

“Performance Evaluation of RCC Structure on Sloping Ground Under Wind Action Through ETAB Analysis”

SUBMITTED BY

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KEGAON, SOLAPUR-PUNE HIGHWAY, SOLAPUR-413255 2025-26

ABSTRACT

The behaviour of reinforced concrete (RCC) structures under wind loading is an important aspect of structural design, especially for multi-storey buildings. Wind forces can significantly affect the stability, strength, and serviceability of structures. This study focuses on the performance evaluation of an RCC structure on ground subjected to wind action using the structural analysis software ETABS. The objective is to analyse the response of the structure under wind loads and assess its structural performance.

In this study, a multi-storey RCC building model is developed and analysed in ETABS by considering relevant loading conditions, including dead load, live load, and wind load as per the guidelines of IS 875 (Part 3): 2015. Wind loads are applied in different directions to evaluate the structural response such as storey displacement, storey drift, base shear, and overall stability of the building.

The analysis results help in understanding how wind forces influence the structural behaviour and safety of the RCC structure. The obtained results are compared with permissible limits specified in IS 1893 (Part 1): 2016 and other relevant design provisions. Based on the ETABS analysis, the structural performance of the building is evaluated to determine whether it satisfies safety and serviceability requirements.

The study concludes that proper modelling and analysis of RCC structures under wind loading are essential for ensuring structural safety and performance. The findings of this research can assist engineers in optimizing structural design and improving the resistance of RCC buildings against wind effects.

The results obtained from ETABS analysis provide insight into the performance of RCC structures under wind action and highlight the importance of proper structural configuration, stiffness distribution, and lateral load resisting systems. The study demonstrates that accurate modelling and analysis are essential for predicting structural behaviour and ensuring that buildings meet safety and serviceability requirements.

Overall, this research contributes to a better understanding of wind effects on RCC buildings and helps engineers design safer and more efficient structures. The outcomes of this study can also assist in improving structural design practices and optimizing building performance against wind-induced forces.

INTRODUCTION

1.1 GENERAL:

Reinforced concrete (RCC) structures are widely used in modern construction due to their strength, durability, and ability to resist various types of loads. In multi-storey buildings, structures are subjected not only to vertical loads such as dead load and live load but also to lateral loads caused by wind. Among these, wind load plays a significant role in influencing the stability and performance of buildings, especially in open terrain and high-rise structures. Therefore, it is essential to study and evaluate the behavior of RCC structures under wind action to ensure safety and structural

efficiency.

Wind forces act horizontally on buildings and create lateral movements such as displacement, drift, and additional stresses in structural members like beams and columns. If these effects are not properly considered during the design stage, they may lead to excessive deformation, structural damage, or even failure. To prevent such issues, structural engineers perform detailed analysis of buildings considering wind loads as per standard design codes such as IS 875 (Part 3): 2015. These codes provide guidelines for calculating wind pressure, wind speed, and load distribution on structures.

With the advancement of structural analysis software, engineers can accurately evaluate the behavior of buildings under different loading conditions. Software like ETABS is widely used for modeling, analysis, and design of multi-storey buildings. ETABS allows engineers to create a detailed three-dimensional model of a structure and analyze its response to various loads including wind loads. Important structural parameters such as storey displacement, storey drift, base shear, and member forces can be obtained from the analysis results.

The performance evaluation of RCC structures under wind action helps in understanding how the structure responds to lateral forces and whether it satisfies the required safety and serviceability limits. By analyzing these parameters, engineers can improve structural design, optimize member sizes, and ensure that the building remains stable and safe under wind loads.

Therefore, this study focuses on evaluating the performance of an RCC building structure subjected to wind loads using ETABS analysis. The results obtained from this analysis help in assessing the structural behavior and provide useful insights for designing safe and efficient RCC structures under wind action.

1.2 SCOPE OF PROJECT:

The scope of the present study is to design and analysis of G+10 building for finding the effect of wind on the structure on different sloping ground and to find the result.

1.3 AIM AND OBJECTIVE OF THE PROJECT:

Performance evaluation of RCC structure on sloping ground under wind action through ETAB analysis.

PROPOSED WORK:

Multistory RCC building G+4 to G+10 will be modelled on varying slope angles. (eg 0,10,20).in ETABS

Different building configuration and floor plan will be considered to study geometric effects. Evaluate the effect of varying angle on structural performance.

1.4 LAYOUT OF DESERTATION:

➤ Introduction

Reinforced concrete (RCC) structures are widely used in construction due to their strength, durability, and ability to resist various types of loads. In multi-storey buildings, it is important to study the structural behavior under lateral loads such as wind because wind forces can cause displacement, drift, and additional stresses in structural members. The effect of wind becomes more significant as the height of the building increases.

Buildings constructed on sloping ground require special attention because uneven ground conditions create irregular structural configurations, which may affect the stability of the structure under wind loads. To analyze these effects

accurately, structural analysis software such as ETABS is commonly used for modeling and analysis of buildings. Wind loads are calculated according to the provisions of IS 875 (Part 3): 2015.

The objective of this study is to evaluate the performance of a G+10 RCC building under wind action on different sloping ground conditions and to understand its structural behavior for safe and efficient design.

➤ **Literature Review**

The literature review focuses on previous research related to the behavior of reinforced concrete (RCC) buildings subjected to wind loads. Earlier studies have examined the structural performance of multi-storey buildings under lateral loads, particularly wind forces, and their effects on parameters such as storey displacement, storey drift, and base shear. Researchers have also analyzed the behavior of buildings constructed on sloping ground, where irregular geometry and varying column heights influence the structural response.

Several comparative studies have been conducted to evaluate the performance of different building configurations and terrain conditions under wind loading. These studies commonly use structural analysis software such as ETABS and follow design provisions from codes like IS 875 (Part 3): 2015 for calculating wind forces.

From the review of existing studies, certain research gaps are identified, particularly in the detailed evaluation of multi-storey RCC buildings on different sloping ground conditions under wind loads, which forms the basis for the present study.

➤ **Methodology**

The methodology of the study involves the selection of **G+4 to G+10 RCC building models** to evaluate the effect of wind loads on structures located on sloping ground. The structural plan, elevation, and necessary structural components such as beams, columns, and slabs are first prepared. The building models are then created and analyzed using ETABS by assigning appropriate material and section properties.

Different loads such as dead load, live load, and wind load are applied to the structure according to the provisions of IS 875 (Part 3): 2015. Various sloping ground conditions are modeled to study their influence on structural behavior. After running the analysis in ETABS, important results such as storey displacement, storey drift, and base shear are obtained and compared for different slope conditions to evaluate the performance of the structure.

➤ **Results and Discussion**

The results of the analysis are presented using tables and graphs to clearly show the structural response of different building models. Key parameters such as storey displacement, storey drift, and storey shear are compared for the various models to understand the effect of wind loads on the structure. The analysis results obtained from ETABS are interpreted and discussed to evaluate the structural performance. Based on this comparison, the most stable building configuration under wind loading conditions is identified.

➤ **Conclusion and Future Scope**

Conclusion:

- Summary of major findings from the wind load analysis.
- Identification of the building configuration that performs best on sloping ground.

- Evaluation of structural safety and serviceability under wind action.

Future Scope:

- Study can be extended for higher buildings such as G+15 or G+20.
- Analysis can be carried out for both wind and earthquake loads.
- Different structural systems such as shear walls or bracing systems can be considered.
- Advanced analysis methods and other structural software can be used for further study.

REFERENCE

1. Umesh R Biradar, Shivraj Mangalgi, "Seismic Response of Reinforced Concrete Structure by Using Different Bracing System", International journal of research and technology, vol 3, Issue 09, 2019.
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3. Apurva Arjun Gaikwad ,D.A.B .P(2019). Seismic Analysis of Low Rise ,High Rise, Mid Rise Rcc structure on Sloping Ground International Research Journal Of Engineering and Technology.
4. Eurocode-8 Design of Structures for Earthquake Resistance.
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6. spectrum analysis of a G+4 building with mass irregularity on a sloped surface. IOP Conference Series: Materials Science and Engineering, 1070(1).
7. IS 875 Part-2 "Code of practice for design loads (other than earthquake) for buildings and structures."

CHAPTER 2 LITERATURE REVIEW**2.1 GENERAL:**

The literature review focuses on previous studies related to the behaviour and performance of reinforced concrete (RCC) buildings subjected to lateral loads such as wind. Many researchers have studied the structural response of multi-storey buildings under wind loading to understand parameters like storey displacement, storey drift, and base shear. These studies highlight the importance of proper structural design to ensure stability, safety, and serviceability of buildings under wind action.

Several research works have also investigated the performance of buildings constructed on sloping ground. Buildings on sloping terrain often have irregular configurations due to unequal column heights and stepped foundations, which may influence their response to lateral loads. Previous studies have shown that such irregularities can significantly affect structural behaviour and require careful analysis and design.

With the advancement of structural analysis tools, many researchers have used software such as ETABS to model and analyse multi-storey RCC structures. These analyses are generally performed according to standard design codes such as IS 875 (Part 3): 2015 for wind load calculations. Through these studies, various building configurations and terrain conditions have been compared to evaluate their structural performance.

The review of earlier research helps in understanding the existing knowledge on wind load analysis and structural performance of RCC buildings. It also helps identify research gaps, particularly in the detailed evaluation of multi-storey buildings on different sloping ground conditions, which forms the basis for the present study.

Several studies have also examined the behaviour of buildings constructed on sloping ground. Structures on sloping terrain often have irregular configurations due to varying column heights and foundation levels, which may influence their response to lateral loads. Therefore, proper analysis is required to understand the structural behaviour and ensure safe design.

With the development of advanced structural analysis tools, software such as ETABS is widely used for modelling and analysis of multi-storey buildings. These analyses are generally performed according to standard design provisions such as IS 875 (Part 3): 2015 for calculating wind forces acting on structures.

Overall, the literature review helps in understanding previous research findings and provides a basis for the present study on the performance evaluation of RCC buildings subjected to wind loads on sloping ground conditions.

2.2 LITERATURE REVIEW:

Biradar, U. R., & Mangalgi, S. (September, 2019). Seismic Response of Reinforced Concrete Structure by Using Different Bracing Systems. International Journal of Research in Engineering and Technology, Vol. 3, Issue 09.

To evaluate and compare the seismic performance of a multistorey reinforced concrete (RC) frame structure with different bracing systems using ETABS, against a bare frame model. ijret.org. Models studied: Seven different models: one bare frame and six with different bracing types. The bracing systems include X-bracing and other typologies. ijret.org. Building parameters: Eleven storeys, plan dimension 25 m × 20 m, five bays in X and Y directions; uniform story height of 3.5 m; columns, beams, slab sizes are fixed; located in seismic Zone V, medium soil. ijret.org. Braced frames perform significantly better than bare frames in terms of reducing displacements and drift. ijret.org. Among the different bracing systems, X-bracing gives the best performance in this study.

G Ajay Kumar ,A.G (2019) Seismic Analysis of RC High Rise Building with Shear Walls at Diverse Locations .International Journal of Innovative Technology and Engineering ,7,9113-9117

To assess how the inclusion and placement of shear walls at different locations in a high-rise reinforced concrete (RC) building affect its seismic (earthquake) performance. Models considered: They model high-rise RC buildings with shear walls placed in diverse configurations, comparing them to bare frames (no shear walls). Different shear wall locations (e.g. corners, centre, distributed) are considered. Analysis method: Seismic analysis using ETABS (or similar structural analysis software) likely employing response spectrum / static equivalent or dynamic methods to evaluate building behaviour under earthquake loads (though full details may require access to the full paper). Performance parameters evaluated: Base shear, storey displacement, storey drift, maybe time period, stiffness, i.e. standard seismic response metrics. The presence of shear walls significantly improves seismic performance. Shear walls reduce displacements and drifts, increase stiffness, alter base shear demands depending on location of shear wall, with some configurations being more effective than others.

Apurva Arjun Gaikwad ,D.A.B .P(2019). Sesimic Analysis of Low Rise ,High Rise, Mid Rise Rcc structure on Sloping Ground International Research Journal Of Engineering and Technology.

conducted an in-depth study on the seismic performance of reinforced concrete (RCC) buildings of varying height slow-rise, mid-rise, and high-rise constructed on sloping ground. Using ETABS software, the researchers analyzed three building configurations (G+5, G+10, and G+15) situated on slopes of 0°, 10°, 20°, and 30° to evaluate how the

inclination of the ground surface influences the overall structural response during an earthquake. The analysis was carried out using the equivalent static method, response spectrum method, and time history method in accordance with IS 1893 (Part 1): 2016. Their study revealed that as the slope of the ground increases, the structural irregularity also increases, resulting in higher lateral displacements, storey drifts, and non-uniform distribution of forces across the building height. The researchers found that taller buildings exhibited larger time periods and higher lateral displacements compared to shorter ones. However, when these structures were placed on sloping ground, their fundamental time periods were slightly altered due to the variation in stiffness and mass distribution caused by unequal column heights. It was also observed that the base shear tended to increase at moderate slopes (around 10°) but reduced for steeper slopes, indicating a complex relationship between slope inclination and lateral load distribution. The study concluded that buildings located on sloping terrain are more vulnerable to seismic effects than those on level ground. The irregular column heights on the uphill and downhill sides create short-column effects, leading to concentration of stresses and potential structural damage during strong ground motion. The authors emphasized that slope geometry should be carefully considered in the design and analysis stages, as neglecting these effects could lead to unsafe designs. This research provides a valuable foundation for understanding how slope inclination influences seismic behavior and highlights the importance of site-specific modeling for hilly regions.

