

Analysis Of Multistorey Commercial Building Using Etabs

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ABSTRACT

Shear walls are among the most effective structural components used in reinforced concrete (RCC) buildings to resist lateral loads caused by wind and seismic forces. Their proper placement significantly improves the stiffness, stability, and overall structural performance of high-rise buildings. This study investigates the effect of different shear wall locations on the behaviour of a G+30 multistorey commercial building using ETABS software. Four structural models were developed and analysed: a conventional frame structure without shear walls, a model with shear walls at the corners, a model with shear walls at the centre, and a model with shear walls at both the centre and corners. Linear static analysis was performed to evaluate key response parameters such as storey displacement and storey drift. The results indicate that the inclusion of shear walls considerably reduces lateral displacement and inter-storey drift compared to the conventional frame system. Among the analysed configurations, the model with shear walls placed at both the centre and corners exhibited the best structural performance, providing maximum stiffness and enhanced resistance against lateral loads. The study concludes that optimal shear wall placement is essential for improving the safety, serviceability, and seismic performance of high-rise commercial buildings.

Keywords: Shear wall, Commercial building, Storey drift, Storey displacement, ETABS

1. INTRODUCTION

Reinforced concrete shear walls serve as critical structural elements designed to withstand lateral forces generated by wind loads and seismic activity. These walls are typically integrated into buildings at strategic locations, including areas between column grids, stairwells, elevator shafts, and utility corridors. Their primary function involves transferring wind and earthquake forces directly to the building's foundation while simultaneously providing lateral rigidity to the overall structural system and supporting vertical gravity loads.

While reinforced concrete frame structures effectively handle both vertical and horizontal loading conditions, tall buildings present unique challenges. As building height increases, the required beam and column dimensions become substantially larger, creating congested reinforcement zones at structural joints. This congestion complicates concrete placement and consolidation procedures, while excessive lateral displacement generates significant internal forces throughout structural members.

Shear walls exhibit behavior similar to flexural elements and are essential components in high-rise construction to prevent structural failure. From both economic and deflection control perspectives, shear walls often become necessary design elements. When positioned optimally within a building's layout, these walls create highly effective lateral force resistance systems.

This study examines one commercial building model alongside four dual structural system configurations, all developed using ETABS software, to evaluate their comparative effectiveness and performance characteristics.

1.1 Shear Wall

Introduction and Importance: Within structural engineering practice, designing buildings capable of handling both gravitational loads and horizontal forces has gained paramount significance, particularly in regions susceptible to seismic events and high wind conditions. Shear walls stand out as among the most efficient and commonly implemented solutions for lateral force resistance. These vertical structural components are specifically engineered to counteract in-plane horizontal forces originating from wind pressure and earthquake motion. By providing both strength and rigidity, shear walls help buildings maintain structural form and stability during extreme loading events, substantially enhancing overall structural performance by restricting horizontal movement and averting potential structural failure.

Materials and Construction Methods: While shear walls can be constructed using various materials including reinforced masonry, steel, or timber based on construction methodology and local building practices, reinforced concrete remains the predominant choice due to its superior strength characteristics, longevity, and fire-resistant properties. These concrete walls may be either cast-in-situ or prefabricated, and are strategically positioned within building layouts, commonly surrounding stairwells, lift shafts, or along building perimeters. Strategic positioning maximizes lateral force resistance while simultaneously fulfilling functional and aesthetic requirements. Incorporating walls within service cores represents a prevalent design strategy that achieves both structural efficiency and optimal space utilization.

Structural Configurations: Multiple shear wall configurations exist to address varying structural requirements. The rectangular shear wall represents the most fundamental and prevalent type, offering simplicity in design and construction execution. Alternative arrangements include L-shaped, T-shaped, and U-shaped configurations, which may be necessary for architectural integration or specific structural demands. Coupled shear wall systems comprise multiple walls interconnected through coupling beams or floor slabs, functioning as unified structural elements that deliver enhanced strength and adaptability, particularly beneficial in tall building applications. Design considerations encompass not only dimensional specifications and reinforcement requirements but also strategic placement alignment with the building's mass center to minimize torsional responses during seismic events.

Seismic Performance and Design Standards: Shear walls assume critical importance in earthquake-prone regions. During seismic events, horizontal ground motion generates substantial lateral forces on structures, with shear walls serving as the primary defense mechanism by controlling building oscillation and preventing structural collapse. When properly engineered, these elements demonstrate ductile characteristics, enabling energy absorption and dissipation without catastrophic failure. Contemporary seismic design regulations, including IS 13920 for Indian applications and international frameworks such as ACI 318 and Eurocode 8, establish comprehensive guidelines for shear wall design, reinforcement, and detailing to ensure optimal performance under cyclic loading conditions. Critical detailing elements including confinement provisions, anchorage systems, splice arrangements, and boundary element specifications are essential for maintaining structural integrity during seismic loading.

Construction Implementation: From a construction perspective, shear walls offer relatively simple implementation compared to alternative lateral resistance systems such as braced frameworks or moment-resisting frames. Cast-in-place construction involves simultaneous forming and pouring with adjacent slabs and columns, creating monolithic structures with superior stiffness characteristics. Precast shear wall systems utilize off-site manufacturing followed by on-site assembly, potentially reducing construction duration while requiring meticulous connection detailing to preserve structural continuity. Irrespective of construction methodology, rigorous quality control measures and appropriate supervision remain fundamental to ensuring intended structural performance.

Summary and Future Applications: Shear walls constitute an essential element of contemporary structural systems, especially for medium to high-rise construction in areas experiencing elevated wind velocities or seismic activity. They provide substantial contributions to building lateral stability through horizontal force resistance and lateral deformation control. Beyond structural advantages, these elements integrate seamlessly with architectural design concepts, delivering both aesthetic and functional value. As urban development trends toward vertical expansion and emphasis on safety and resilience intensifies, shear wall implementation will continue as a cornerstone of earthquake-resistant and wind-resistant building design practices.

1.2 Story Drift

In structural engineering, particularly in the context of seismic analysis and design, story drift plays a fundamental role in evaluating the lateral deformation of multi-story buildings under dynamic loads. Story drift refers to the relative horizontal displacement between the floors of a building when subjected to lateral forces, such as those generated during an earthquake or high wind events. It is typically measured as the difference in displacement between the floor at the top and bottom of a story, divided by the height of that story, resulting in a dimensionless value known as the inter-story drift ratio. This parameter is crucial for assessing the deformation compatibility of structural and non-structural components, ensuring that both can endure seismic events without significant damage or loss of functionality. Engineers rely on story drift as a key performance metric to evaluate not just the strength but also the flexibility and ductility of structural systems under earthquake loading.

