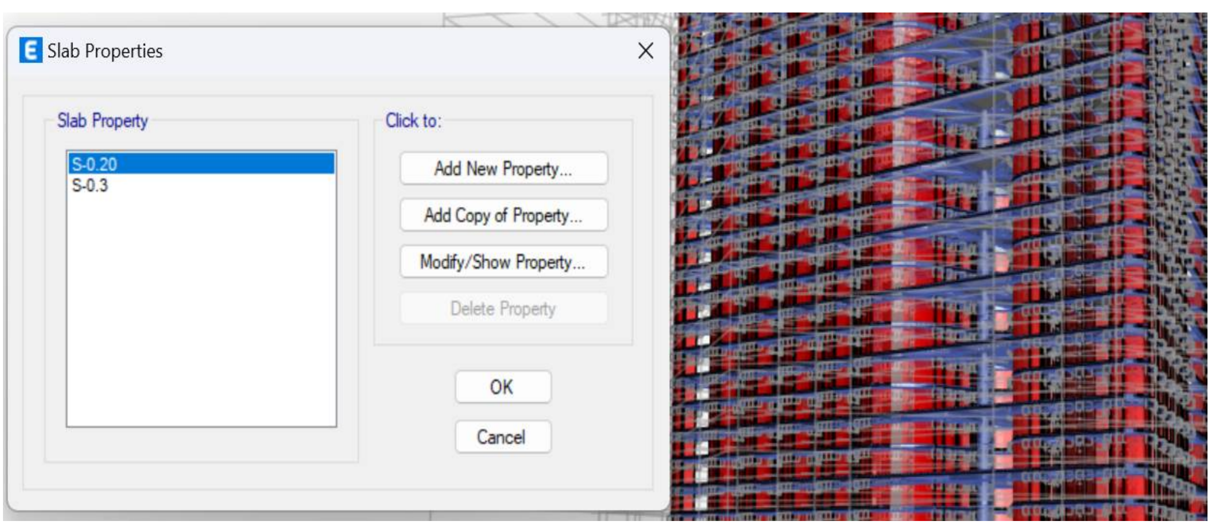

Figure E.9 Slab Details

5) Elevation 3D-view

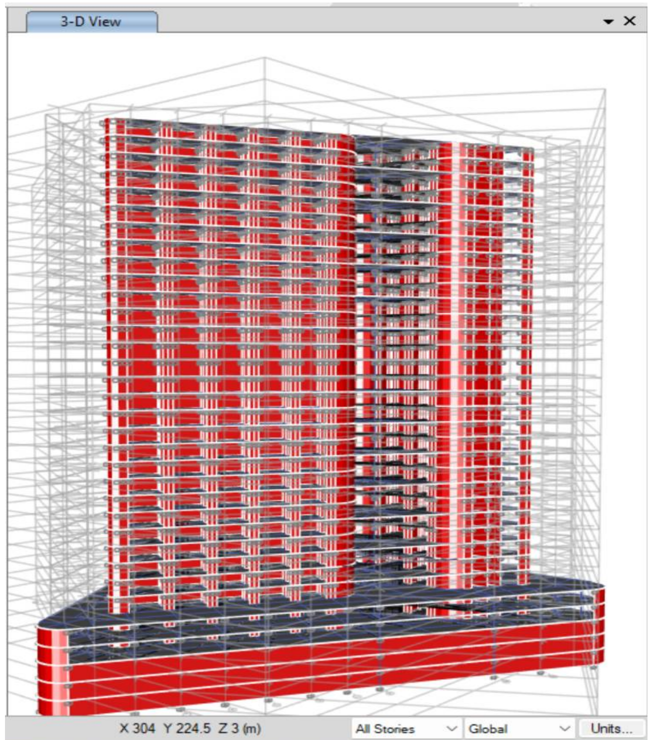

Figure E.10 Elevation 3D-view

6) Types of Property Modification Factors

- Material Strength Reduction Factors: Reduction factors adjust material strengths, such as concrete compressive strength and steel yield strength, to account for variability in material properties, workmanship, and environmental conditions. These factors ensure that structural designs have an adequate margin of safety against material uncertainties and variations.
- Load Reduction Factors: Load reduction factors modify applied loads, such as gravity loads, wind loads, and seismic forces, to account for load combinations, load duration effects, and probability-based criteria. These factors ensure that structural designs are robust and capable of withstanding extreme loading conditions without exceeding permissible stress limits.
- Temperature Modification Factors: Temperature modification factors adjust material properties, such as thermal coefficients and expansion coefficients, to account for temperature variations and thermal gradients in structural elements. These factors ensure that structural designs accommodate thermal effects, minimize thermal stresses, and maintain stability under temperature fluctuations