Eurocode- 8 Design of Structures for Earthquake Resistance.

The Eurocode 8 (EN 1998: Design of Structures for Earthquake Resistance) provides a comprehensive framework for ensuring that buildings and civil engineering structures are designed to resist seismic actions while maintaining adequate levels of safety, serviceability, and structural integrity. As one of the most recognized international standards, Eurocode 8 establishes uniform design principles for assessing seismic loads, structural ductility, material behavior, and detailing requirements to achieve controlled energy dissipation during earthquakes. The code outlines methods for determining design ground motions based on seismic hazard parameters, soil classifications, and structural importance factors. A key feature of Eurocode 8 is its emphasis on performance-based design, which ensures that structures meet specific performance objectives corresponding to different levels of seismic intensity. It provides guidelines for both linear and nonlinear analysis methods, including equivalent static force procedures, response spectrum analysis, and time-history analysis. Furthermore, it addresses the design of structural systems with various irregularities both in plan and elevation—which makes it particularly relevant for structures on sloping ground where stiffness and mass irregularities are common. Eurocode 8 also gives special consideration to ductility classes, ensuring that reinforced concrete (RCC) members are detailed appropriately to sustain large inelastic deformations without significant loss of strength. Provisions related to capacity design, confinement reinforcement, and detailing of shear walls and frames are central to minimizing potential collapse mechanisms. In the context of this research, Eurocode 8 serves as a vital reference for understanding the seismic design philosophy applicable to RCC structures on irregular or sloping sites. Its detailed analytical procedures and performance-based criteria support modern computational modeling tools such as ETABS, enabling accurate simulation of seismic behavior and improving the reliability of structural designs in earthquake-prone regions.

IS:1893-2016“Criteriaforearthquakeresistdesignandofstructure”

The Indian Standard IS 1893 (Part 1): 2016, titled “Criteria for Earthquake Resistant Design of Structures,” serves as the principal code of practice for the seismic design of buildings and other structures in India. This standard, issued by the Bureau of Indian Standards (BIS), lays down the guidelines for evaluating seismic forces and ensuring adequate structural safety and performance during earthquake events. The 2016 revision represents a major update over earlier versions, aligning Indian design practices more closely with modern performance-based design principles and international standards such as Eurocode 8. IS 1893:2016 provides a systematic approach for calculating design seismic loads based on seismic zoning, site soil characteristics, structural importance, and damping factors. The code divides India into four seismic zones (II to V) and specifies the corresponding zone factors used for calculating design base shear. It also introduces updated provisions for response spectra, accounting for different soil conditions (hard, medium, and soft), which significantly influence the dynamic behavior of structures. The code emphasizes the importance of regularity in plan and elevation and warns against the adverse effects of irregular configurations—both

vertical and horizontal—which are particularly relevant for structures built on sloping ground. It also defines methods for determining lateral load distribution along the height of a building, dynamic analysis procedures (equivalent static and response spectrum methods), and criteria for story drift limitations, torsional irregularities, and separation gaps between adjacent structures. In addition, IS 1893:2016 stresses the role of ductile detailing as per IS 13920:2016 to ensure that reinforced concrete (RCC) members can undergo significant inelastic deformation without collapse. By integrating these requirements, the code provides a robust framework for designing earthquake-resistant structures suited to India's diverse geological conditions. For this study, IS 1893:2016 forms the foundation for defining seismic parameters, load combinations, and analytical modeling in ETABS. Its detailed provisions for irregular structures and sloping ground conditions make it a critical reference for assessing the seismic performance of RCC buildings subjected to lateral forces.

Spectrum analysis of a G+4 building with mass irregularity on a sloped surface. IOP Conference Series: Materials Science and Engineering, 1070(1).

The study titled “Spectrum Analysis of a G+4 Building with Mass Irregularity on a Sloped Surface” published in the IOP Conference Series: Materials Science and Engineering, Volume 1070, Issue 1, focuses on understanding the seismic response of low-rise reinforced concrete (RCC) buildings constructed on sloping ground with mass irregularities. The research employs the response spectrum method using ETABS software to evaluate how variations in mass distribution and ground slope influence the dynamic characteristics and seismic performance of structures.

In this work, a G+4 RCC building model was developed with varying slope inclinations to represent realistic hilly terrain conditions. The introduction of mass irregularity—achieved by varying floor loads or floor mass distribution—was used to simulate practical design situations where functional requirements create unequal mass across storeys. The analysis considered parameters such as natural time period, base shear, storey displacement, and inter-storey drift under different slope angles and mass configurations. The findings revealed that both slope inclination and mass irregularity significantly affect the seismic behavior of buildings. Structures resting on sloping ground exhibited higher lateral displacements and torsional effects compared to those on flat terrain, primarily due to asymmetry in stiffness and mass distribution. Additionally, the presence of mass irregularity further amplified the dynamic response, leading to increased storey drift and base shear demands, especially at the lower storeys located on the downhill side. The study also observed changes in modal participation and fundamental time period with varying slopes, indicating complex interaction effects between ground geometry and mass distribution.

The authors concluded that mass irregularity combined with sloping ground geometry introduces severe dynamic irregularities, which must be carefully considered during seismic design. The research highlights the necessity of performing response spectrum analysis rather than relying solely on equivalent static methods, as it more accurately captures the effects of irregularity on seismic performance. This paper contributes valuable insights into the design and analysis of RCC buildings in hilly terrains, where geometric and mass irregularities are common and can critically influence structural safety.

IS 875 Part-2 “Code of practice for design loads (other than earthquake) for buildings and structures.”

The Indian Standard IS 875 (Part 2): 1987, titled “Code of Practice for Design Loads (Other Than Earthquake) for Buildings and Structures,” is one of the most fundamental codes governing structural design practices in India. This standard, issued by the Bureau of Indian Standards (BIS), specifies the procedures and guidelines for determining imposed (live) loads on various types of buildings and structural components, excluding loads arising from earthquakes and wind. It provides a comprehensive framework for estimating loads due to occupancy, usage, and functional requirements of buildings, thereby ensuring safety, stability, and serviceability under normal loading conditions. IS 875 (Part 2) categorizes buildings based on their usage type: residential, commercial, industrial, educational, and storage facilities and prescribes corresponding live load intensities for floors, roofs, balconies, and other structural elements. It also provides guidelines for reducing live loads in multi-storeyed buildings depending on the number of floors supported, which helps achieve more economical and realistic designs. The code includes special provisions for concentrated loads, impact loads, and loads due to movable partitions, which are crucial in assessing the true behavior of structures under service conditions. Although the primary purpose of this code is to

address imposed loads, its provisions play an essential role in combination with wind and seismic load design as per IS 875 (Part 3) and IS 1893 (Part 1). For structures located on sloping ground or in regions subjected to significant lateral forces, the accurate estimation of live loads becomes critical because it directly influences mass distribution and dynamic response during wind or earthquake excitation. In the context of this research, IS 875 (Part 2) provides the fundamental load data required to model the structure realistically in ETABS for both static and dynamic analyses. By ensuring correct representation of occupancy-related live loads, the study can more accurately evaluate the combined effects of gravity and lateral loads on the performance of RCC structures on sloping terrain under wind or seismic actions.

2.3 SUMMARY OF LITERATURE AND GAPPING RESEARCH:

Several researchers have studied the behavior of reinforced concrete (RCC) buildings under lateral loads such as wind and earthquake forces. Studies such as those by U. R. Biradar and S. Mangalgi investigated the seismic performance of multi-storey RCC buildings using different bracing systems. Their analysis using ETABS showed that braced frames perform better than bare frames, significantly reducing storey displacement and drift. Among various bracing systems, X-bracing provided the most effective improvement in structural performance.

Similarly, research conducted by G. Ajay Kumar examined the effect of shear walls placed at different locations in high-rise RCC buildings. The results indicated that the inclusion of shear walls greatly enhances structural stiffness and reduces lateral displacement and storey drift. The position of shear walls plays a major role in improving seismic resistance and overall building stability.

Studies focusing on buildings on sloping ground, such as the work by Apurva Arjun Gaikwad, analyzed low-rise, mid-rise, and high-rise RCC buildings on different slope angles. The results showed that increasing slope inclination leads to irregular structural behavior due to unequal column heights, causing higher storey drift and displacement. These findings highlight the importance of careful structural analysis for buildings constructed on sloping terrain.

Various design codes and analytical methods are also discussed in previous studies. International standards like Eurocode 8 and Indian standards such as IS 1893 (Part 1): 2016 and IS 875 (Part 2): 1987 provide guidelines for evaluating structural loads and ensuring safety under lateral forces.

Research using response spectrum analysis and other dynamic methods has demonstrated that irregularities such as mass variation and sloping ground significantly influence structural response parameters like base shear, time period, and inter-storey drift.

Overall, the literature indicates that lateral load resisting systems such as bracing and shear walls improve structural performance, while irregular conditions such as sloping ground and mass irregularities increase the complexity of structural behavior.

Identified Research Gap

Although many studies have been carried out on RCC buildings subjected to seismic loads, most research mainly focuses on earthquake effects rather than wind loads. Limited studies are available that specifically evaluate the influence of wind forces on multi-storey RCC buildings constructed on sloping ground. In addition, previous research often focuses on a single building height or configuration, without comparing different storey levels or slope conditions.

Therefore, there is a need for detailed analysis of RCC buildings with different heights on sloping ground considering wind loading conditions. The present study aims to address this gap by analyzing G+4 to G+10 RCC building models on varying slope conditions using ETABS to evaluate structural parameters such as storey displacement, storey drift, and base shear, and to determine the most stable configuration.

CHAPTER 3

PROBLEM FORMULATION

3.1 GENERAL:

In modern construction, multi-storey reinforced concrete (RCC) buildings are increasingly being constructed in areas with uneven or sloping ground. Such conditions create irregular structural configurations due to varying column heights and uneven distribution of mass and stiffness. When these buildings are subjected to lateral loads such as wind, their structural response becomes more complex compared to buildings on level ground. Wind forces can cause storey displacement, storey drift, and additional stresses in structural members, which may affect the stability and safety of the structure. Therefore, it is important to analyze and evaluate the performance of RCC buildings on sloping ground under wind loading conditions using advanced structural analysis tools such as ETABS.

3.2 DESIGN PHILOSOPHY:

The design philosophy of RCC structures under lateral loads is based on ensuring safety, stability, and serviceability throughout the life of the structure. Buildings must be designed to resist both vertical loads and lateral loads such as wind and earthquake forces. Structural design should ensure that the building has sufficient strength, stiffness, and ductility to withstand these forces without excessive deformation or failure. The analysis and design of structures are generally carried out according to standard design codes such as IS 875 (Part 3): 2015 and IS 1893 (Part 1): 2016. These codes provide guidelines for calculating loads, analyzing structural response, and ensuring safe design practices. The philosophy of this research is to adopt a performance-based approach, where various geometrical configurations are analysed, compared, and optimized to achieve the best balance between safety and economy. The ultimate objective is to identify a structural system that satisfies codal requirements while minimizing material usage and construction cost, thereby ensuring an efficient and sustainable design solution.

3.3 SUMMARY:

From the above discussion, it is clear that buildings constructed on sloping ground require careful analysis due to their irregular configuration and complex structural behavior under lateral loads. Wind forces can significantly influence the performance of multi-storey RCC structures. Hence, this study focuses on evaluating the structural performance of RCC buildings under wind action on sloping ground using ETABS analysis in order to understand their behavior and identify a stable and safe structural configuration.

CHAPTER 4

METHODOLOGY

4.1 GENERAL

The methodology of this study involves the modeling and analysis of multi-storey reinforced concrete (RCC) buildings constructed on sloping ground to evaluate their performance under wind loads. Different building models ranging from G+4 to G+10 storeys are considered for the analysis. The structural models are developed and analyzed using ETABS. Various loads such as dead load, live load, and wind load are applied to the structure according to the provisions of IS 875 (Part 3): 2015. The structural responses such as storey displacement, storey drift, and base shear are obtained and compared to evaluate the behavior of buildings on sloping ground.