Story drift has a direct correlation with the potential damage a building may suffer during an earthquake. When a building sways laterally, the extent of that movement determines how much strain is placed on structural elements like beams and columns, as well as on non-structural components such as infill walls, facades, glazing systems, and mechanical or electrical installations. Excessive inter-story drift can lead to cracking or failure of masonry walls, detachment of cladding, misalignment or rupture of piping and conduits, and even progressive collapse in extreme cases. Historical earthquakes, including the 1994 Northridge earthquake in California and the 1995 Kobe earthquake in Japan, highlighted the destructive impact of uncontrolled story drift, especially in buildings with irregular stiffness distribution or inadequate detailing. These real-world events reinforced the necessity of incorporating drift control into modern seismic design philosophies to safeguard not only human life but also the functional integrity of critical infrastructure.

To mitigate these risks, building codes and seismic design standards around the world have established allowable limits on story drift. For example, the American Society of Civil Engineers (ASCE) Standard 7 specifies maximum inter-story drift ratios ranging from 1% to 2%, depending on the occupancy classification, structural system, and the expected level of seismic activity. Similarly, Eurocode 8, which governs seismic design in European countries, sets out comparable drift limits but allows for national adjustments to reflect local seismic conditions. These limits aim to strike a balance between structural resilience and economic feasibility, ensuring that buildings can withstand strong seismic shaking without sustaining irreparable damage. Importantly, these code-specified drift limits are typically evaluated under design basis earthquake (DBE) scenarios, which represent moderate to strong earthquake events with a reasonable probability of occurrence during the building's lifespan.

A major concern in seismic design is the presence of irregularities in drift distribution along the height of a building. One of the most critical forms of irregularity is the so-called "soft-story" mechanism, where one story—often the ground floor—has significantly less stiffness or strength compared to adjacent stories. This condition leads to a concentration of deformation in that specific story, increasing the risk of catastrophic failure. Soft-story collapses have been responsible for numerous building failures in past earthquakes, particularly in structures with open parking levels or commercial storefronts at the ground level. To address this issue, seismic codes require engineers to identify and correct such irregularities through increased lateral stiffness, careful load path design, and enhanced ductile detailing. In performance-based seismic design approaches, nonlinear static (pushover) and dynamic (time-history) analyses are frequently used to assess and mitigate soft-story behaviour, allowing for more accurate prediction and control of inter-story drift under realistic loading conditions.

Controlling story drift is not solely a matter of structural safety; it also has implications for building functionality and post-earthquake recovery. Non-structural components, which may not contribute to the lateral resistance of a structure, are often highly sensitive to drift-induced deformations. Hospitals, data centres, and emergency response facilities, for instance, require tight drift control to maintain operability after seismic events. As a result, stricter drift limits are applied to essential facilities, and engineers must carefully coordinate structural and architectural systems to accommodate expected deformations. Moreover, excessive drift can result in economic losses even when buildings do not collapse, due to the high cost of repairing damaged partitions, ceilings, windows, and mechanical equipment. Thus, drift management contributes significantly to community resilience and the sustainability of the built environment.

In conclusion, story drift is a key parameter in the seismic evaluation and design of buildings, capturing the lateral deformation demands imposed by earthquake ground motions. It serves as a critical indicator of both structural and non-structural performance, influencing everything from material selection and detailing to overall building configuration. Building codes and performance-based design frameworks have increasingly emphasized drift control to reduce damage, prevent collapse, and enhance post-earthquake recovery. As the engineering community continues to adopt more advanced modelling techniques and performance objectives, the role of story drift will remain central in the pursuit of safer, more resilient structures in earthquake-prone regions.

1.3 Story Displacement

Story displacement is a fundamental concept in structural engineering that refers to the horizontal movement of each floor level of a building when subjected to lateral forces such as wind, seismic loads, or impact. Unlike story drift, which measures the relative displacement between consecutive floors, story displacement denotes the absolute lateral movement of a specific story or level with respect to a fixed reference point, typically the base or foundation of the structure. This displacement occurs due to the lateral deformation of structural members under external loading and is a key indicator of how a building responds to lateral forces. Understanding story displacement is critical in predicting structural behaviour during extreme events and plays a central role in both elastic and inelastic response analyses.

The magnitude and pattern of story displacement vary depending on several factors, including the building's height, stiffness distribution, mass distribution, type of structural system, and the nature of the applied loading. In low-rise buildings, the displacement profile is generally more linear, while in high-rise structures, displacements tend to increase nonlinearly with height due to higher flexibility in upper stories. A proper understanding of displacement profiles enables engineers to design buildings that remain stable, even when subjected to strong lateral forces. Typically, maximum displacements occur at the roof level, and the shape of the displacement curve can indicate whether the structure is behaving as a rigid body, a flexible frame, or a combination of both. Identifying and controlling excessive displacement is vital to maintaining structural integrity and minimizing damage to both structural and non-structural components.

In seismic design, story displacement becomes especially significant as it directly relates to the lateral demand imposed by ground motion. During an earthquake, a building is subjected to a complex set of lateral accelerations that produce varying displacement patterns across different stories. The larger the displacement, the more likely it is that the building will experience structural distress, including yielding of members, large cracks, or failure of joints and connections. Moreover, excessive displacements can compromise vertical load paths, particularly in buildings with weak lateral systems, leading to partial or total collapse. As such, modern seismic design procedures emphasize the need to limit story displacements through appropriate structural configurations, lateral load-resisting systems (e.g., shear walls, braced frames, moment-resisting frames), and advanced material use that ensures both stiffness and ductility.

Building codes and design standards such as ASCE 7, Eurocode 8, and the International Building Code (IBC) provide explicit guidelines for evaluating story displacement and setting allowable limits. These limits are intended to prevent damage to structural and non-structural systems while ensuring safety, serviceability, and functionality. While story displacement is not directly limited in the same way as inter-story drift, it plays a vital role in assessing global structural behaviour and determining the design of key structural components. In performance-based design approaches, maximum story displacement is often checked against target thresholds that reflect specific performance objectives—such as immediate occupancy, life safety, or collapse prevention—under different seismic hazard levels. Engineers use various methods, including equivalent static force procedures, response spectrum analysis, and nonlinear time-history analysis to estimate displacements accurately during the design and assessment stages.

Story displacement is not only a measure of structural demand but also a determinant of comfort, especially in tall buildings where lateral movements can be perceptible to occupants. In high-rise structures, wind-induced displacements may not pose a structural threat but can cause discomfort, motion sickness, or even interfere with building services like elevators. In these cases, structural engineers must consider displacement control measures, such as increasing lateral stiffness, adding tuned mass dampers, or using outrigger systems to reduce overall movement. Furthermore, displacement compatibility is crucial for ensuring the proper functioning of expansion joints, facade systems, piping, and electrical conduits that span across stories or connect to external systems. If not designed to accommodate the expected displacements, these components may suffer from significant damage or failure even when the main structure remains intact.