7) Columns Modification Factors

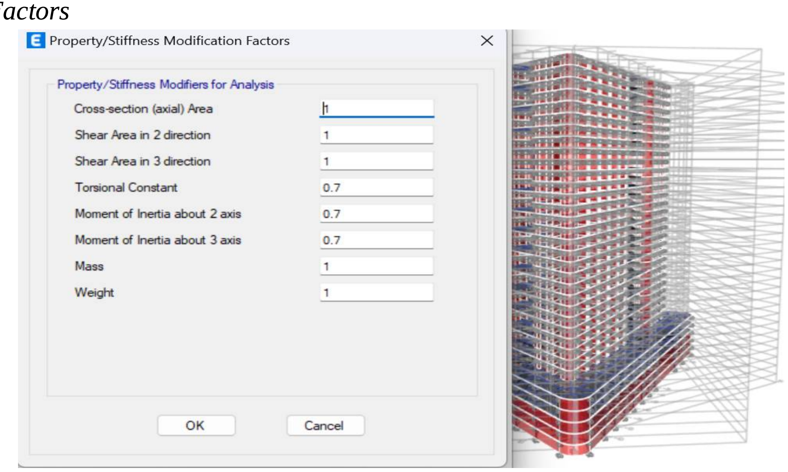

Figure E.11 Columns Modification Factors

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8) Beams Modification Factors