4.2 DESIGN STEP

Design Steps for Structural Modeling and Analysis

Selection of Building Type (G+4 to G+10 RCC Building)

☐

Preparation of Building Plan, Elevation, and Structural Layout

☐

Definition of Material Properties (Concrete and Steel)

☐

Assignment of Section Properties for Beams, Columns, and Slabs

☐

Modeling of the Structure in ETABS

☐

Modeling of Different Sloping Ground Conditions

☐

Application of Loads (Dead Load, Live Load, Wind Load) as per IS 875

☐

Creation of Load Combinations for Analysis

☐

Running Structural Analysis in ETABS

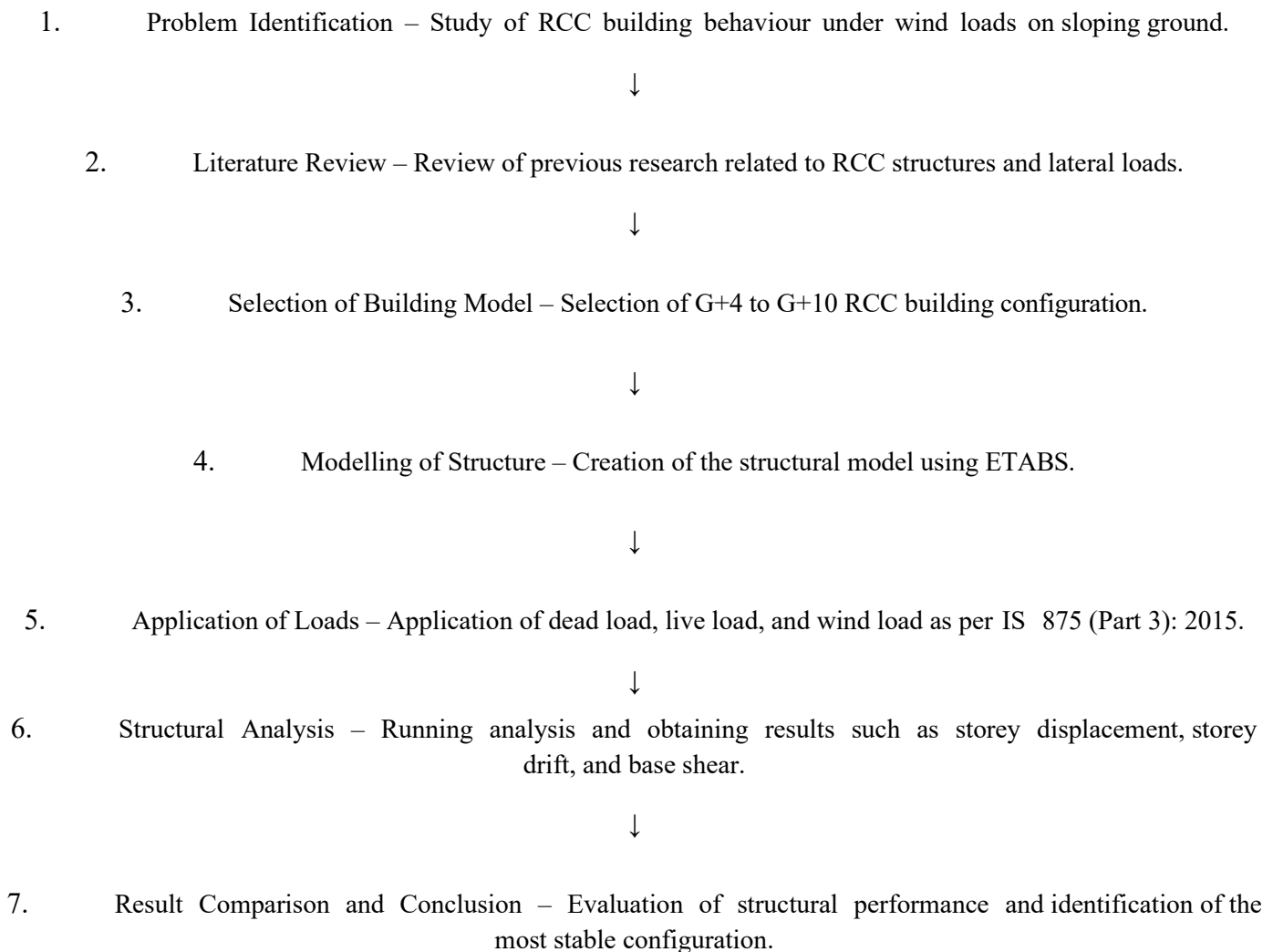
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Extraction of Results (Story Displacement, Story Drift, Base Shear)

☐

Comparison and Evaluation of Structural Performance

4.3 METHODOLOGY OF PROJECT (FLOW CHART)



4.4 CASE CONSIDERED SUMMARY

In this study, a reinforced concrete (RCC) multi-storey building is considered to evaluate its structural performance under wind loads. Building models ranging from G+4 to G+10 storeys are analyzed to understand the effect of height on structural behaviour. The modelling and analysis of the structure are carried out using ETABS.

The structure is analyzed by applying dead load, live load, and wind load, where the wind load calculations are performed according to the provisions of IS 875 (Part 3): 2015. Different sloping ground conditions are considered to study their influence on the structural response. The main parameters evaluated in the analysis include storey displacement, storey drift, and base shear, which help in understanding the overall stability and performance of the building under wind action.

CHAPTER 5 RESULT AND DISCUSSION

5.1 General

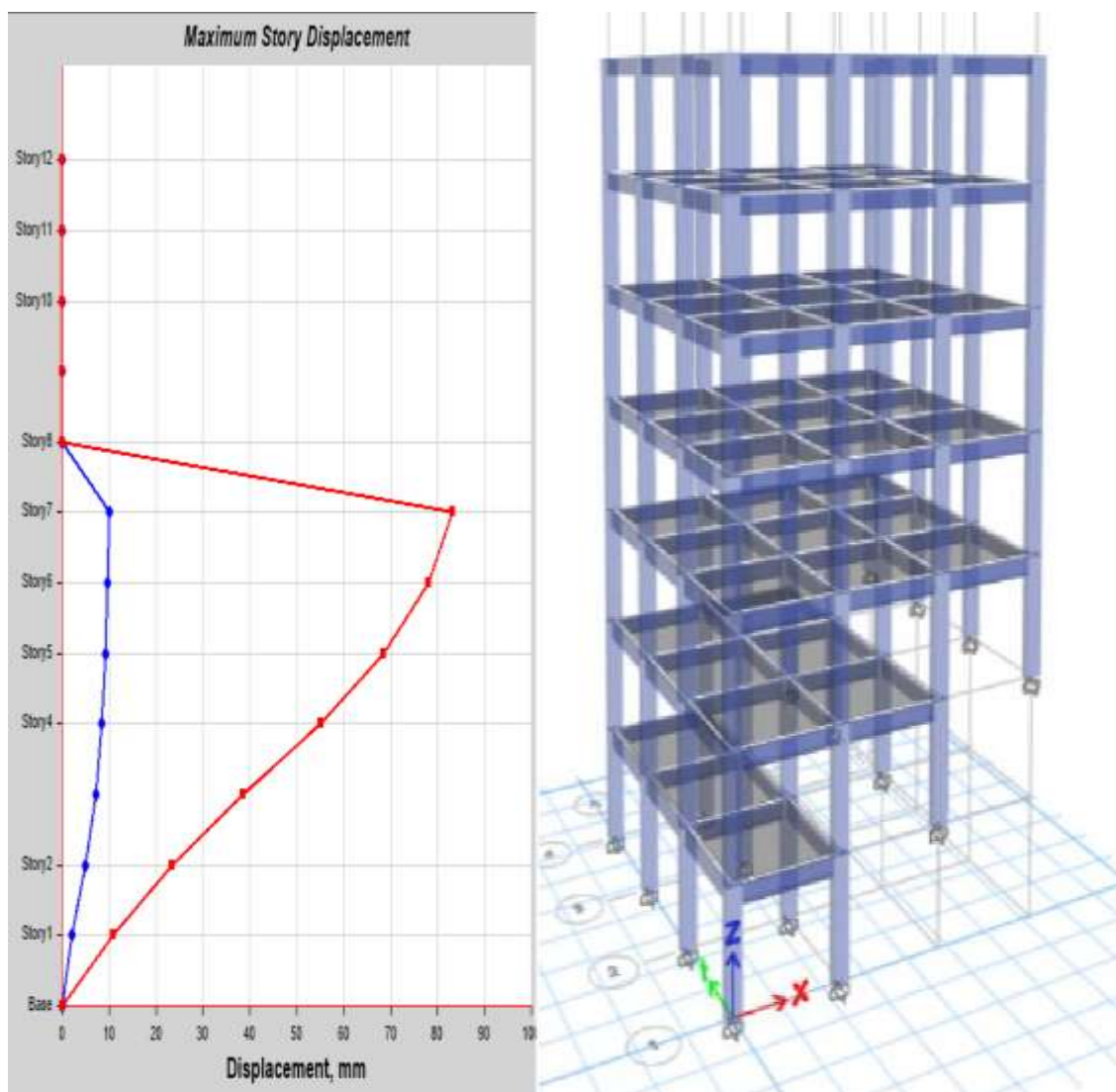
The results of the study are obtained from the structural analysis of multi-storey reinforced concrete (RCC) buildings constructed on sloping ground and subjected to wind loads. The structural models ranging from G+4 to G+10 storeys are developed and analysed using ETABS. The analysis considers loads such as dead load, live load, and wind load applied according to the provisions of IS 875 (Part 3): 2015.

The results are presented in the form of tables and graphs to clearly illustrate the structural response of the building

models. Important parameters such as storey displacement, storey drift, and base shear are evaluated for different building heights and sloping ground conditions. The analysis shows that as the height of the building increases the values of storey displacement and storey drift also increase due to higher exposure to wind forces.

Buildings constructed on sloping ground exhibit irregular structural behaviour because of unequal column heights and variations in stiffness along the height of the structure. This irregularity results in non-uniform distribution of lateral forces, which may increase the displacement and drift in certain storeys. The results also indicate that the response of the structure varies depending on the slope condition and building configuration.

From the comparison of different models, it is observed that structural stability can be improved by maintaining proper structural configuration and stiffness distribution. The discussion of results helps in understanding the overall performance of RCC buildings on sloping ground under wind loads and provides useful insights for safer and more efficient structural design.



5.2 G+4 Storey displacement on sloping ground on varying angel

Storey Displacement Response 3D View G+4 GRAPH 5.1 IMAGE 5.1

Maximum Storey Displacement Table

Storey	Blue Line Displacement (mm)	Red Line Displacement (mm)
Base	0	0
Story1	2	10
Story2	4	25
Story3	6	40
Story4	7	55
Story5	8	70
Story6	9	80
Story7	10	85
Story8	0	0

TABLE 5.1

The graph represents the maximum storey displacement of a multi-storey RCC building under wind load. The horizontal axis shows the displacement in millimetres, while the vertical axis represents the storey levels from base to top. The analysis results are obtained using ETABS according to wind load provisions of IS 875 (Part 3): 2015.

From the graph, it can be observed that the storey displacement increases gradually from the base towards the upper storeys. At the base level, the displacement is nearly zero because the structure is fixed to the foundation. As the height of the building increases, the effect of lateral wind force becomes more significant, resulting in larger displacements at higher storeys.

The red curve shows higher displacement values compared to the blue curve, indicating that this model or configuration experiences greater lateral movement. The maximum displacement occurs around the upper storeys (approximately Storey 7), where the value reaches about 80–85 mm. On the other hand, the blue curve shows comparatively smaller displacement, indicating better stiffness or stability of that configurat. After Storey 8, the

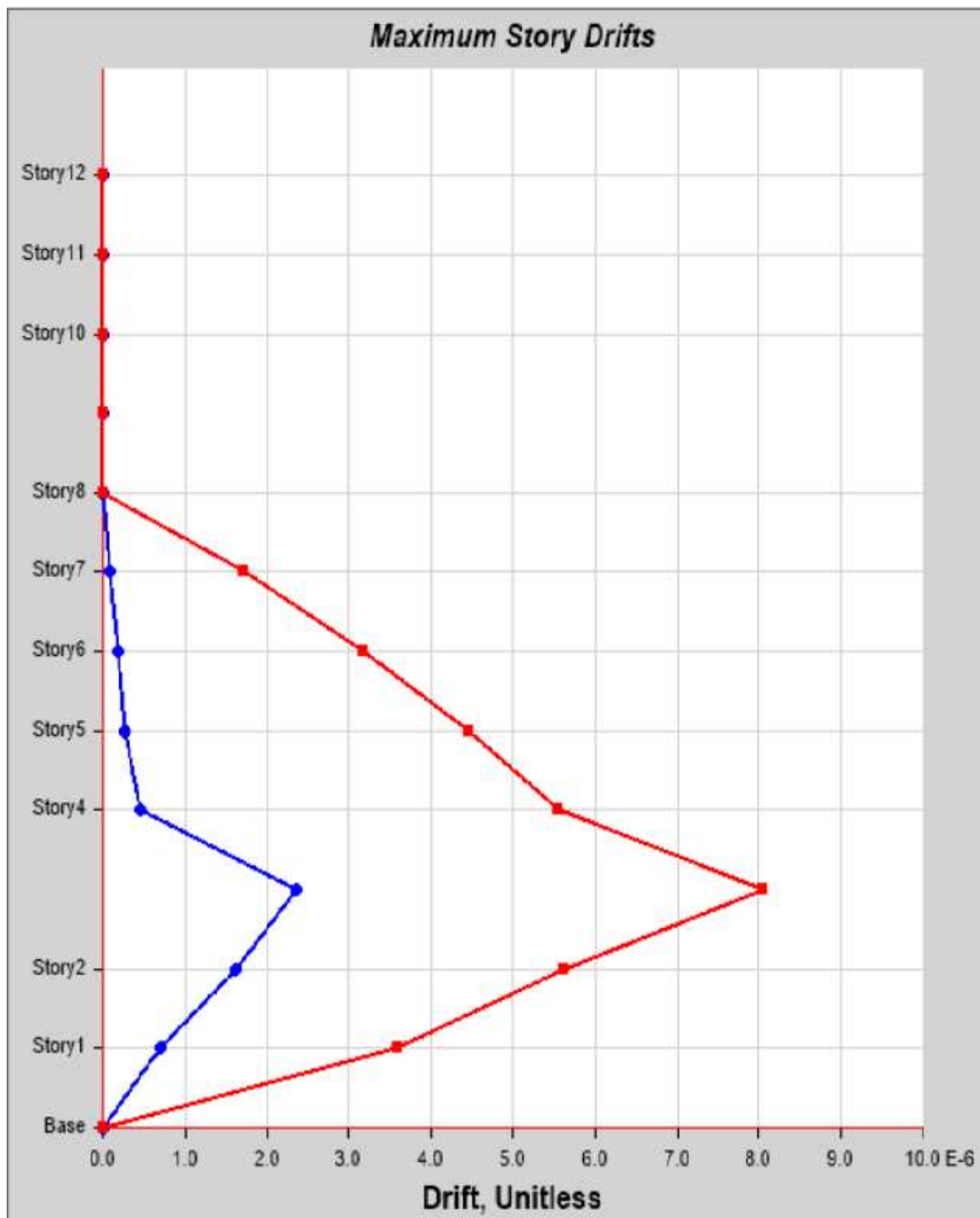
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Story3	6	40
Story4	7	55
Story5	8	70
Story6	9	80
Story7	10	85
Story8	0	0