In conclusion, story displacement is a vital parameter in understanding and designing the lateral response of buildings under various loading scenarios. It reflects the building's absolute movement during lateral excitation and is instrumental in evaluating stability, structural performance, and occupant comfort. Accurate prediction and control of story displacements are essential for meeting safety, serviceability, and resilience goals in structural design. As engineering practice evolves towards performance-based and resilience-focused methodologies, story displacement continues to serve as a key metric in achieving safer and more reliable built environments, particularly in regions exposed to significant seismic or wind hazards.

1.4 Shape and Location of Shear Walls

The shape and location of shear walls play a crucial role in the structural behaviour and performance of a building. While the material and strength of the wall are essential, the geometry and positioning of shear walls are equally important in ensuring efficient resistance to lateral loads. Poorly located or improperly shaped shear walls can lead to undesirable effects such as torsional movements, excessive deflections, or even structural failure under strong lateral forces. Therefore, understanding the influence of wall shape and location is essential in the design of earthquake-resistant and wind-resistant buildings.

Shear walls are available in a variety of shapes to suit different architectural layouts and structural requirements. The most common and simplest form is the rectangular shear wall, which is easy to design and construct. These

walls offer high stiffness and are usually placed symmetrically to balance lateral load resistance. In many modern buildings, however, space limitations and functional needs may require different geometries. For instance, L-shaped shear walls are typically used at the corners of buildings to provide resistance in both directions. Similarly, T-shaped and U-shaped walls offer enhanced rigidity and are often used in buildings with irregular floor plans or at points where greater lateral resistance is needed.

A particularly effective configuration is the box-type or core wall system, in which a central core of shear walls surrounds elevator shafts and stairwells. This arrangement behaves like a large tube and offers excellent torsional resistance and stability. Another variation is the coupled shear wall system, in which two or more walls are connected by horizontal beams (called coupling beams). This allows the walls to work together as a unified structural element, increasing ductility and energy dissipation capacity during seismic events. The shape and orientation of such coupled systems must be carefully analyzed to avoid stress concentration and ensure coordinated movement.

Equally important to shape is the location of shear walls within a building. Ideally, shear walls should be placed symmetrically along both principal axes of the structure to avoid torsion. If the centre of rigidity (from the shear wall system) and the centre of mass (from the building's total weight) do not align, it results in torsional eccentricity, causing the building to twist during lateral movement. This can amplify damage during earthquakes, particularly to the corners or extremities of the structure. Therefore, it is best to locate shear walls near the centre of the building or along both ends of the building in a balanced arrangement.

In practical applications, shear walls are often located around staircases, lift shafts, toilets, or service cores, where they do not interfere with open spaces or windows. This makes it possible to integrate them into the building design without compromising aesthetics or usable space. In residential buildings, for example, internal partition walls can be designed as structural shear walls. In commercial and high-rise structures, shear walls are often concentrated in the core area, contributing to a strong and centralized lateral load-resisting system. The distribution of shear walls across the height and width of the building must also be uniform to prevent weak or soft storey behaviour.

In conclusion, the shape and location of shear walls are key factors in achieving a well-performing and safe structural design. Properly shaped walls improve stiffness and strength, while strategic placement ensures balanced load distribution and minimizes torsional effects. When correctly integrated into the architectural and structural layout, shear walls not only enhance the safety of the building but also optimize construction efficiency and material usage. As a result, careful consideration of these factors during the planning and design stages is essential for constructing durable and resilient buildings.

II. LITERATURE REVIEW

Rajiv Banerjee et.al (2020) “Defining Optimum Location of Shear Wall in an Irregular Building by Considering Torsion” The present investigation establishes optimal shear wall positioning strategies for irregularly-shaped high-rise buildings. Selection criteria for effective shear wall locations are clearly defined and illustrated with practical examples. Dynamic analysis of multiple structural configurations is performed using ETABS version 16, utilizing Time History and Response Spectrum analysis methods. This work identifies key factors contributing to torsional response in tall buildings and demonstrates effective techniques for managing torsion and story drift through strategic shear wall integration in high-rise construction.

Md. Kawsarul Islam kabbo et.al (2024) “Dynamic Analysis of a G+13 Storey RCC Building Using Shear Wall in Three Different Location on Various Seismic Zone”. Contemporary seismic design protocols for multi-story reinforced concrete structures demand rigorous consideration of lateral force resistance mechanisms due to increasing global seismic activity. High-rise structural systems require sufficient lateral stiffness to accommodate earthquake-induced base shear and wind loading without exceeding serviceability and ultimate limit states. Shear walls function as specialized lateral force-resisting elements that provide in-plane stiffness and strength to counteract seismic loading, thereby enhancing overall structural performance of tall buildings through increased lateral rigidity. This investigation analyzes shear wall placement optimization in a G+13 residential structure to determine effective configurations for slender high-rise buildings through quantitative assessment of inter-story displacement, drift ratios, base shear coefficients, and fundamental period values across seismic zones as specified in IS 1893:2016. The analytical framework evaluates three structural configurations under varying seismic zone classifications: centralized core shear wall systems, perimeter corner shear wall arrangements, and hybrid core-corner combinations. The research objective focuses on determining structural capacity under code-prescribed

lateral loading and performance beyond allowable deformation thresholds. The computational model incorporates medium soil classification (Type II) with high-velocity wind loading of 148 mph (66.2 m/s) to simulate realistic environmental conditions. Experimental results demonstrate that hybrid core-corner shear wall configurations exhibit superior lateral load resistance characteristics compared to individual placement strategies, measured through reduced displacement profiles and enhanced stiffness distribution. However, analysis indicates that even optimized shear wall arrangements may provide inadequate protection for high slender structures subjected to maximum design ground motion in Zone V seismic regions, necessitating additional lateral force-resisting systems or enhanced damping mechanisms.

Vijayashree N et.al (2022) “Comparative analysis on seismic behaviour of multi storeyed RCC building in different soil strata considering the position of shear wall”. Seismic events originate primarily from tectonic fault rupture mechanisms within the earth's lithosphere, with additional sources including volcanic displacement, gravitational mass movements, explosive mining activities, and nuclear detonations. India's geographic location within active seismic zones necessitates rigorous earthquake-resistant design methodologies to ensure structural integrity under dynamic loading conditions. Contemporary engineering practice focuses on designing structures with adequate ductility and energy dissipation capacity rather than attempting absolute earthquake immunity, recognizing that economic feasibility requires balanced performance objectives. Shear walls function as primary lateral force-resisting elements that augment the structural capacity of reinforced concrete frame systems through in-plane stiffness and strength contributions. Structural irregularities, defined by vertical discontinuities in geometric configuration, mass distribution patterns, stiffness characteristics, and strength properties, create complex dynamic response behaviors that significantly influence seismic performance parameters. This research investigates the seismic response of a high-rise structure with systematically varied shear wall configurations to determine optimal placement strategies for enhanced structural performance. The analytical model comprises a 15-story building subjected to comprehensive displacement analysis, strength evaluation, and stability assessment using ETABS 2016 finite element software. The investigation incorporates Zone-II seismic design parameters with three distinct soil classification types: Type I (rock/hard soil with high shear wave velocity), Type II (medium dense soil with intermediate properties), and Type III (soft clay/loose sand with low bearing capacity) to evaluate site-structure interaction effects. Comparative analysis employs both equivalent static force procedure and dynamic response spectrum analysis to capture different aspects of seismic behavior. Analytical results are systematically documented in tabular format with graphical comparative presentations to quantify performance variations and establish design optimization criteria for shear wall placement in high-rise reinforced concrete structures.