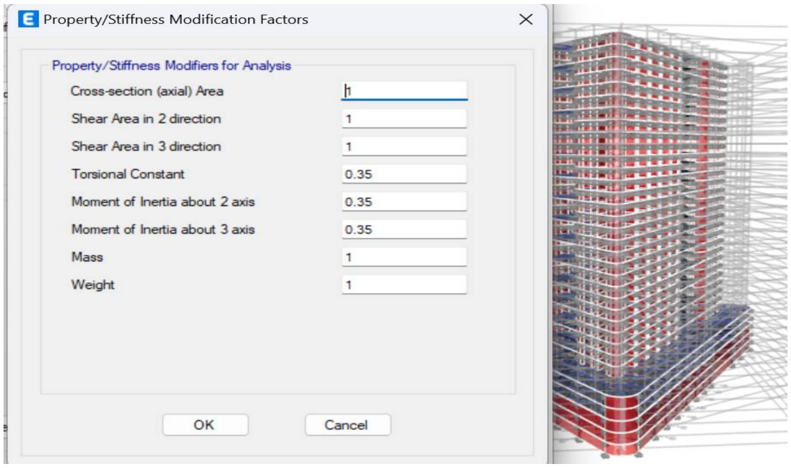


Figure E.12 Beams Modification Factors

9) Shear Wall Modification Factors

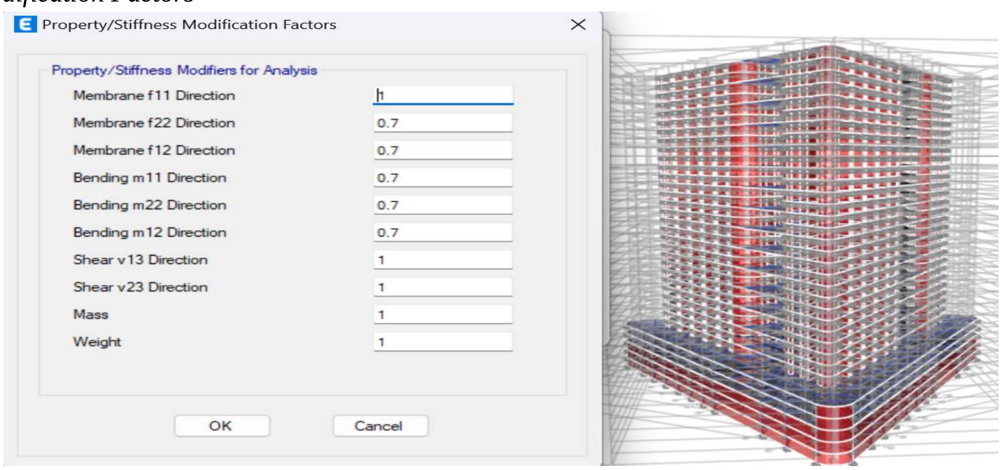


Figure E.13 Shear Wall Modification Factors

10) Slab Modification Factors

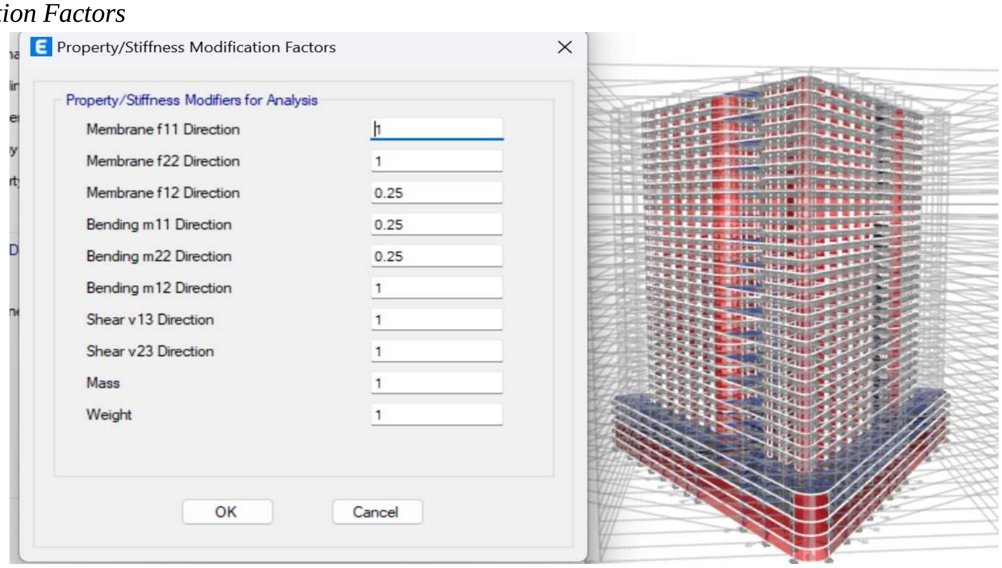


Figure E.14 Slab Modification Factors

D. Response Spectrum Analysis (RSA)

Response Spectrum Analysis (RSA) is a dynamic analysis method commonly used in the seismic design of tall buildings. This section focuses on the application of RSA to evaluate the structural response of tall building structures subjected to seismic loading.

Concept of Response Spectrum:

- Definition: The response spectrum is a plot of the maximum structural response (displacement, velocity, or acceleration) as a function of natural period or frequency for a given damping ratio. It provides a simplified representation of the dynamic characteristics of the structure under seismic excitation.
- Characteristics: The response spectrum captures the effects of different seismic input frequencies on the structural response, allowing engineers to assess the overall dynamic behavior and identify critical modes of vibration. It is derived from the seismic ground motion records and represents the maximum response for each vibration period.

IV. RESULTS AND DISCUSSION

The results and discussion section of the thesis report presents the findings of the analysis conducted on tall building structures using linear dynamic analysis techniques and examines the implications of tension cracking in shear walls. This section provides a comprehensive overview of the structural response, including dynamic behavior, modal characteristics, and the influence of tension cracking on structural performance.

A. Structural Response Analysis

1) Dynamic Behavior: The results of linear dynamic analysis reveal the dynamic behavior of tall building structures under different loading conditions, such as wind, seismic, and other dynamic loads. Engineers analyze the response of the structure in terms of displacements, accelerations, inter-story drifts, and modal characteristics to assess its performance and integrity.
2) Modal Characteristics: Modal analysis identifies the natural frequencies, mode shapes, and modal participation factors of the tall building structure. Engineers examine the dominant modes of vibration and their influence on the overall structural response, highlighting critical areas susceptible to dynamic effects.