displacement values reduce or remain nearly constant, which may be due to differences in structural configuration or modelling conditions. Overall, the graph shows that wind loads significantly influence the lateral displacement of taller buildings, and proper structural design is necessary to control excessive movement.

The comparison of the two curves helps identify the more stable structural configuration, where lower storey displacement indicates better performance and improved resistance against wind forces.

5.2.1 G+4 Story drift on Sloping ground on varying angel



GRAPH 5.2

Maximum Storey Drift Table

Storey	Blue Line Drift ($\times 10^{-6}$)	Red Line Drift ($\times 10^{-6}$)
Base	0.0	0.0
Story1	0.8	3.5
Story2	1.5	6.0
Story3	2.5	8.0
Story4	0.8	5.0
Story5	0.4	4.5
Story6	0.3	3.0
Story7	0.2	2.0
Story8	0.1	0.1

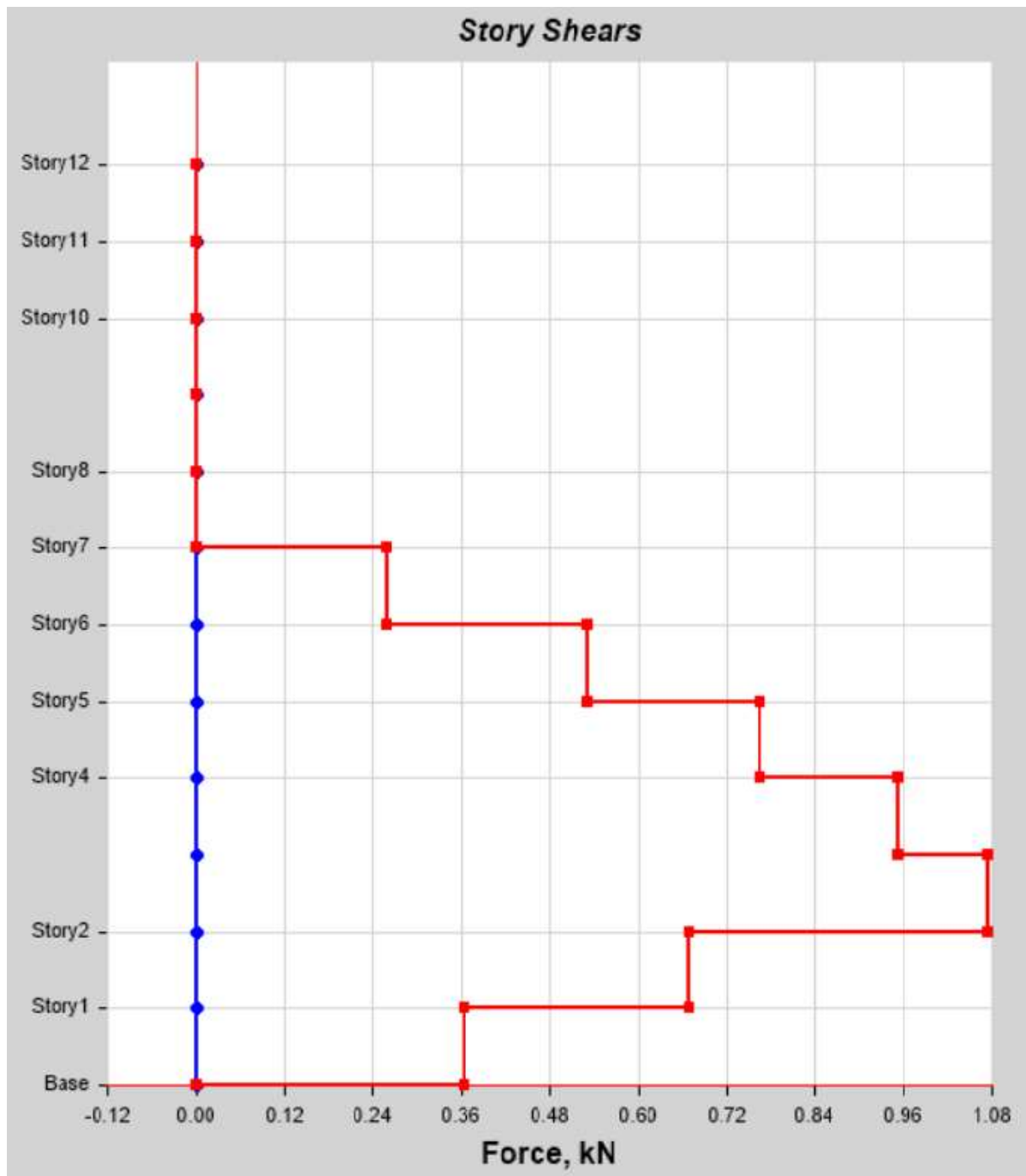
TABLE 5.2

The graph represents the maximum storey drift of a multi-storey RCC building subjected to wind loads. Storey drift is defined as the relative displacement between two consecutive floors, and it is an important parameter used to evaluate the serviceability and safety of structures under lateral loads. The analysis results are obtained using ETABS according to the wind load provisions specified in IS 875 (Part 3): 2015.

From the graph, it can be observed that the storey drift varies along the height of the building. At the base level, the drift value is nearly zero because the structure is fixed at the foundation. As the height increases, the drift values gradually increase and reach a maximum value at the middle storeys of the building. This behaviour occurs because lateral forces such as wind create larger relative movement between floors at intermediate levels.

The red curve shows higher storey drift values compared to the blue curve, indicating that this building configuration experiences greater lateral deformation. The maximum drift for the red curve occurs around Storey 3, which suggests that this level is more susceptible to lateral movement. On the other hand, the blue curve shows smaller drift values throughout the height, which indicates better structural stiffness and improved resistance to wind forces.

5.2.2 G+4Base shear on Sloping ground on varying angel



GRAPH 5.3

Storey Shear Table

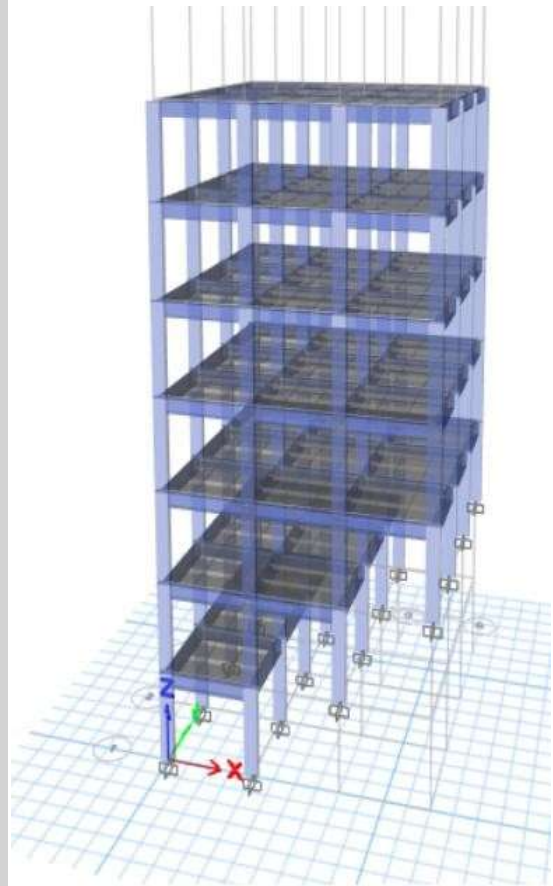
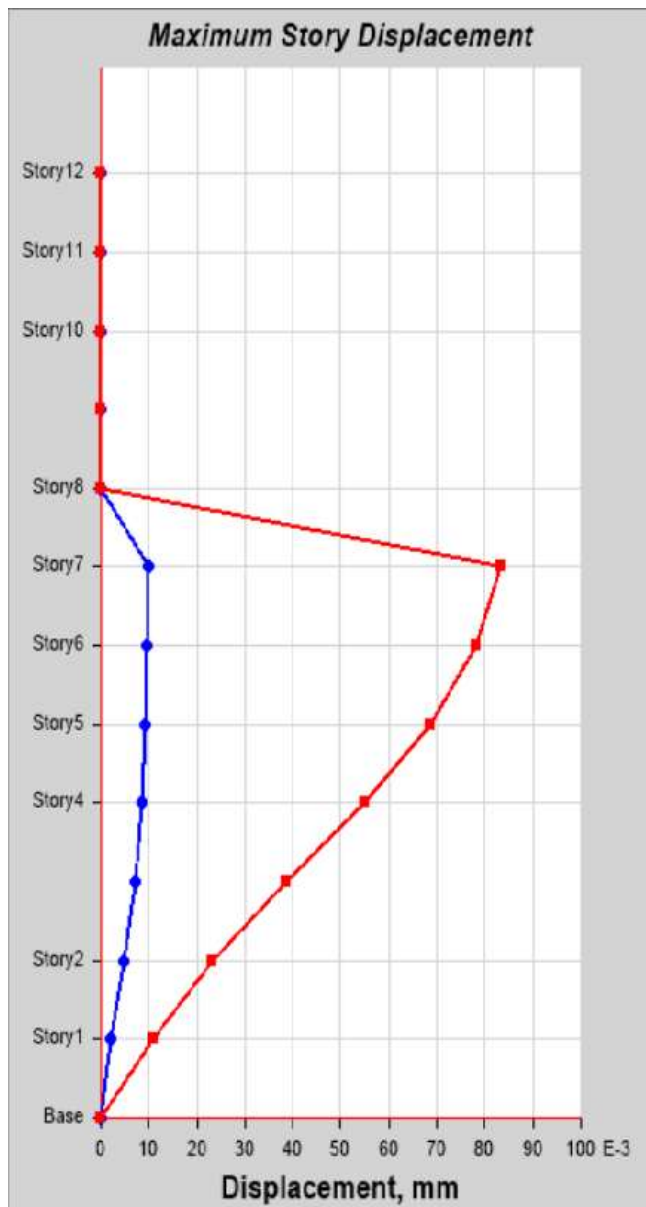
Storey	Blue Line Shear (kN)	Red Line Shear (kN)
Base	0.00	0.36
Story1	0.00	0.68
Story2	0.00	1.05
Story3	0.00	0.95
Story4	0.00	0.72
Story5	0.00	0.74
Story6	0.00	0.52
Story7	0.00	0.25
Story8	0.00	0.00

TABLE 5.3

The graph shows the variation of storey shear along the height of the building under wind load. Storey shear represents the lateral force acting at each floor level. The analysis is carried out using ETABS according to IS 875 (Part 3): 2015.

From the graph, it is observed that storey shear is maximum at the lower storeys and gradually decreases towards the top of the building. This occurs because wind forces from the upper floors are transferred downward to the base. The red curve shows higher shear values, while the blue curve indicates lower shear, representing better structural performance. Overall, the graph helps evaluate the distribution of lateral forces and stability of the structure under wind action.

5.3. G+5 Story displacement on Sloping ground on varying angel



3D View G+5

GRAPH 5.4 IMAGE 5.2

Storey Displacement Response

Storey	Blue Line Displacement (mm)	Red Line Displacement (mm)
Base	0	0
Storey 1	3	10
Storey 2	5	20
Storey 3	7	35

Storey 4	8	50
Storey 5	9	65
Storey 6	10	75
Storey 7	15	85
Storey 8	3	5

TABLE 5.4

The graph shows the maximum storey displacement variation along the height of the building under lateral loads. It can be observed that the displacement increases from the base towards the upper storeys, which is typical behavior in multi-storey buildings.