Sekar Mentari et.al (2021) “Analysis of Effective Location of Shear Wall for High Rise Building with U – Configuration”. Indonesia is one of the countries that is prone to earthquakes. In addition to the dead loads, superimposed dead loads, and live loads, the design of buildings in Indonesia must be concerned with earthquake loads. Installing shear walls in the building structure as the Special Moment Frame Dual System is one of a solution to withstand earthquake loads. However, the location of shear walls must be considered, especially in buildings with horizontal irregularities. This study aims to determine the optimum location of the shear walls in a 10-storey building that has U-configuration with dynamic earthquake loads. This research is a numerical simulation ran by modelling the structure with software. To know the effect of the shear wall's location on a building, several variations of the shear wall configuration with different positions have been conducted. It can be seen the lateral displacement of each floor and the shear force are the response structure to withstand the dynamic earthquake loads. Shear walls that are located close to the centre of mass of the building are the optimum variation because the position of the shear wall is the closest to the core area of the building, which is the rotational axis of the building.

Ashikur Rahman Simon et.al (2023) “Orientation and location of shear walls in RC buildings to control deflection and drifts”. Lateral load-induced drift and deflection control constitutes a critical design consideration in high-rise structural systems subjected to wind loading and seismic excitation. Shear wall systems provide superior lateral force-resisting mechanisms through high in-plane rigidity and strength characteristics, enabling effective resistance to substantial horizontal force components while simultaneously carrying axial gravity loads through composite structural action. The geometric configuration and spatial distribution of shear walls within the structural framework significantly influence dynamic response characteristics and seismic performance parameters, with suboptimal placement potentially inducing mass-stiffness eccentricity that generates torsional coupling effects and compromises structural integrity under lateral loading conditions. This research investigates optimal shear wall placement strategies through parametric modelling and comparative analysis of reinforced concrete structures with systematically varied shear wall configurations to minimize drift amplification and

deflection response under lateral loading scenarios. A 10-story RC building model is developed using ETABS finite element software to evaluate five distinct shear wall arrangements: centralized core configuration, lateral and interior wall distribution, perimeter boundary placement, corner positioning, and hybrid center-perimeter arrangement. Each structural configuration undergoes rigorous analysis under combined lateral and gravity loading per BNBC 2020 design provisions, with quantitative performance assessment through comparative evaluation of story shear distribution (V_i), inter-story drift ratios (θ_i), lateral displacement profiles (Δ_i), lateral stiffness characteristics (K_i), torsional irregularity parameters ($\delta_{max}/\delta_{avg}$), and fundamental period values (T_1) relative to a reference bare frame system. Analytical results demonstrate that perimeter shear wall configuration provides optimal performance characteristics for drift and deflection control in reinforced concrete high-rise structures, exhibiting superior lateral load distribution, enhanced structural stiffness, reduced torsional effects, and minimized displacement response under seismic and wind loading conditions.

Md. Sohel Rana et.al (2024) “Investigation of RCC Structure with Shear Walls Positioned at Various Locations in a Multi-Storied Residential Building”. To address the limitations of horizontal land expansion, the world is experiencing a growing demand for tall buildings. Nevertheless, when erecting towering structures, it becomes essential to manage drift and deflection arising from lateral stresses such as wind and seismic activity. Typically, shear wall systems efficiently mitigate these lateral strains. The robustness and planar stiffness of shear walls enable them to withstand substantial horizontal stresses and gravity loads concurrently. A structure's ability to withstand lateral loads during seismic activity is significantly impacted by the direction and placement of its shear walls. Shear walls that are poorly constructed are the most frequent source of torsion, which is brought on by architectural eccentricities. Consequently, this study becomes significant in deciding the ideal area and direction of shear walls inside supported substantial designs to limit float and diversion. The findings of this study, derived from analyzing various shear wall configurations in a simulated ten-storey reinforced concrete building using ETABS software, hold significant importance. They demonstrate how effectively different shear wall layouts handle lateral pressures and provide recommendations for placing shear walls in reinforced concrete structures to improve their ability to withstand lateral loads during seismic activity. This study concludes that, compared to all models, Model 5 is safer and stiffer. Therefore, installing shear walls where model 5 of the building is located may provide maximum stiffness, rigidity, and the slightest deflection, thereby enhancing the structure's resilience to seismic activity.

Tarak Banerjee et.al (2021) “A Study on Optimizing the Positioning of Shear Walls for a Plus Shaped Irregular Building”. Structural irregularities in building plan configurations, specifically re-entrant corners and torsional irregularities, constitute critical parameters in seismic analysis due to their significant influence on dynamic response amplification and stress concentration mechanisms. Building geometries including U, H, V, E, and plus-shaped configurations, developed primarily to satisfy architectural functional requirements, demonstrate increased seismic vulnerability with damage concentration occurring at re-entrant corner locations due to abrupt changes in structural stiffness and mass distribution. Conventional mitigation strategies involve structural separation into discrete units through seismic joints, though plus-shaped tall multi-story buildings remain problematic as re-entrant corner irregularity ratios frequently exceed code-prescribed limits for plan irregularity coefficients. Shear wall systems in high seismic zones require specialized detailing provisions, with geometric placement serving as a fundamental parameter governing structural performance under dynamic loading conditions, where strategic positioning can significantly enhance seismic response characteristics without altering fundamental shear wall design specifications. Ten-story plus-shaped structural configurations with elongated wing elements exhibit increased susceptibility to corner stress concentrations and torsional coupling effects, manifesting as dog-tail wagging response modes characterized by differential displacement between structural wings during seismic excitation. This investigation evaluates three parametric shear wall placement strategies—centralized core positioning, flange edge installation, and re-entrant corner placement—through comparative seismic analysis to establish optimal performance characteristics and structural response behavior. Computational results indicate that strategic shear wall installation at re-entrant corner locations provides effective mitigation of irregular response characteristics by reducing stress concentrations, controlling torsional effects, and maintaining structural continuity in geometrically complex building configurations subjected to dynamic loading conditions, thereby establishing design optimization criteria for seismically resistant plus-shaped structures.