B. Tension Cracking Analysis

1) Identification of Cracking Mechanisms: The analysis of tension cracking in shear walls investigates the causes and mechanisms leading to cracking under dynamic loading conditions. Engineers assess factors such as material properties, reinforcement detailing, and loading patterns to understand the initiation and propagation of cracks in shear walls.
2) Effects on Structural Integrity: The implications of tension cracking on the structural integrity and performance of tall building structures are examined. Engineers evaluate the severity of cracking, its impact on stiffness, strength, and ductility, and the potential for progressive failure or reduced serviceability.

C. Integration of Analysis Results

1) Correlation of Dynamic Response with Cracking: Engineers correlate the dynamic response of tall building structures obtained from linear dynamic analysis with the occurrence and propagation of tension cracking in shear walls. This integration provides insights into the relationship between dynamic loading, structural behavior, and crack formation.
2) Mitigation Measures: Based on the analysis findings, engineers propose mitigation measures to address tension cracking and enhance the seismic resilience of tall building structures. This may include improvements in reinforcement detailing, construction practices, and design criteria to minimize the risk of cracking and ensure structural safety.

D. Discussion and Implications

1) Structural Performance: The discussion evaluates the overall structural performance of tall building structures in response to dynamic loading and tension cracking. Engineers analyze the effectiveness of design strategies, construction techniques, and mitigation measures in improving structural resilience and reducing vulnerability to dynamic effects.
2) Design Recommendations: The implications of the analysis results are discussed in the context of design recommendations for tall building structures. Engineers propose guidelines, best practices, and code revisions to address the challenges posed by dynamic loading and tension cracking, ensuring the safety and reliability of future construction projects.

E. *Tension Cracking of Shear Walls*

Understanding Shear Walls and Their Function

Shear walls are essential structural components in tall building construction, playing a critical role in resisting lateral loads and providing overall stability to the structure. This section delves into the fundamental understanding of shear walls, their function, and their significance in tall building design.

F. *Definition and Characteristics*

1) Definition: Shear walls are vertical elements typically made of reinforced concrete or masonry that are strategically located throughout the building's floor plan to resist lateral forces, such as wind and seismic loads. They are designed to transfer these forces to the building's foundation and provide stiffness and strength to the structure.
2) Characteristics: Shear walls are characterized by their high aspect ratio, which refers to their height-to-width ratio. They are typically slender elements that extend over multiple stories of the building, allowing them to efficiently resist lateral loads while occupying minimal floor space.

G. *Function in Tall Buildings*

1) Lateral Load Resistance: The primary function of shear walls in tall buildings is to resist lateral loads generated by wind, seismic events, or other dynamic forces. Shear walls act as vertical cantilevered beams, transferring lateral forces to the foundation and preventing excessive horizontal displacement and deformation of the structure.
2) Structural Stability: Shear walls provide structural stability and prevent overturning, sliding, or collapse of the building under lateral loading conditions. By distributing lateral forces vertically and laterally, shear walls ensure that the building remains upright and maintains its overall integrity during extreme loading events.

H. *Role in Reducing Drift and Acceleration*

1) Inter-Story Drift Reduction: Shear walls mitigate inter-story drift, which refers to the relative displacement between adjacent floors of the building. By providing lateral stiffness and resisting lateral deflections, shear walls limit the magnitude of inter-story drift, ensuring occupant comfort and structural performance.
2) Acceleration Control: Shear walls also play a role in controlling acceleration levels within the building during seismic events. By enhancing the building's lateral stiffness and damping characteristics, shear walls reduce the acceleration experienced by occupants, minimizing the risk of injury and structural damage.

I. *Integration with Other Structural Systems*

1) Complementary Systems: Shear walls are often integrated with other structural systems, such as moment frames, braced frames, and cores, to enhance overall structural performance. These systems work synergistically to distribute loads, control deformations, and optimize the structural response of tall buildings under dynamic loading conditions.
2) Architectural Considerations: Shear walls are incorporated into the architectural design of tall buildings to achieve both structural and aesthetic objectives. Architects collaborate with structural engineers to integrate shear walls seamlessly into the building's layout while ensuring architectural expression and functionality.