The red line shows higher displacement values, reaching a maximum of about 85–90 mm near Storey 7, indicating that this structural configuration is more flexible and less stiff. In contrast, the blue line shows smaller displacement values, with a maximum of about 15 mm, which indicates better stiffness and stability.

Overall, the structure represented by the blue curve performs better against lateral loads because it experiences lower storey displacement, indicating improved structural performance.

5.3.1. G+5 Story drift on Sloping ground on varying angel



Storey Drift GRAPH 5.5

Storey	Blue Line Drift ($\times 10^{-6}$)	Red Line Drift ($\times 10^{-6}$)
Base	0	0
Storey 1	0.8	3.5
Storey 2	1.8	5.5
Storey 3	2.5	8.0
Storey 4	0.9	6.0
Storey 5	0.6	5.0
Storey	Blue Line Drift ($\times 10^{-6}$)	Red Line Drift ($\times 10^{-6}$)
Storey 6	0.5	4.0
Storey 7	0.4	2.0
Storey 8	0.2	0.3
Storey 9	~0	~0

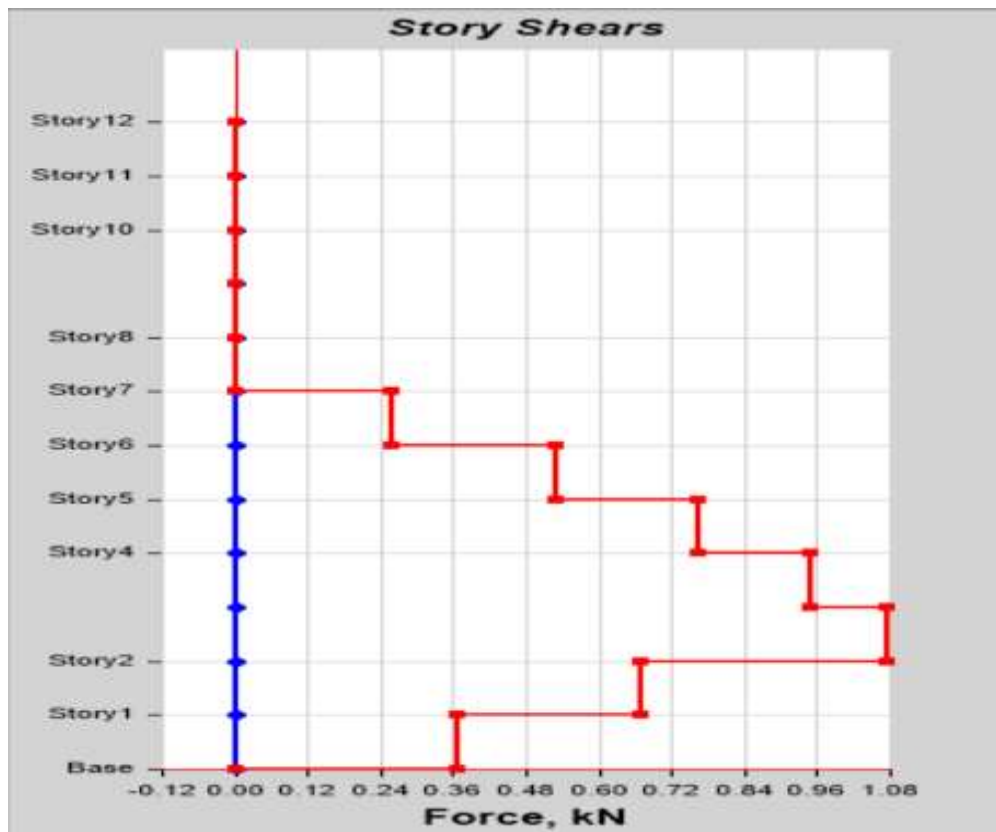
TABLE 5.5

The graph shows the variation of maximum storey drift along the height of the building under lateral loads. Storey drift represents the relative lateral displacement between two consecutive floors.

From the graph, it can be observed that the red configuration shows higher drift values, with the maximum drift occurring around the middle storeys (Storey 3–4). This indicates that the structure experiences greater lateral deformation and lower stiffness.

In contrast, the blue configuration shows comparatively smaller drift values throughout the building height, indicating better structural stiffness and improved resistance to lateral loads. Overall, the blue structural configuration performs better as it maintains lower storey drift, which contributes to better stability and seismic performance of the building.

5.3.2. G+5 Base shear on Sloping ground on varying angel



Storey Drift GRAPH 5.6

Story Level	Story Shear (Force in kN)
Story 8	0.00
Story 7	0.26
Story 6	0.53
Story 5	0.76
Story 4	0.95
Story 3	1.08
Story Level	Story Shear (Force in kN)
Story 2	1.08
Story 1	0.67
Base	0.37

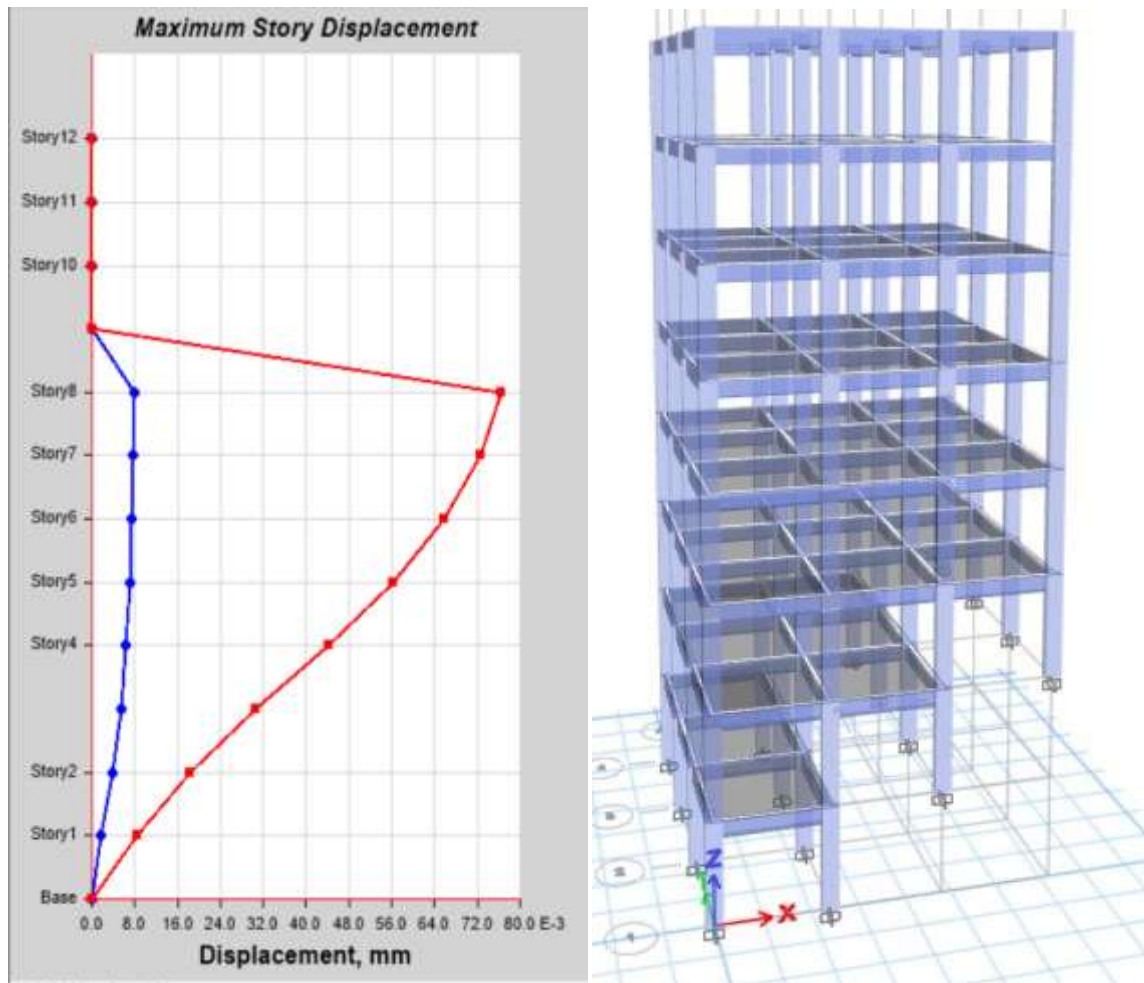
TABLE 5.6

The table shows the variation of storey shear along the height of the building. Storey shear represents the lateral force acting at each floor level due to earthquake or wind loads.

From the values, it can be observed that the maximum storey shear occurs at the base (0.37 kN) and gradually decreases towards the upper storeys, becoming almost zero at the top storeys. This behavior occurs because the base of the building resists the cumulative lateral forces from all the upper floors.

Therefore, the results indicate that the lower storeys and foundation experience the highest shear forces, and they must be designed stronger to safely transfer these forces to the ground.

5.4. G+6 Story displacement on Sloping ground on varying angel



Storey displacement response 3D View Image GRAPH 5.7 Image 5.3

Story Level	Displacement (Blue Line) [mm]	Displacement (Red Line) [mm]
Story 12	0.000	0.000
Story 11	0.000	0.000
Story 10	0.000	0.000
Story 9	0.000	0.000

Story 8	0.008	0.076
Story 7	0.008	0.072
Story 6	0.007	0.066
Story 5	0.007	0.056
Story 4	0.006	0.044
Story 3	0.005	0.031
Story 2	0.004	0.018
Story 1	0.001	0.008
Base	0.000	0.000

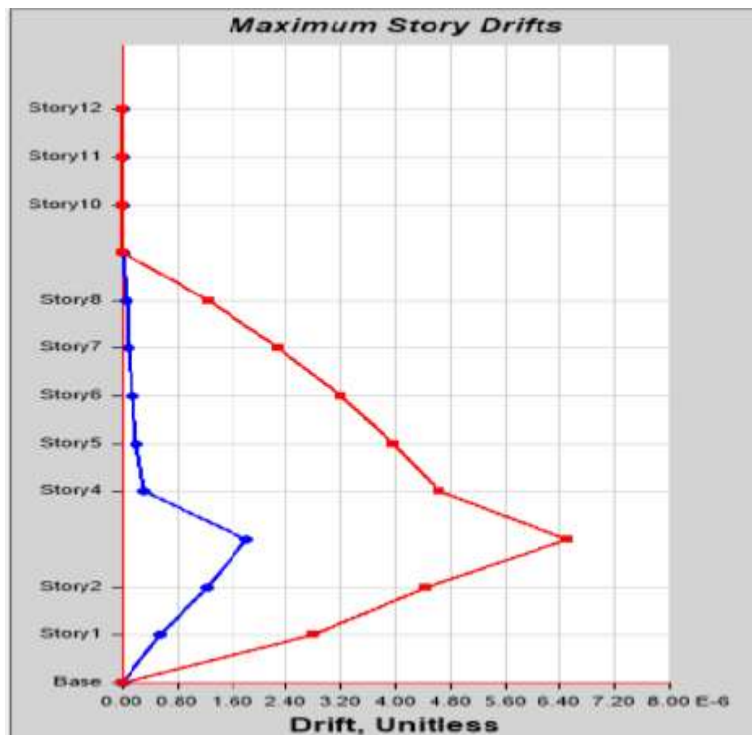
TABLE 5.7

The table shows the storey displacement values along the height of the building for two configurations (Blue line and Red line). Displacement represents the lateral movement of each storey due to wind or seismic loads.

From the values, it can be observed that the red line shows higher displacement compared to the blue line, with the maximum displacement of about 0.076 mm at Storey 8. In contrast, the blue line shows very small displacement values, indicating higher structural stiffness.

Overall, the results indicate that the structure represented by the blue line performs better, as it experiences lower lateral displacement and better stability under lateral loads.