Priti P. Bhosale et.al (2021) “Structural Response of Storied Building for Orientation of Shear Wall.” Shear wall systems constitute primary lateral force-resisting elements in multi-story structural configurations, providing essential seismic safety through enhanced structural stiffness and strength characteristics against dynamic loading conditions. The principal objective of this analytical investigation involves determining optimal shear wall placement strategies in high-rise buildings through comprehensive linear static analysis (LSA) and linear dynamic

analysis (LDA) methodologies. Strategic geometric positioning of shear walls in multi-story structures significantly reduces seismic-induced displacement amplitudes, making location optimization a critical parameter in earthquake-resistant design. This research examines structural response behavior under systematically varied shear wall orientations to establish performance-based placement criteria for enhanced seismic resistance. The investigation methodology involves parametric analysis of building frame systems incorporating different shear wall locations and geometric orientations to identify optimal structural configurations through comparative performance assessment. Shear wall orientation analysis in high-rise buildings requires rigorous investigation during preliminary design phases as a fundamental component of seismic design optimization research. Consequently, this analytical framework focuses on determining appropriate shear wall placement strategies in high-rise reinforced concrete structures through advanced finite element modeling using ETABS-2017 software, establishing quantitative design guidelines for lateral force-resisting system optimization while ensuring compliance with seismic design provisions and structural performance objectives.

III. OBJECTIVES

1. Primary objective of this study is to analyze and design a G+30 commercial building using ETABS software.
2. To carry out the design of key structural elements, including beams, columns, slabs, and other essential components.
3. To study different parameter like story displacement, story drift.
4. To study the difference between normal model to shear wall model.

IV. METHODOLOGY

Study Objectives and Approach- To accomplish the research goals of analyzing and designing a commercial building using ETABS software while ensuring compliance with fundamental requirements including safety, durability, economic viability, aesthetic appeal, constructability, and practical implementation, the following systematic methodology has been established:

Primary Investigation Phase

- Site Assessment
- Geotechnical Investigation
- Structural Layout Planning
- ETABS-Based Analysis and Design
- Manual Verification Process
- Construction Detailing

Site Assessment and Investigation

Surveying forms the foundation of civil engineering practice. Prior to commencing any construction project, comprehensive site surveying must be conducted, followed by preparation of detailed plans and maps incorporating topographical information essential for structural design considerations.

Effective planning and execution of geotechnical site investigations are crucial for acquiring adequate site data necessary for structural design within appropriate timeframes and cost constraints. Laboratory testing determines critical soil engineering properties including moisture content, unit weight, and safe bearing capacity.

AutoCAD software is utilized for preparing structural layout plans.

Case Study Building This research examines a hospital facility featuring reinforced concrete framing with predetermined beam and column dimensions, orientations, and positioning as illustrated in the accompanying drawings. The reinforced concrete frame structure serves as the primary focus of investigation, with beam and column identification based on their respective locations and various building plan parameters.

ETABS Modelling Procedure

The centre line diagram is developed and imported into the ETABS model, following these sequential procedures:

Step 1: Material Property Definition

Navigate to Define menu → Material Properties to add new materials. Concrete grade M25 and steel grade Fe550 are specified in the material property definition. Structural component dimensions (beams, columns, and slabs) are determined based on design requirements.

Step 2: Property Assignment

Following property definition, structural elements are created using the Command menu → Draw Line for beam elements and Create Columns in Region for column elements.

Step 3: Support Assignment

With the plan positioned at the structure base and all columns selected, supports are assigned through Assign menu → Joint/Frame → Restraints (Supports) → Fixed.

Step 4: Load Definition

Loads are specified in ETABS using the Static Load Cases command within the Define menu. The following load parameters are established:

- Dead load from 230mm thick walls: 13.8 kN/m
- Live load: 2 kN/m²
- Floor finish load: 1.5 kN/m²

Step 5: Analysis Execution

Upon completion of the preceding steps, structural analysis is performed with error verification.

Step 6: Design Implementation

Following successful analysis completion, structural element design is executed according to IS 456:2000 specifications. This process involves accessing Design menu → Concrete Design → Select Design Combo, followed by Design menu → Concrete Frame Design → Start Design/Check of Structure, enabling ETABS to perform comprehensive design calculations for all structural components.

The analysis encompasses several key variables

Live Loading (Per IS 875 Part I):	: 2.0 kN/m ²
Floor Finish Loading:	: 1.5 kN/m ²
Concrete Compressive Strength:	: M25 (25 N/mm ²)
Steel Yield Strength:	: Fe500 (500 N/mm ²)
Minimum Clear Cover (Beams & Columns):	: 30 mm
Unit Weight of Concrete:	: 25 kN/m ³
Unit Weight of Masonry Wall:	: 18 kN/m ³

Building Details

Building Category	Commercial building
Framing System	Moment Resisting Frame
Story Count	30 stories
Height of building	90m
Partition Wall Thickness	30 mm (exterior walls), 150 mm (interior partitions)
Live load	2KN/m ² – Balcony, Corridor 1.5KN/m ² – All rooms
Concrete Grade Specification	M25
Reinforcement Steel Grade	HYSD500
Brick Masonry Density	18KN/m ³
Column Size Requirements	C1=230mmX300mm C2=230mmX450mm C3=230mmX525mm C4=230mmX600mm
Beam Dimensional Requirements	B1=230mmX300mm B1=230mmX450mm B2=230mmX525mm B2=230mmX600mm

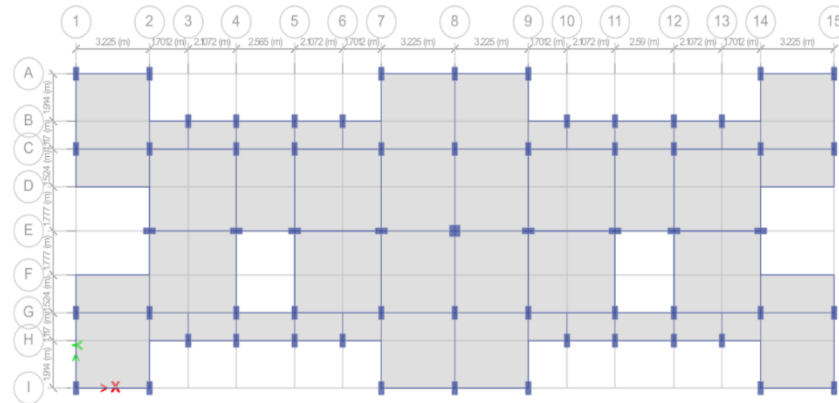
Floor Slab Thickness	150mm
Shear wall thickness	150mm
Zone	3
Importance factor	1.5

V.RESULT

Story displacement: Is defined as the absolute lateral movement of any floor level measured relative to the foundation.

presents story values (in mm) regular configurations Equivalent along the Y-

Model 1



The following displacement for various building subjected to Static Analysis direction.