J. *Causes and Mechanisms of Tension Cracking in Shear Walls*

Tension cracking in shear walls is a phenomenon that can occur due to various factors related to material properties, structural configuration, loading conditions, and construction practices. This section explores the causes and mechanisms behind tension cracking in shear walls, shedding light on the underlying factors that contribute to this structural concern.

Material Properties:

1) Concrete Properties: Variations in concrete strength, quality, and curing practices can influence the propensity for tension cracking in shear walls. Low concrete strength, inadequate curing, and material heterogeneity may lead to localized tensile stresses exceeding the concrete's capacity, resulting in cracking.
2) Reinforcement Details: Improper detailing of reinforcement, such as insufficient reinforcement cover, improper lap splices, or inadequate anchorage lengths, can compromise the structural integrity of shear walls. Inadequate reinforcement detailing may lead to localized stress concentrations and cracking in critical regions of the wall.

K. Factors Influencing Tension Cracking in Shear Walls

Tension cracking in shear walls is influenced by a multitude of factors, including material properties, structural configuration, loading conditions, construction practices, and environmental effects. Understanding these factors is crucial for identifying potential sources of cracking and implementing effective mitigation measures. This section explores the key factors that contribute to tension cracking in shear walls:

1) Material Properties

- Concrete Strength: Low concrete strength or inadequate curing can increase the susceptibility of shear walls to tension cracking, especially during dynamic loading events.
- Reinforcement Detailing: Insufficient reinforcement cover, improper lap splices, or inadequate anchorage lengths can compromise the bond between concrete and reinforcement, leading to localized stress concentrations and crack initiation.

2) Structural Configuration

- Aspect Ratio: Tall and slender shear walls with high aspect ratios may experience higher tensile stresses, particularly near the top and bottom of the wall, increasing the risk of tension cracking.
- Wall Openings: Openings or penetrations in shear walls for doors, windows, or service openings can weaken the structural integrity of the wall, leading to stress concentrations and crack initiation around openings.

3) Loading Conditions

- Lateral Loads: Wind loads, seismic forces, or other lateral loads impose significant tensile stresses on shear walls, particularly during dynamic loading events, increasing the risk of tension cracking.
- Differential Settlement: Non-uniform settlement or differential movement of the foundation can induce bending moments and shear forces in shear walls, leading to localized tensile stresses and crack formation.

4) Construction Practices

- Formwork and Construction Joints: Improper formwork installation, inadequate vibration during concrete placement, or discontinuities in construction joints can introduce weak planes or discontinuities in shear walls, promoting crack formation.
- Construction Sequence: Rapid construction schedules, premature loading, or inadequate curing periods may result in early-age cracking or delayed cracking due to shrinkage and thermal effects.

5) Environmental Effects

- Temperature Variations: Temperature differentials between the interior and exterior of the structure can induce thermal stresses in shear walls, potentially leading to cracking, especially in regions with significant temperature fluctuations.
- Moisture Exposure: Exposure to moisture or environmental conditions conducive to corrosion can degrade the durability of concrete and reinforcement, reducing the resistance of shear walls to tension cracking.

6) Design and Detailing Practices

- Reinforcement Layout: Proper detailing of reinforcement, including adequate spacing, development lengths, and anchorage details, is essential for distributing loads and minimizing stress concentrations that could lead to cracking.
- Load Path Continuity: Ensuring continuity of load paths from the superstructure to the foundation, including proper connection details and load transfer mechanisms, helps mitigate the risk of localized stress concentrations and crack initiation.