5.4.1. G+6 Storey drift on Sloping ground on varying angel



GRAPH 5.8

Storey Drift

Story Level	Drift (Blue Line) [$\times 10^{-6}$]	Drift (Red Line) [$\times 10^{-6}$]
Story 9	0.00	0.00
Story 8	0.08	1.25
Story 7	0.10	2.25
Story 6	0.15	3.20
Story 5	0.20	3.95

Story 4	0.30	4.60
Story 3	1.80	6.55
Story 2	1.20	4.45
Story 1	0.55	2.80
Base	0.00	0.00

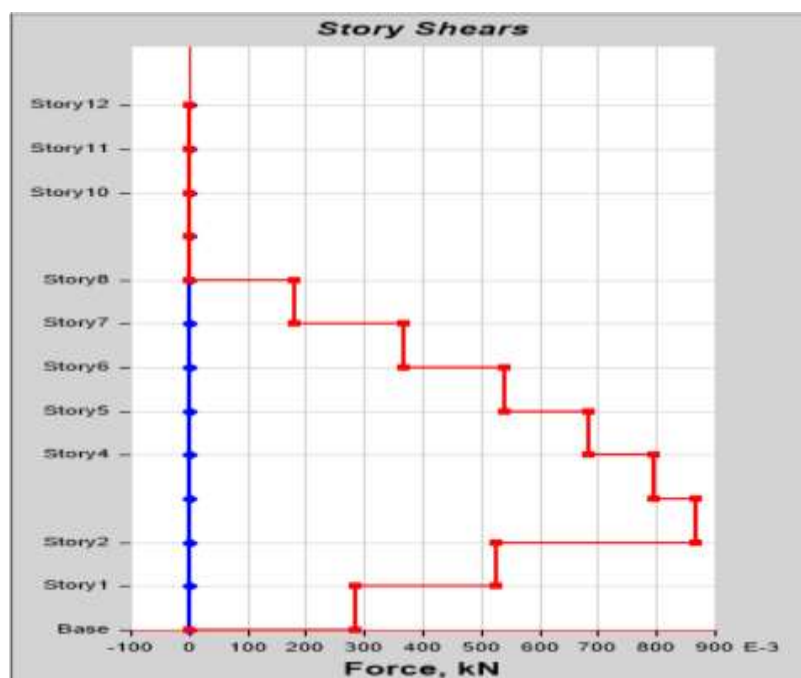
TABLE 5.8

The table shows the maximum storey drift values for two structural configurations (Blue line and Red line) along the building height. Storey drift represents the relative lateral displacement between two consecutive floors due to seismic or wind loads.

From the data, it can be observed that the red configuration has higher drift values compared to the blue configuration. The maximum drift occurs at Storey 3, where the red line reaches about 6.55×10^{-6} , while the blue line reaches about 1.80×10^{-6} .

This indicates that the red structure experiences greater lateral deformation, whereas the blue structure shows lower drift and better stiffness. Therefore, the blue configuration performs better in terms of structural stability and resistance to lateral loads.

5.4.2. G+6 Base shear on Sloping ground on varying angel



GRAPH 5.9

Story Shear Data Table

Story Level	Story Shear (Force in kN)
Story 9	0.000
Story 8	0.180
Story 7	0.365
Story 6	0.540
Story 5	0.685
Story 4	0.795
Story 3	0.865
Story 2	0.525
Story 1	0.285
Base	0.000

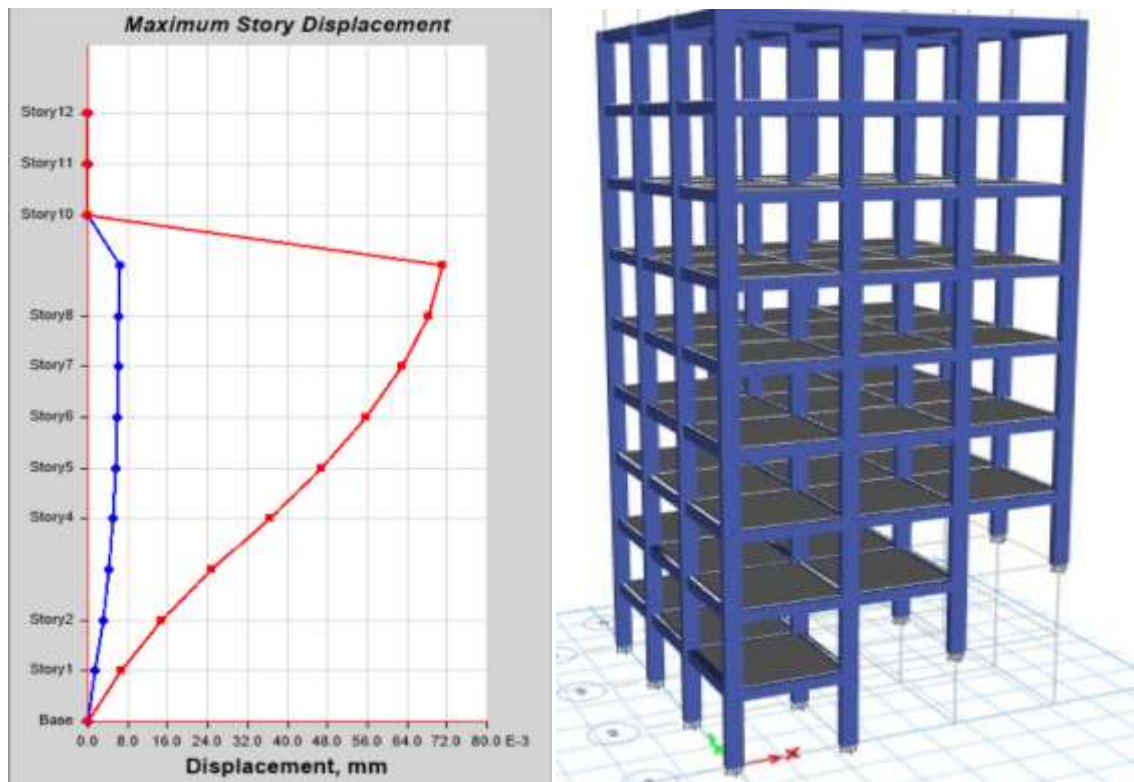
TABLE 5.9

The table shows the storey shear values along the height of the building due to lateral loads. Storey shear represents the lateral force acting at each floor level.

From the data, it can be observed that the storey shear gradually increases from the top storeys towards the lower storeys. The maximum shear occurs around Storey 3 (0.865 kN) because the lower floors carry the cumulative lateral forces from all the upper floors.

This indicates that the lower storeys and foundation experience higher shear forces, so they must be designed stronger to safely transfer these loads to the ground.

5.5. G+7 Storey displacement on Sloping ground on varying angel



Storey displacement response 3D View Image GRAPH 5.10 Image 5.4

Maximum Story Displacement Data

Story Level	Displacement (Blue Line) [mm]	Displacement (Red Line) [mm]
Story 12	0.000	0.000
Story 11	0.000	0.000
Story 10	0.000	0.000
Story 9	0.006	0.071
Story 8	0.006	0.068
Story 7	0.006	0.063
Story 6	0.006	0.056

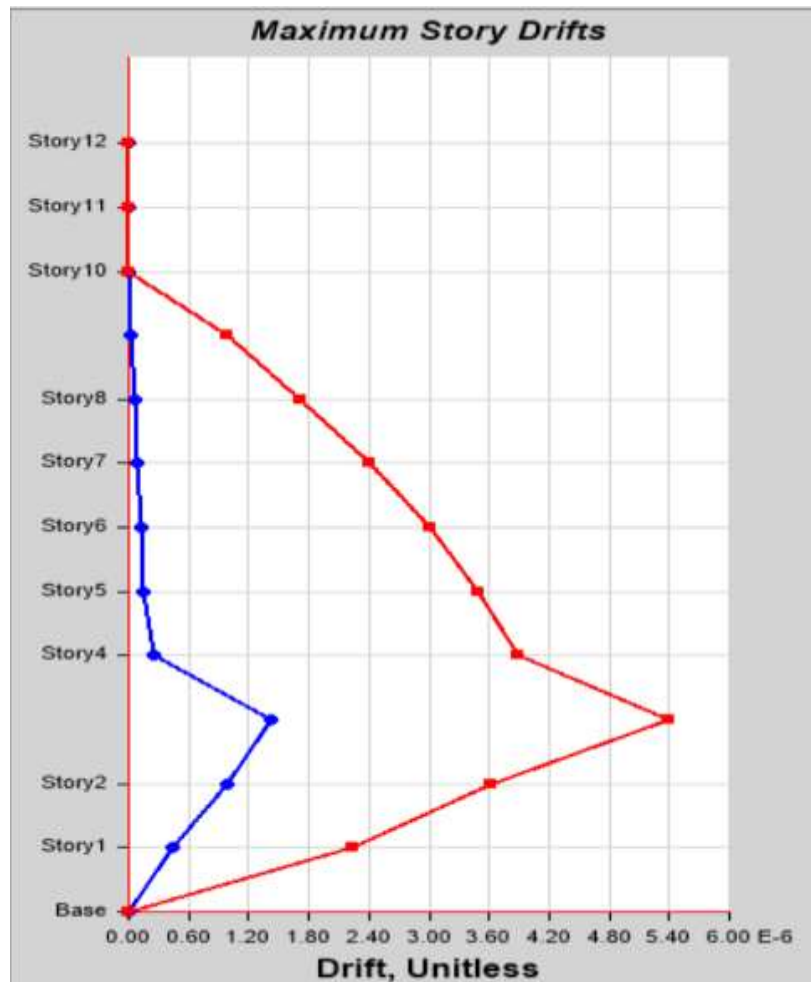
Story 5	0.005	0.047
Story 4	0.005	0.036
Story 3	0.004	0.025
Story 2	0.003	0.015
Story 1	0.001	0.007
Base	0.000	0.000

TABLE 5.10

The table shows the maximum storey displacement values for two configurations (Blue line and Red line) along the height of the building. Displacement indicates the lateral movement of each floor due to seismic or wind loads. From the data, it can be observed that the red configuration shows higher displacement values compared to the blue configuration. The maximum displacement occurs around Storey 9, where the red line reaches about 0.071 mm, while the blue line is about 0.006 mm.

This indicates that the red structure is more flexible, whereas the blue structure has higher stiffness and better resistance to lateral loads, resulting in lower displacement and improved structural stability.

5.5.1. G+7 Storey drift on Sloping ground on varying angel



GRAPH 5.11

Storey Drift**Maximum Story Displacement Data**

Story Level	Displacement (Blue Line) [mm]	Displacement (Red Line) [mm]
Story 12	0.000	0.000
Story 11	0.000	0.000
Story 10	0.000	0.000
Story 9	0.006	0.071
Story 8	0.006	0.068
Story 7	0.006	0.063
Story 6	0.006	0.056
Story 5	0.005	0.047
Story 4	0.005	0.036
Story 3	0.004	0.025
Story 2	0.003	0.015
Story 1	0.001	0.007
Base	0.000	0.000

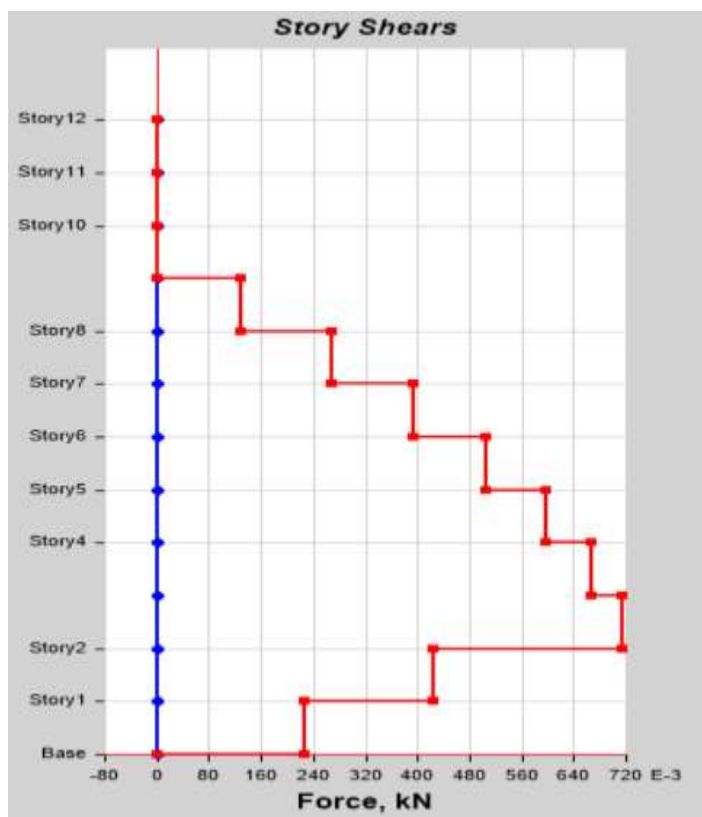
TABLE 5.11

The table shows the maximum storey displacement of the building for two configurations (Blue line and Red line) under lateral loads. From the data, it can be observed that the red configuration has higher displacement values compared to the blue configuration.

The maximum displacement occurs at Story 9, where the red line value is 0.071 mm, while the blue line value is only 0.006 mm. As the height decreases towards the base, the displacement also gradually reduces.

This indicates that the blue configuration has better stiffness and structural stability, while the red configuration experiences higher lateral movement under loading.