Table 1

STORY	MODEL1
FOUNDATION	0
G.L	0.57
Story1	1.826
Story2	3.562
Story3	5.56
Story4	7.762
Story5	10.129
Story6	12.635
Story7	15.258
Story8	17.982
Story9	20.791
Story10	23.672
Story11	26.61
Story12	29.595
Story13	32.612
Story14	35.652

Story15	38.701
Story16	41.748
Story17	44.782
Story18	47.79
Story19	50.76
Story20	53.684
Story21	56.559
Story22	59.364
Story23	62.089
Story24	64.723
Story25	69.685
Story26	72.001
Story27	74.206
Story28	76.308
Story29	75.108
Story30	78.33

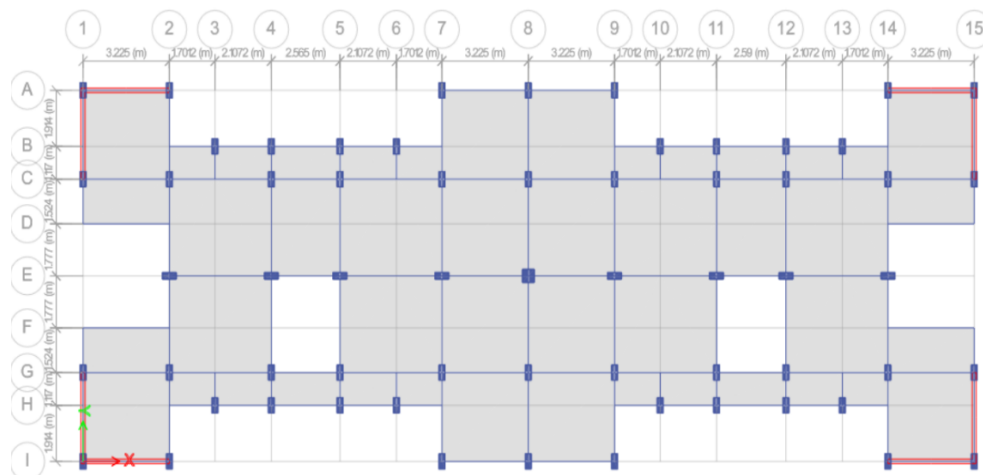
Story drift: It is defined as the ratio of relative displacement between consecutive floors to the corresponding inter-story height. The following presents story drift values (in meters) for various irregular building configurations subjected to Equivalent Static Analysis along the Y-direction.

Table 2

STORY	MODEL1
FOUNDATION	0.00019
G.L	0.000429
Story1	0.000579
Story2	0.000666
Story3	0.000734
Story4	0.000789
Story5	0.000835
Story6	0.000875
Story7	0.000909
Story8	0.000937
Story9	0.000961
Story10	0.000981
Story11	0.000996
Story12	0.001008
Story13	0.001015

Story14	0.001019
Story15	0.001018
Story16	0.001014
Story17	0.001006
Story18	0.000994
Story19	0.000978
Story20	0.000958
Story21	0.000935
Story22	0.000908
Story23	0.000878
Story24	0.000845
Story25	0.000809
Story26	0.000772
Story27	0.000735
Story28	0.000701
Story29	0.000674
Story30	0.00019

Model 2 ; Shear wall is provided at the corner of building.



Storey displacement

Table 3

STORY	MODEL 2
FOUNDATION	0
G.L	0.461
Story1	1.466

Story2	2.894
Story3	4.603
Story4	6.552
Story5	8.705
Story6	11.037
Story7	13.516
Story8	16.119
Story9	18.826
Story10	21.617
Story11	24.477
Story12	27.39
Story13	30.342
Story14	33.318
Story15	36.307
Story16	39.295
Story17	42.271
Story18	45.222
Story19	48.137
Story20	51.007
Story21	53.819
Story22	56.567
Story23	59.24
Story24	61.832
Story25	64.337
Story26	66.077
Story27	71.314
Story28	73.469
Story29	74.126
Story30	75.552

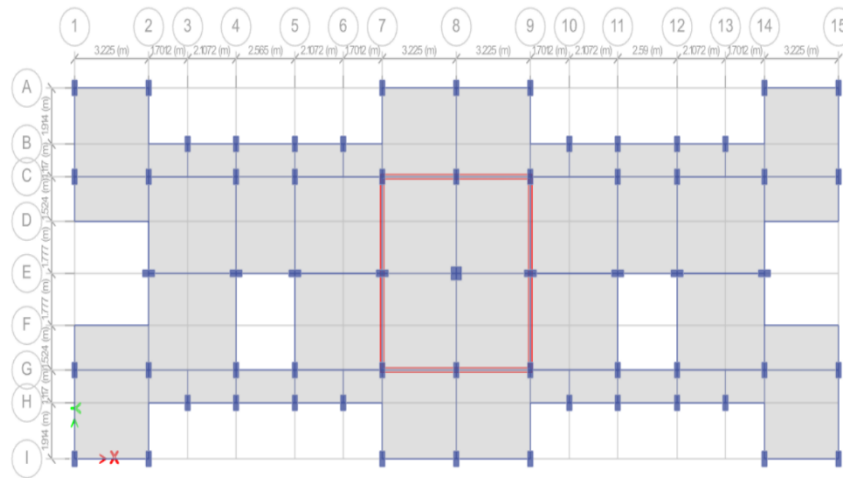
Storey drift

Table 4

STORY	MODEL 2
FOUNDATION	0
G.L	0.000154
Story1	0.000344
Story2	0.000476
Story3	0.00057
Story4	0.000651

Story5	0.00072
Story6	0.000777
Story7	0.000826
Story8	0.000868
Story9	0.000902
Story10	0.00093
Story11	0.000953
Story12	0.000971
Story13	0.000984
Story14	0.000992
Story15	0.000996
Story16	0.000996
Story17	0.000992
Story18	0.000984
Story19	0.000972
Story20	0.000956
Story21	0.000938
Story22	0.000916
Story23	0.000891
Story24	0.000864
Story25	0.000835
Story26	0.000805
Story27	0.000775
Story28	0.000745
Story29	0.000718
Story30	0.000695

Model 3: Shear wall is provided at centre of building.



Storey displacement

Table 5

STORY	MODEL 3
FOUNDATION	0
G.L	0.363
Story1	1.113
Story2	2.147
Story3	3.376
Story4	4.775
Story5	6.323
Story6	8.006
Story7	9.813
Story8	11.73
Story9	13.742
Story10	15.84
Story11	18.12
Story12	20.249
Story13	22.879
Story14	27.245
Story15	29.641
Story16	32.055
Story17	34.475
Story18	36.896
Story19	39.307
Story20	41.7

Story21	44.068
Story22	46.405
Story23	48.704
Story24	50.96
Story25	53.67
Story26	55.323
Story27	57.425
Story28	59.474
Story29	60.168
Story30	61.474