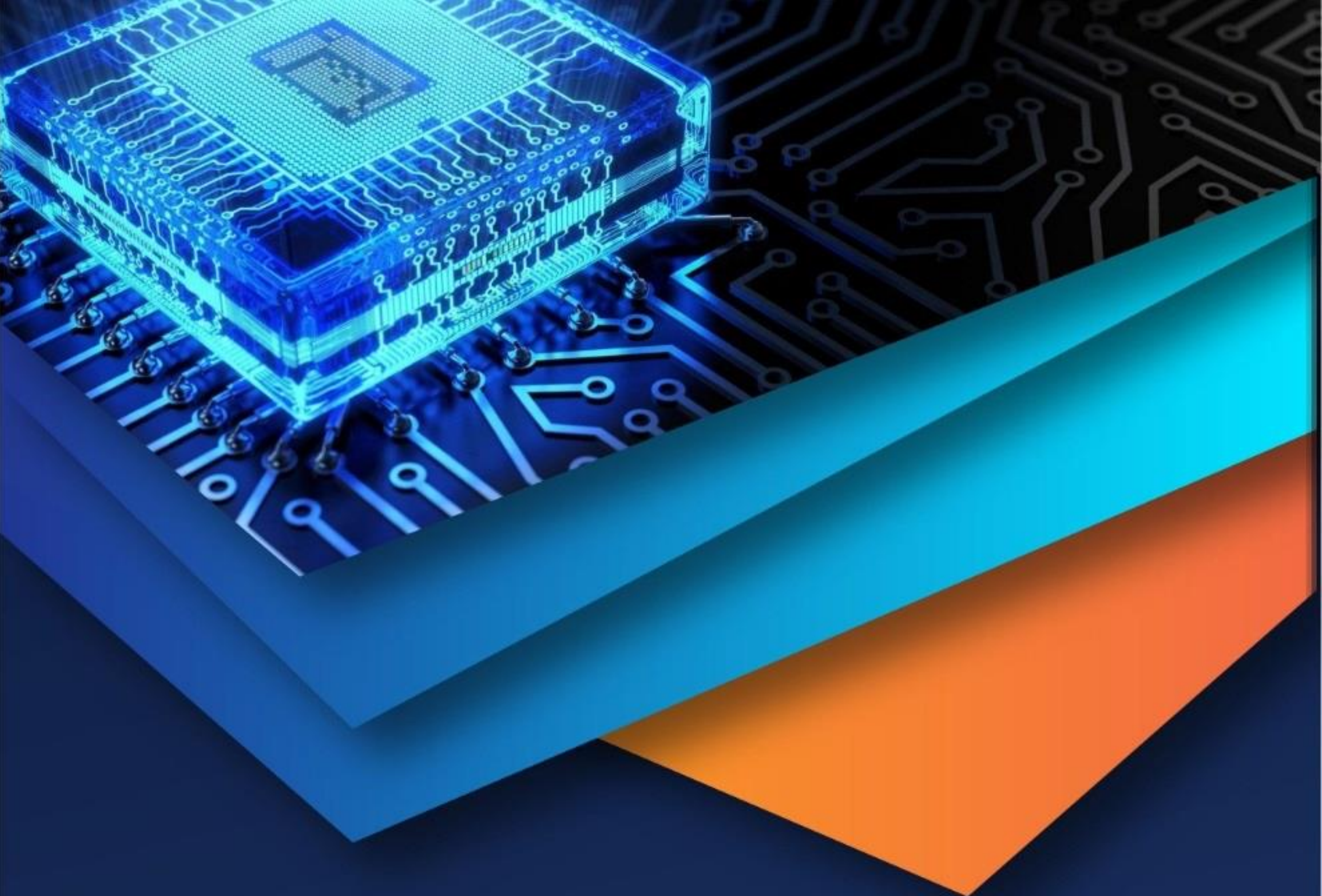
V. CONCLUSIONS

1) Identified critical regions of shear walls experiencing high dynamic loading-induced stresses, such as corners, wall openings, and re-entrant corners.
2) Found a correlation between areas of high dynamic response and regions prone to tension cracking, highlighting the importance of targeted crack mitigation measures.
3) Analyzed stress distributions and crack initiation mechanisms in shear walls under dynamic loading conditions.
4) Identified factors influencing crack propagation, including material properties, reinforcement detailing, and structural configurations.

5) Established serviceability criteria based on dynamic response spectra and tension cracking assessments to ensure structural performance meets design objectives.
6) Implemented crack control measures, such as reinforcement enhancements and wall configuration optimizations, to mitigate the risk of cracking and ensure serviceability.
7) Established crack monitoring programs to regularly inspect and monitor crack development in shear walls throughout the building's life cycle.
8) Conducted routine maintenance activities to prolong the service life of shear walls and minimize the risk of deterioration.