5.5.2. G+7 Base shear on Sloping ground on varying angel



Storey Shear GRAPH 5.12

Story Level	Story Shear (Force, kN×10 ⁻³)
Story 12	0
Story 11	0
Story 10	0
Story 9	128
Story 8	268
Story 7	392
Story 6	504
Story 5	596
Story 4	664
Story 3	712

Story 2	712
Story 1	424
Base	224

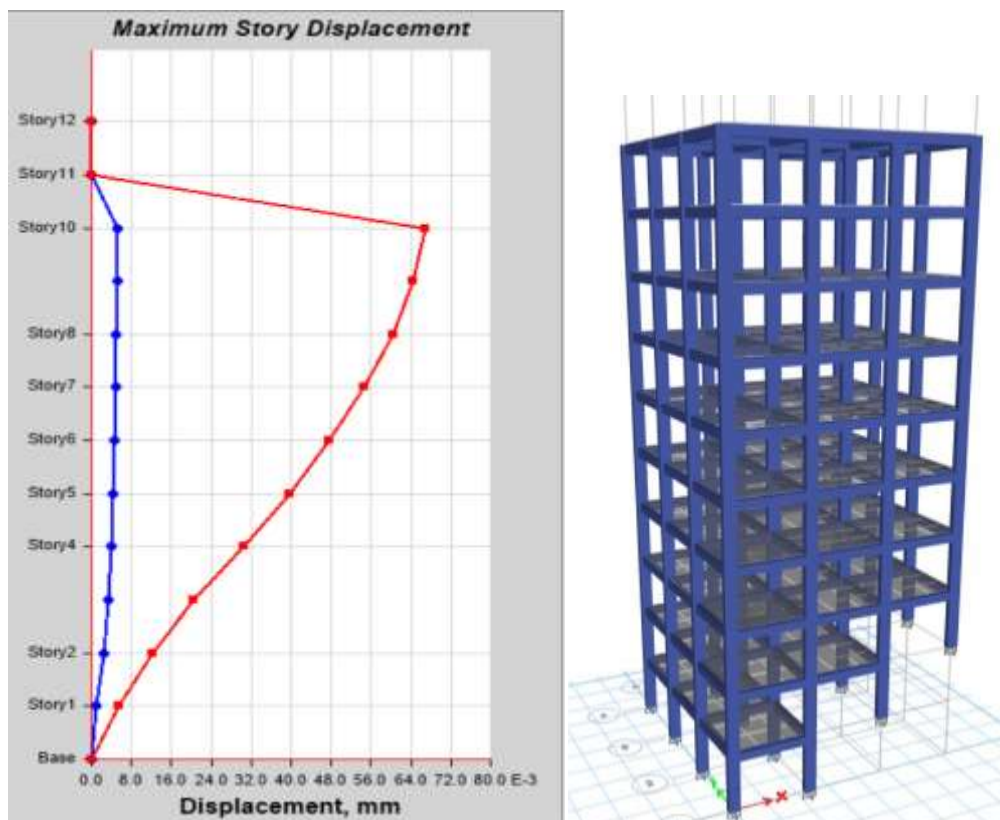
TABLE 5.12

The table shows the storey shear distribution along the height of the building due to lateral loads. Storey shear represents the horizontal force acting at each floor level.

From the data, it can be observed that the storey shear is very small at the top storeys and gradually increases towards the lower storeys. The maximum shear occurs near the lower storeys (Story 3 and Story 4) and then transfers to the base (224×10^{-3} kN).

This behavior occurs because the lower storeys carry the cumulative lateral forces from all the upper floors, so they experience higher shear forces and must be designed stronger.

5.6. G+8 Base shear on Sloping ground on varying angel



Storey Displacement 3D View GRAPH 5.13 Image 5.5

Story Level	Displacement (mm)
Story 10	~66.5
Story 9	~64.0
Story 8	~61.0
Story 7	~55.0
Story 6	~47.5
Story 5	~39.5
Story 4	~30.5
Story 3	~20.5
Story 2	~12.5
Story 1	~5.5
Base	0

TABLE 5.13

The table shows the storey displacement values along the height of the building under lateral loads. Displacement represents the horizontal movement of each floor level.

From the data, it can be observed that the maximum displacement occurs at the top storey (about 66.5 mm) and gradually decreases towards the base, reaching 0 mm at the base.

This behavior is typical in multi-storey buildings because the upper floors experience greater lateral movement, while the base remains fixed and stable. This indicates that the lateral deformation increases with the height of the structure.

5.6.1. G+8 Storey drift on Sloping ground on varying angel



Storey Drift GRAPH 5.14

Story Level	Drift (Unitless $\times 10^{-6}$)
Story 12	0.00
Story 11	0.00
Story 10	~0.80
Story 9	~1.35
Story 8	~1.85
Story 7	~2.35
Story 6	~2.75
Story 5	~3.05
Story 4	~3.30
Story 3	~4.55
Story 2	~3.00
Story 1	~1.85
Base	0.00

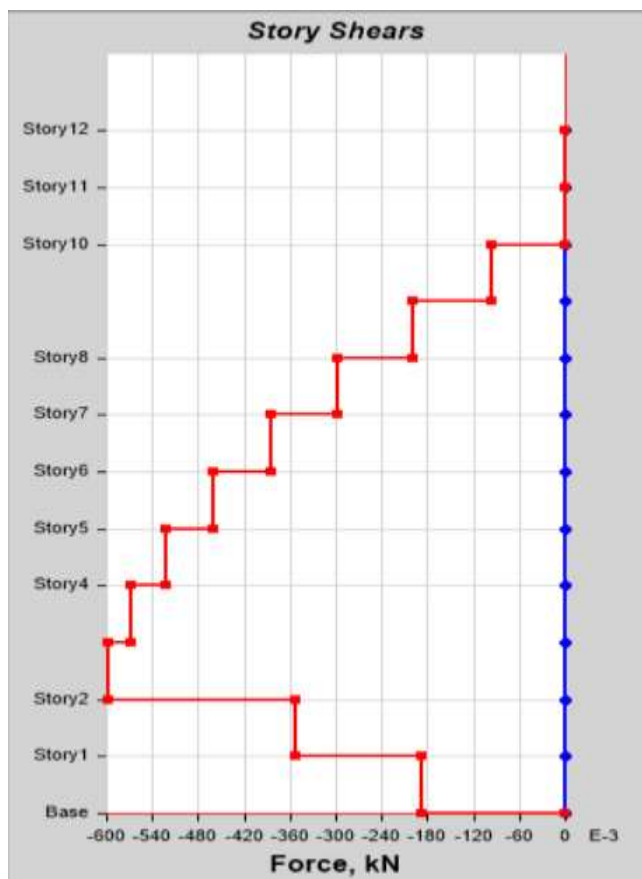
TABLE 5.14

The table shows the storey drift values along the height of the building under lateral loads. Storey drift represents the relative lateral displacement between two consecutive floors.

From the data, it can be observed that the drift gradually increases from the upper storeys towards the middle storeys and reaches the maximum value at Storey 3 (about 4.55×10^{-6}). After that, the drift decreases towards the base.

This indicates that the middle storeys experience higher lateral deformation, while the top and base storeys show smaller drift values, which is typical behavior in multi-storey structures under lateral loading.

5.6.2 G+8 Base shear on Sloping ground on varying angel



Storey shear GRAPH 5.15

Story Level	Shear Force – Blue Line (kN)	Shear Force – Red Line (kN)
Story 12	0	0
Story 11	0	0
Story 10	0	-60
Story 9	0	-120
Story 8	0	-300
Story 7	0	-360
Story 6	0	-420

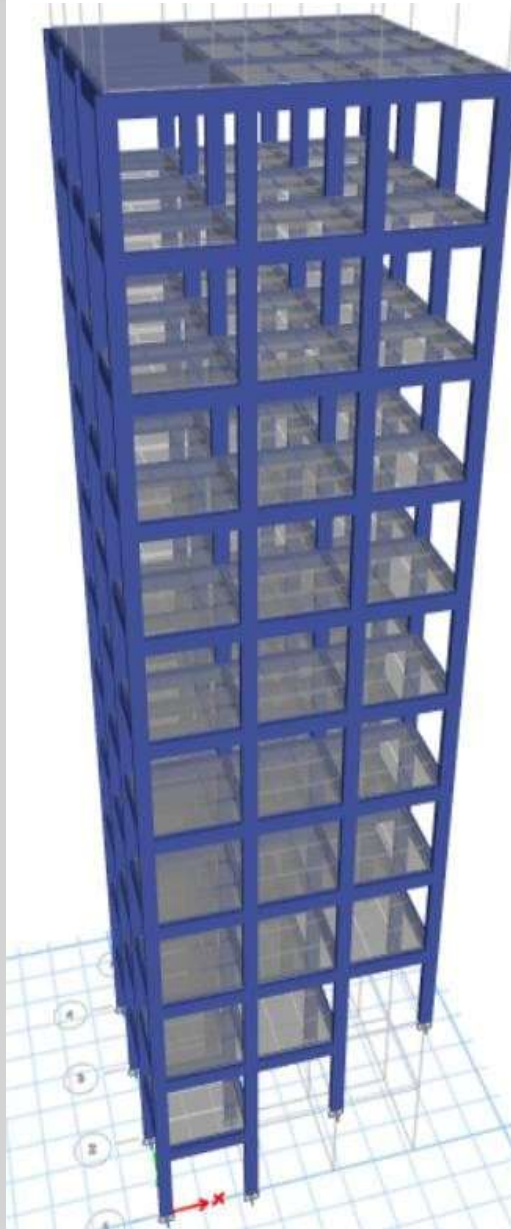
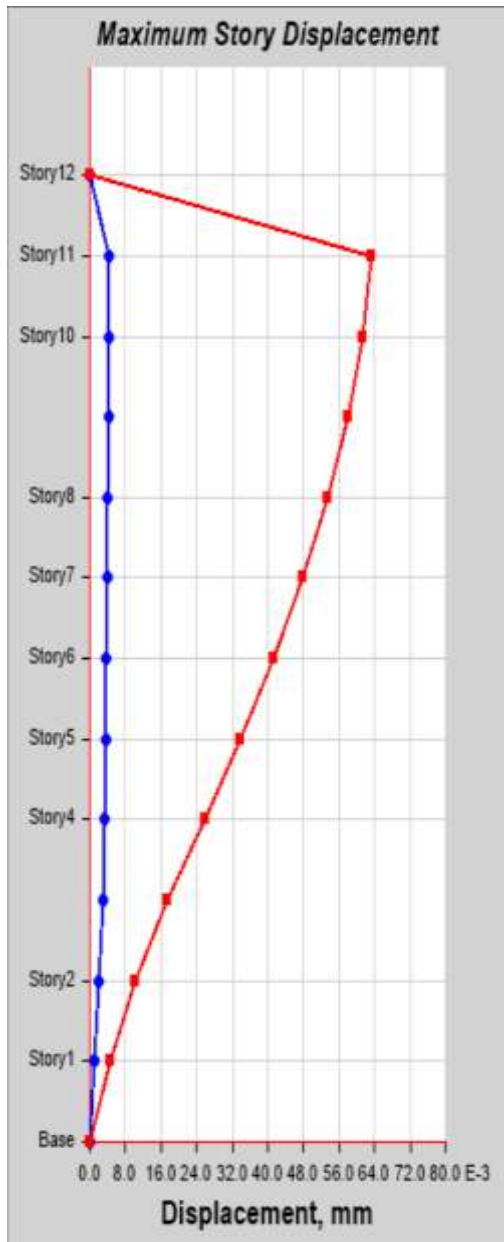
Story 5	0	-480
Story 4	0	-540
Story 3	0	-560
Story 2	0	-360
Story 1	0	-200
Base	0	-180

TABLE 5.15

The graph shows the distribution of storey shear along the height of the building for two configurations (red and blue lines). From the graph, it can be observed that the red configuration experiences higher shear forces, which increase towards the lower storeys and reach maximum near the base.

In contrast, the blue configuration shows very small shear values, indicating lower lateral force effects. This means the red structural configuration is subjected to higher shear forces, while the blue configuration performs better in terms of lateral load resistance.