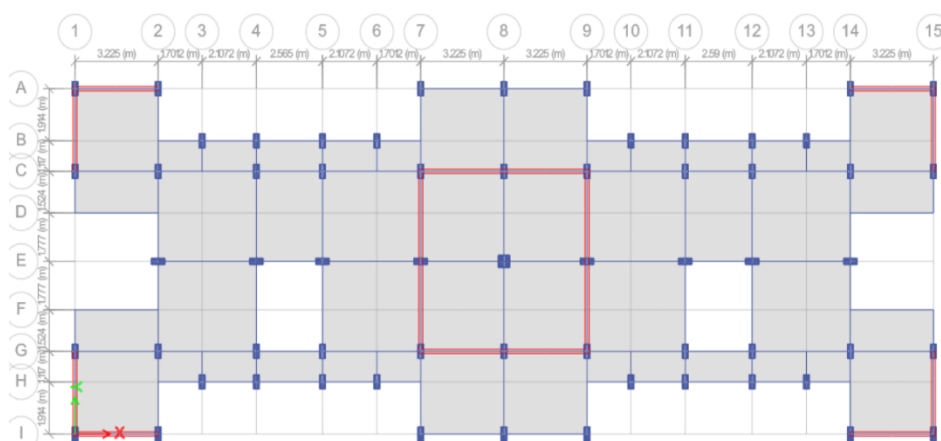
Storey drift

Table 6

STORY	MODEL 3
FOUNDATION	0
G.L	0.000121
Story1	0.000256
Story2	0.000345
Story3	0.00041
Story4	0.000466
Story5	0.000516
Story6	0.000561
Story7	0.000602
Story8	0.000639
Story9	0.000671
Story10	0.000699
Story11	0.000724
Story12	0.000745
Story13	0.000764
Story14	0.000778
Story15	0.00079
Story16	0.000799

Story17	0.000804
Story18	0.000807
Story19	0.000807
Story20	0.000804
Story21	0.000798
Story22	0.000789
Story23	0.000779
Story24	0.000766
Story25	0.000752
Story26	0.000736
Story27	0.000719
Story28	0.000701
Story29	0.000683
Story30	0.000667

Model 4: Shear wall are provided at centre and corners of building.



Storey displacement

Table 7

STORY	MODEL 4
FOUNDATION	0
G.L	0.294
Story1	0.902
Story2	1.74
Story3	2.75
Story4	3.913
Story5	5.212
Story6	6.634
Story7	8.171

Story8	9.807
Story9	11.535
Story10	13.342
Story11	15.221
Story12	17.162
Story13	19.156
Story14	21.196
Story15	23.273
Story16	25.379
Story17	27.506
Story18	29.646
Story19	31.793
Story20	33.939
Story21	36.077
Story22	38.2
Story23	40.304
Story24	42.381
Story25	44.428
Story26	46.44
Story27	48.415
Story28	50.351
Story29	52.249
Story30	54.108

Storey drift

Table 8

STORY	MODEL 4
FOUNDATION	0
G.L	0.000098
Story1	0.000206
Story2	0.000279
Story3	0.000337
Story4	0.000388
Story5	0.000433
Story6	0.000474
Story7	0.000512
Story8	0.000546
Story9	0.000576

Story10	0.000603
Story11	0.000626
Story12	0.000647
Story13	0.000665
Story14	0.00068
Story15	0.000692
Story16	0.000702
Story17	0.000709
Story18	0.000714
Story19	0.000716
Story20	0.000715
Story21	0.000713
Story22	0.000708
Story23	0.000701
Story24	0.000693
Story25	0.000682
Story26	0.000671
Story27	0.000658
Story28	0.000645
Story29	0.000632
Story30	0.00062

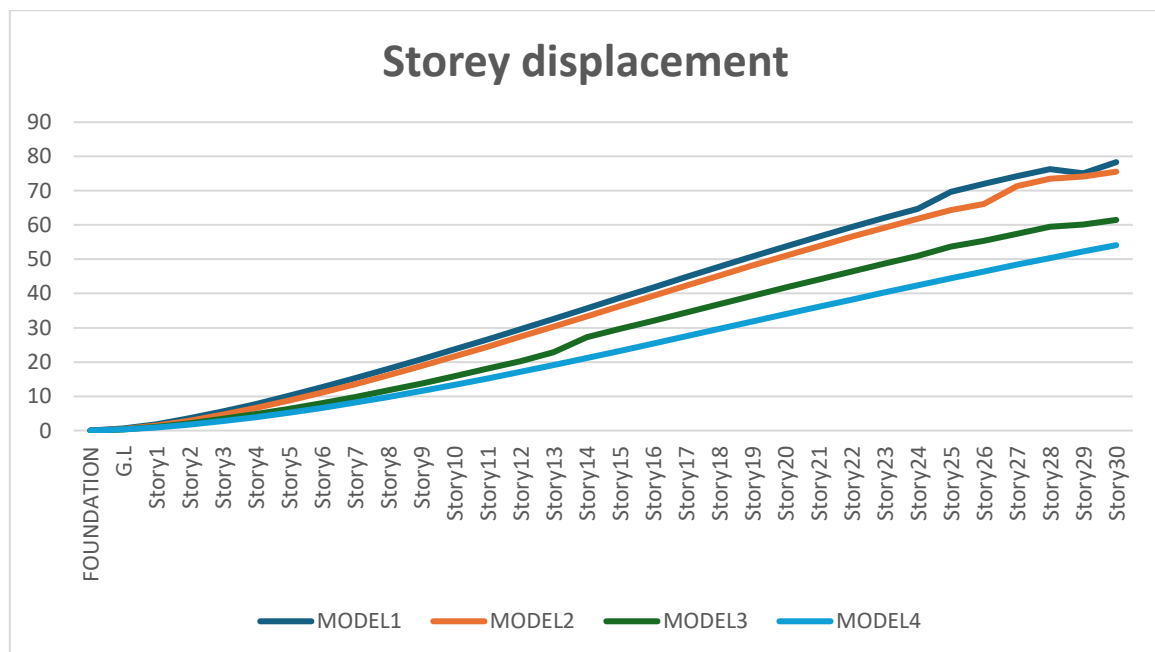
Storey displacement

Table 9

Story	Model: 1	Model: 2	Model: 3	Model: 4
FOUNDATIO N	0	0	0	0
G.L	0.57	0.461	0.363	0.294
Story1	1.826	1.466	1.113	0.902
Story2	3.562	2.894	2.147	1.74
Story3	5.56	4.603	3.376	2.75
Story4	7.762	6.552	4.775	3.913
Story5	10.129	8.705	6.323	5.212
Story6	12.635	11.037	8.006	6.634
Story7	15.258	13.516	9.813	8.171
Story8	17.982	16.119	11.73	9.807
Story9	20.791	18.826	13.742	11.535
Story10	23.672	21.617	15.84	13.342
Story11	26.61	24.477	18.12	15.221

Story12	29.595	27.39	20.249	17.162
Story13	32.612	30.342	22.879	19.156
Story14	35.652	33.318	27.245	21.196
Story15	38.701	36.307	29.641	23.273
Story16	41.748	39.295	32.055	25.379
Story17	44.782	42.271	34.475	27.506
Story18	47.79	45.222	36.896	29.646
Story19	50.76	48.137	39.307	31.793
Story20	53.684	51.007	41.7	33.939
Story21	56.559	53.819	44.068	36.077
Story22	59.364	56.567	46.405	38.2
Story23	62.089	59.24	48.704	40.304
Story24	64.723	61.832	50.96	42.381
Story25	69.685	64.337	53.67	44.428
Story26	72.001	66.077	55.323	46.44
Story27	74.206	71.314	57.425	48.415
Story28	76.308	73.469	59.474	50.351
Story29	75.108	74.126	60.168	52.249
Story30	78.33	75.552	61.474	54.108

1. From the chart it is observed that storey displacement is 19.12% in model 2, 36.31% in model 3 & 48.42% in model 4 compared to model 1 at base level.
2. The displacement is 6.18% in model 2, 29.60% in model 3 & 39.86% in model 4 compared to model 1 at 15th story.
3. The displacement is 3.81% in model 2, 21.74% in model 3 & 31.11% in model 4 compared to model 1 at 30th story.