REFERENCES

[1] J.Y.R. Liew, Y.S. Chua, Z. Dai "Structures" 2019 ;21:135-149. https://doi.org/10.1016/j.istruc.2019.02.010
[2] Baoyin Sun, Quan Gu, Peizhou Zhang, Yong Li & Jinping Ou "Journal of Earthquake Engineering" 2021;25:1732-1761. https://doi.org/10.1080/13632469.2019.1597785
[3] Mehrnoosh Ramezani, Mohammad Reza Mohammadizadeh, Saeed Shojaee "The Structural Design of Tall and Special Buildings" 2019;28:5'. https://doi.org/10.1002/tal.1591
[4] K. Wijesooriya, D. Mohotti, A. Amin, K. Chauhan "Structures" 2020;25:448-462. https://doi.org/10.1016/j.istruc.2020.03.031
[5] Xin Nie, Jia-Ji Wang, Mu-Xuan Tao, Jian-Sheng Fan, Y. L. Mo, F. ASCE, and Zi-Yu Zhang "Journal of Structural Engineering" 2020;146:5' https://doi.org/10.1061/(ASCE)ST.1943-541X.0002596
[6] Najah Assainar and Sujit Kumar Dalui "Asian Journal of Civil Engineering" 2021; 22:33-48. https://doi.org/10.1007/s42107-020-00296-2.
[7] Fangwei Hou and Mohammad Jafari "Sustainable Cities and Society" 2020; 62:102736'. https://doi.org/10.1016/j.scs.2020.102376.
[8] Han-Soo Kim, You-Jin Lim and Hye-Lym Lee "Journal of Building Engineering" 2020;31:101379'. https://doi.org/10.1016/j.jobe.2020.101379.
[9] David Ugalde and Diego Lopez-Garcia "Journal of Building Engineering" 2020; 30:101369'. https://doi.org/10.1016/j.jobe.2020.101369 .
[10] M.A. Cando, M.A. Hube, P.F. Parra and C.A. Arteta "Engineering Structures" 2020;219:110724. https://doi.org/10.1016/j.engstruct.2020.110724.
[11] Zhen Wang, Wei Pan and Zhiqian Zhang "Structures" 2020;26:39-53. https://doi.org/10.1016/j.istruc.2020.04.006.
[12] Shubhangi Jha, Shreyansh Singh and Siddhant Choudhary "IJARET" 2020;11:371-380.
[13] M.A. Bezabeh1, G.T. Bitsuamlak and S. Tesfamariam "Wind and Structures" 2020;31:103-142. HTTPS://DOI.ORG/10.12989/WAS.2020.31.2.103.
[14] Shazim Ali Memon, Muhammad Zain, Dichuan Zhang, Sardar Kashif Ur Rehman, Muhammad Usman and Deuckhang Lee "Journal of Structural Integrity and Maintenance" 2020;5:155-170. https://doi.org/10.1080/24705314.2020.1765270
[15] Ayu Wandira Puspitasari and Jongwook Kwon "Journal of Asian Architecture and Building Engineering" 2021; 20:356-367. https://doi.org/10.1080/13467581.2020.1787839
[16] Sitaram Vemuri1 and Srimaruthi Jonnalagadda "IJAEM" 2023; 5:58-68.
[17] Phichaya Suwansaya and Pennung Warnitchai "Building" 2023; 13:3'.
[18] Wang, Jinyang, et al. "Development of a New Computational Model for Shear Wall-Frame Structure Based on Fiber Element Method." Advances in Structural Engineering, vol. 24, no. 10, 2021, pp. 2535-2552.
[19] Yang, Y. B., et al. "Seismic Damage Evaluation of a High-Rise Shear Wall Structure Based on Numerical Analysis." Journal of Earthquake Engineering, vol. 24, no. 1, 2020, pp. 156-175.
[20] Chopra, Anil K. Dynamics of Structures: Theory and Applications to Earthquake Engineering. Prentice Hall, 2011.
[21] Chopra, Anil K., and Raymond K. Goel. "A Modal Pushover Analysis Procedure for Estimating Seismic Demands for Buildings." Earthquake Engineering & Structural Dynamics, vol. 31, no. 3, 2002, pp. 561-582.
[22] FEMA P-695. "Quantification of Building Seismic Performance Factors." Federal Emergency Management Agency, 2009.
[23] Paulay, Thomas, and M. J. N. Priestley. Seismic Design of Reinforced Concrete and Masonry Buildings. John Wiley & Sons, 1992.



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