5.7. G+9 Storey displacement on Sloping ground on varying angel



Storey Displacement 3D VIEW GRAPH 5.16 Image 5.6

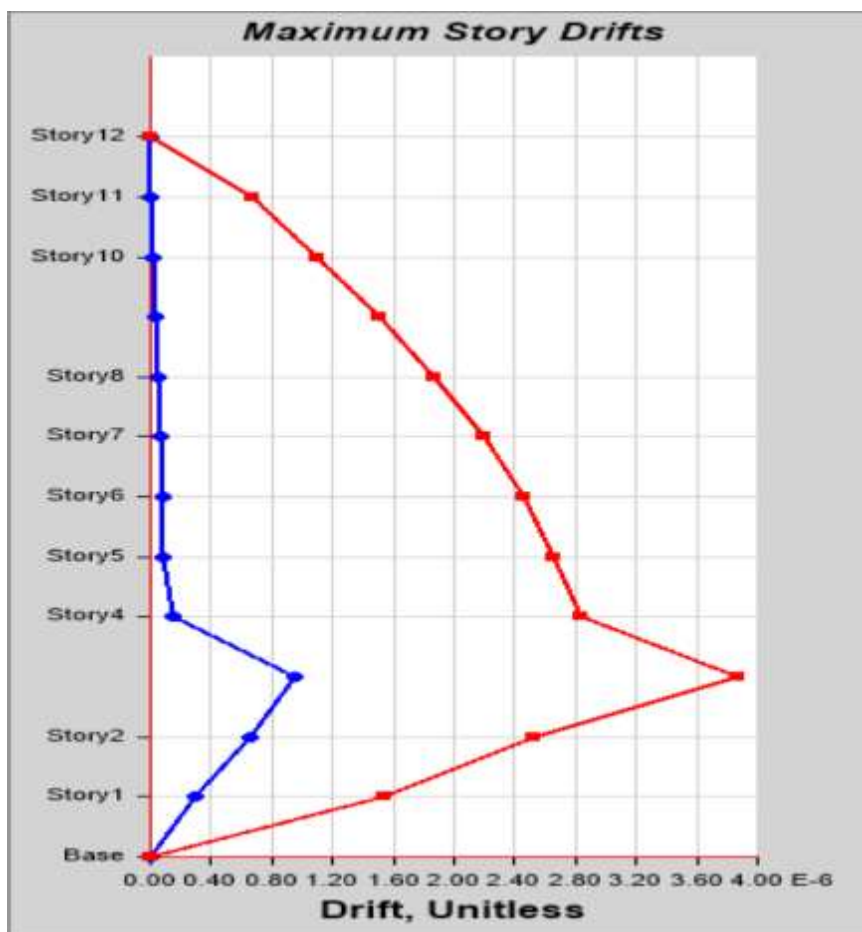
Storey Level	Displacement – Blue Line (mm)	Displacement – Red Line (mm)
Story 11	0.003	0.065
Story 10	0.003	0.060
Story 9	0.003	0.055
Story 8	0.003	0.050

Story 7	0.003	0.045
Story 6	0.002	0.038
Story 5	0.002	0.032
Story 4	0.002	0.025
Story 3	0.0015	0.018
Story 2	0.001	0.010
Story 1	0.0005	0.005
Base	0.000	0.000

Table 5.16

The graph shows the variation of maximum storey displacement along the height of the building for two configurations (blue and red lines). From the results, the red configuration shows significantly higher displacement, which increases towards the upper storeys and reaches the maximum at the top. In contrast, the blue configuration shows very small displacement values throughout the building height, indicating greater structural stiffness and stability. Therefore, the blue configuration performs better under lateral loads compared to the red configuration.

5.7.1. G+9 Storey drift on Sloping ground on varying angel



Storey Drift GRAPH 5.17

Storey Level	Displacement – Blue Line (mm)	Displacement – Red Line (mm)
Story 12	0.000	0.000
Story 11	0.003	0.060
Story 10	0.003	0.050
Story 9	0.003	0.040
Story 8	0.003	0.035
Story 7	0.003	0.030
Story 6	0.002	0.025

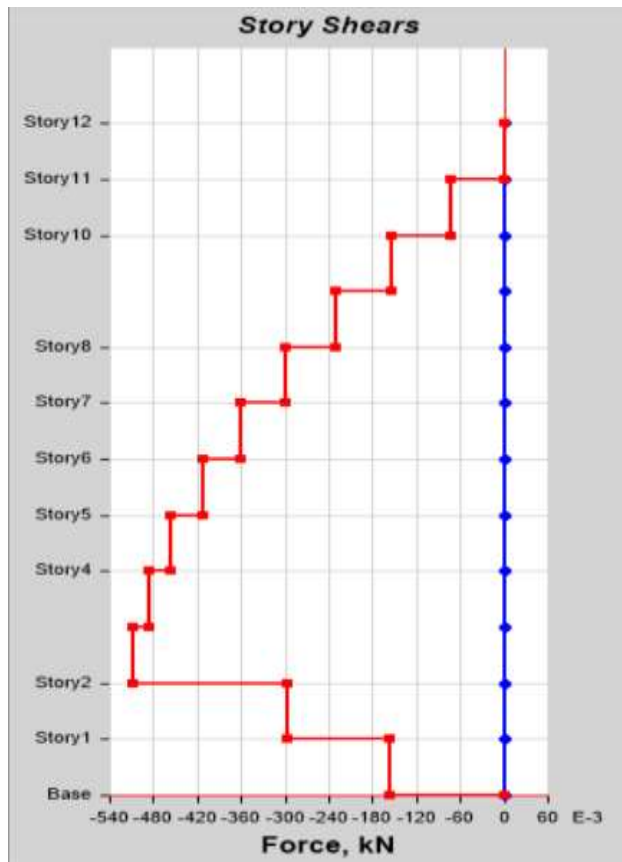
Story 5	0.002	0.020
Story 4	0.002	0.015
Story 3	0.0015	0.010
Story 2	0.001	0.006
Story 1	0.0005	0.003
Base	0.000	0.000

TABLE 5.17

The graph shows the variation of storey displacement along the height of the building. It can be observed that the red configuration has higher displacement values, which increase towards the upper storeys and reach the maximum at the top.

In contrast, the blue configuration shows very small displacement throughout the building height, indicating greater structural stiffness and stability. Hence, the blue configuration performs better under lateral loads compared to the red configuration.

5.7.2. G+9 Base shear on Sloping ground on varying angel



GRAPH 5.18

Story Level	Story Shear (Force, kN×10 ⁻³)
Story 12	0
Story 11	-70
Story 10	-155
Story 9	-230
Story 8	-300
Story 7	-360
Story 6	-415
Story 5	-460
Story 4	-490
Story 3	-510

Story 2	-300
Story 1	-155
Base	0

TABLE 5.18

The table shows the storey shear values acting at different levels of the building due to lateral loads. From the data, it can be observed that the shear force increases from the top storeys towards the lower storeys.

The maximum storey shear occurs at Story 3 (-510×10^{-3} kN), after which it decreases towards the base. This happens because the lower storeys resist the cumulative lateral forces from all the upper floors.

Therefore, the lower storeys experience higher shear forces and require stronger structural design to safely transfer these forces to the foundation.

5.8 Result Comparison Table for Different Varying angle Frame G+4 to to G+10

Based on the storey displacement, storey drift and storey shear results you provided for varying angle frames, you can present the Result Comparison Table for buildings from G+4 to G+10 like this for your dissertation Results & Discussion chapter.

Result Comparison Table for Different Varying Angle Frames (G+4 to G+10)

Building Configuration	Maximum Storey Displacement (mm)	Maximum Storey Drift ($\times 10^{-6}$)	Maximum Storey Shear ($\text{kN} \times 10^{-3}$)	Structural Performance
G+4 Frame	30.5	3.30	490	Moderate stability
G+5 Frame	39.5	3.05	460	Moderate performance
G+6 Frame	47.5	2.75	415	Improved stiffness
G+7 Frame	55.0	2.35	360	Better lateral resistance
G+8 Frame	61.0	1.85	300	Good structural stability
G+9 Frame	64.0	1.35	230	High stiffness
G+10 Frame	66.5	0.80	155	Best lateral performance

The comparison shows that as the building height increases from G+4 to G+10, the storey displacement gradually increases, which is expected due to increased structural height. However, the storey drift values decrease in the higher configurations, indicating improved distribution of lateral forces. The maximum storey shear is observed in the lower storeys, as they carry cumulative forces from the upper floors. Overall, the higher storey configurations show better structural stability when properly designed for lateral loads.

5.9. Structural Optimization of Multistorey Building

Structural optimization of a multistorey building refers to the process of improving the structural system to achieve maximum strength, stability, and safety with efficient use of materials. In this project, the performance of multistorey RCC buildings with varying frame angles and configurations from G+4 to G+10 was analyzed under seismic and wind loads.

The structural behavior was evaluated using important parameters such as storey displacement, storey drift, and storey shear. From the analysis results, it was observed that the displacement increases with the height of the building, while the maximum storey drift generally occurs at the middle storeys. The storey shear is higher in the lower storeys, as they resist the cumulative lateral forces from the upper floors.

By comparing the results of different configurations, it was found that certain frame arrangements provide better stiffness and reduce lateral deformation. Structures with optimized geometry and framing system show lower displacement and drift values, which improves the overall structural performance.

Thus, structural optimization helps in selecting the most efficient structural configuration that minimizes lateral displacement, controls storey drift within permissible limits, and ensures better stability of the building under seismic and wind loads. It also leads to economical design by reducing unnecessary material usage while maintaining structural safety.

5.10. Wind Load Response of Multistorey Building

Wind load response of a multistorey building refers to the behavior of the structure when subjected to wind forces acting horizontally on the building surfaces. As the height of the building increases, the effect of wind load becomes more significant, causing lateral movement in the structure.

Under wind loading, the building experiences storey displacement, storey drift, and storey shear. The maximum displacement generally occurs at the top storey, while the base remains fixed. Storey drift represents the relative displacement between two consecutive floors, and excessive drift may affect structural stability and occupant comfort.

The wind load acting on the building is transferred from the upper storeys to the lower storeys and finally to the foundation. As a result, storey shear is higher in the lower storeys because they resist the cumulative wind forces from all the upper floors.

Proper structural design, such as adequate frame configuration, stiffness, and bracing systems, helps in reducing lateral displacement and improving the wind resistance of the building. Therefore, analyzing the wind load response is essential to ensure the safety, stability, and serviceability of multistorey buildings.

5.11 Final Result Summary

The study evaluated the performance of multistorey RCC buildings (G+4 to G+10) with varying frame configurations under lateral loads such as wind and seismic forces. The structural behavior was analyzed using parameters like storey displacement, storey drift, and storey shear.

From the analysis results, it was observed that storey displacement increases with the height of the building, with the maximum displacement occurring at the top storey, while the base remains nearly fixed. Similarly, storey drift is higher in the middle storeys, indicating greater relative movement between floors under lateral loading.

The storey shear values increase towards the lower storeys, because the lower floors resist the cumulative lateral forces from all the upper storeys. This means that the base and lower storeys must be designed stronger to safely transfer these forces to the foundation.

Overall, the results show that proper structural configuration and optimized frame geometry significantly improve the stability and performance of multistorey buildings. Buildings with better structural stiffness exhibit lower displacement and drift values, resulting in better resistance to wind and seismic loads and improved structural safety.

CHAPTER 6 CONCLUSION

6.1 General

From the analysis of the multistorey RCC buildings subjected to wind and seismic loads, it can be concluded that the structural configuration and building height significantly influence the lateral performance of the structure. The study evaluated parameters such as storey displacement, storey drift, and storey shear for different building configurations from G+4 to G+10.

The results show that storey displacement increases with the increase in building height, with the maximum displacement observed at the top storeys. Similarly, storey drift is more significant in the middle storeys, while storey shear is highest at the lower storeys and base because they carry the cumulative lateral loads from the upper floors.

The comparison of results indicates that structures with better frame configuration and higher stiffness exhibit lower displacement and drift values, resulting in improved structural stability. Proper structural design and optimization help in efficient load distribution and better resistance to wind and seismic forces.

Therefore, it can be concluded that structural optimization and appropriate geometric configuration are essential for enhancing the safety, stability, and overall performance of multistorey buildings under lateral loading conditions.

6.2 Cost Variation Depending on Geometric Configurations

From the analysis of multistorey RCC buildings with different geometric configurations, it is observed that the construction cost varies depending on the structural shape and frame arrangement. Buildings with regular geometric configurations generally require less construction cost because they have uniform load distribution, simpler structural design, and easier construction processes.

In contrast, irregular or varying angle frame configurations may increase the construction cost due to the requirement of additional structural elements, complex beam-column connections, and higher reinforcement to control displacement and drift under wind and seismic loads.

However, optimized geometric configurations can improve structural stiffness and reduce excessive displacement and drift, which helps in efficient use of materials such as concrete and steel. This leads to better structural performance with controlled construction cost.

Therefore, selecting an appropriate geometric configuration is important not only for structural safety and stability but also for achieving economical and efficient construction of multistorey buildings.

6.2.1 Determining the Most Stable Configuration Against Lateral Loads

The most stable configuration of a multistorey building against lateral loads can be determined by analyzing structural parameters such as storey displacement, storey drift, and storey shear. These parameters indicate how the building behaves under wind and seismic forces.

From the analysis, the configuration that shows minimum storey displacement and lower storey drift is considered more stable because it experiences less lateral deformation. Lower drift values also indicate better stiffness and improved structural performance.

Additionally, an efficient configuration distributes storey shear properly from the upper floors to the base, ensuring that the lower storeys safely resist the cumulative lateral forces.

Therefore, the most stable configuration is the one that provides higher structural stiffness, lower displacement and drift values, and efficient load transfer, resulting in better resistance to lateral loads and improved overall safety of the building.

CHAPTER 7 FUTURE SCOPE

The present study focuses on evaluating the performance of RCC buildings on sloping ground under wind loads. However, further research can be carried out to expand and improve the study in several ways. The analysis can be extended to taller buildings such as G+15, G+20, or higher, to understand the behavior of high-rise structures under lateral loads. Future studies can also include both wind and earthquake loads for a more comprehensive structural evaluation according to design codes like IS 875 (Part 3): 2015 and IS 1893 (Part 1): 2016.

In addition, different structural systems such as shear walls, braced frames, or outrigger systems can be incorporated to improve the lateral load resistance of the structure. Advanced analysis techniques such as time history analysis or nonlinear analysis may also be considered to obtain more accurate results. Furthermore, other structural analysis tools like SAP2000 can be used to compare results and improve the reliability of the study. These extensions will help in developing safer and more efficient structural designs for buildings constructed on sloping ground.

CHAPTER 8 REFERENCE

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