Storey drift

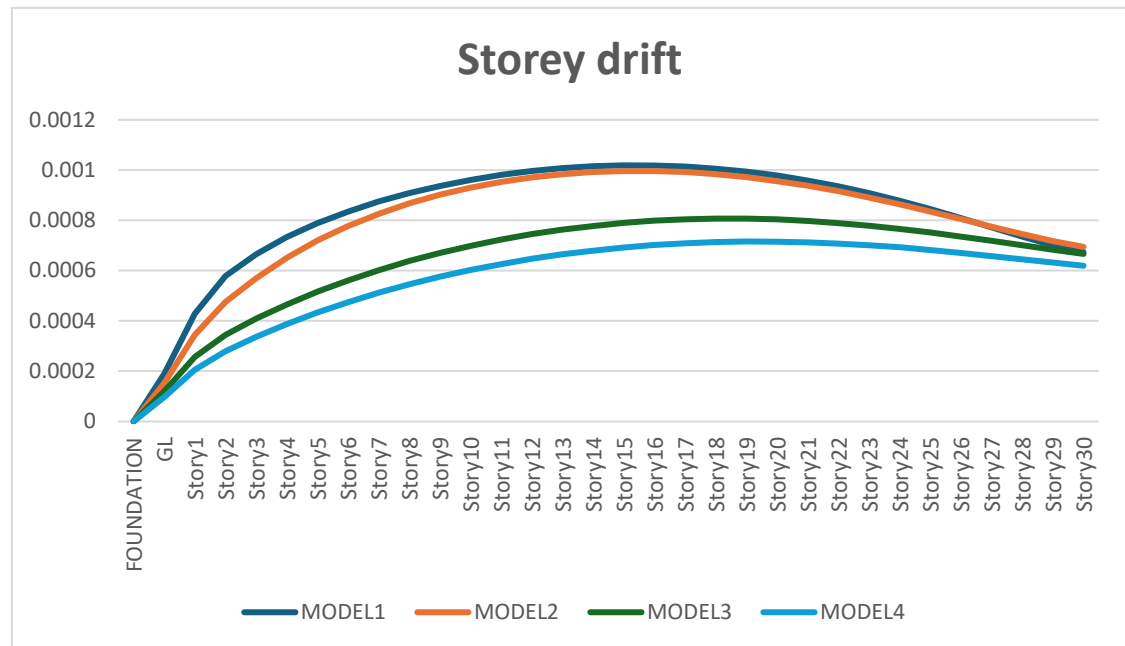
Table 10

Story	Model: 1	Model: 2	Model: 3	Model: 4
FOUNDATIO N	0	0	0	0
GL	0.00019	0.000154	0.000121	0.000098
Story1	0.000429	0.000344	0.000256	0.000206
Story2	0.000579	0.000476	0.000345	0.000279
Story3	0.000666	0.00057	0.00041	0.000337
Story4	0.000734	0.000651	0.000466	0.000388
Story5	0.000789	0.00072	0.000516	0.000433
Story6	0.000835	0.000777	0.000561	0.000474
Story7	0.000875	0.000826	0.000602	0.000512
Story8	0.000909	0.000868	0.000639	0.000546
Story9	0.000937	0.000902	0.000671	0.000576
Story10	0.000961	0.00093	0.000699	0.000603
Story11	0.000981	0.000953	0.000724	0.000626
Story12	0.000996	0.000971	0.000745	0.000647
Story13	0.001008	0.000984	0.000764	0.000665
Story14	0.001015	0.000992	0.000778	0.00068
Story15	0.001019	0.000996	0.00079	0.000692
Story16	0.001018	0.000996	0.000799	0.000702
Story17	0.001014	0.000992	0.000804	0.000709
Story18	0.001006	0.000984	0.000807	0.000714
Story19	0.000994	0.000972	0.000807	0.000716
Story20	0.000978	0.000956	0.000804	0.000715
Story21	0.000958	0.000938	0.000798	0.000713
Story22	0.000935	0.000916	0.000789	0.000708
Story23	0.000908	0.000891	0.000779	0.000701
Story24	0.000878	0.000864	0.000766	0.000693
Story25	0.000845	0.000835	0.000752	0.000682
Story26	0.000809	0.000805	0.000736	0.000671
Story27	0.000772	0.000775	0.000719	0.000658
Story28	0.000735	0.000745	0.000701	0.000645
Story29	0.000701	0.000718	0.000683	0.000632
Story30	0.000674	0.000695	0.000667	0.00062

1. From the chart it is observed that storey drift is 18.94% in model 2, 36.31% in model 3 & 48.42% in model 4 compared to model 1 at base level.
2. The displacement is 2.25% in model 2, 22.47% in model 3 & 32.09% in model 4 compared to model 1 at 15th story.

3. The displacement is 3.11% in model 2, 1.038% in model 3 & 8.01% in model 4 compared to model 1 at 30th story.

VI.



CONCLUSIONS

1. Storey displacement and drift increase significantly from Model 1 to Model 4 at Base storey.
2. Model 2 shows a moderate increase (~19%), while Model 3 (~36%) and Model 4 (~48%) show substantial increases at base storey.
3. Model 2 exhibits a small increase in displacement (~6%) at 15th storey.
4. Model 3 and Model 4 show notable increases of ~30% and ~40%, respectively, indicating reduced stiffness at mid-height in these models at 15th storey.
5. Model 2 shows a minimal increase in displacement (~3.8%) at 30th storey
6. Model 3 and Model 4 have increased displacement (~22% and ~31%) in the first set of data at 30th storey.
7. A second set shows even lower increases at the 30th storey: Model 2 (~3.1%), Model 3 (~1.03%), and Model 4 (~8.01%) at 30th storey.

Overall Trend:

8. Displacement and storey drift increase progressively from Model 2 to Model 4 at all levels.
9. Model 2 performs best in controlling displacement and drift.
10. Model 4 shows the poorest performance, indicating less structural efficiency.
11. Increased displacement and drift in higher models suggest reduced stiffness or less effective lateral load resistance.
12. Model 2 is structurally more efficient compared to Models 3 and 4.

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