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Review on BIM-Based (Revit+Robot Software) Comparative Wind Load Analysis of High-Rise RCC Buildings in Zone-III, IV and V

Pratibha Namdev Khillare[1,*], Satish S. Manal[2]

Abstract

Wind load is one of the most critical factors influencing the design and serviceability of high-rise reinforced concrete (RCC) buildings. As building height increases, wind-induced effects such as storey drift, lateral displacement, and structural stiffness become dominant design considerations. Numerous studies have been conducted using conventional and advanced techniques such as Finite Element Method (FEM), Computational Fluid Dynamics (CFD), and Building Information Modelling (BIM). However, limited research focuses on comparative analysis across different wind zones using an integrated BIM–FEM approach. This paper presents a comprehensive review of existing research on wind behaviour of high-rise buildings. The influence of building geometry, structural systems, material properties, and analysis tools on wind response is critically examined. The review also identifies key research gaps and highlights the need for a consistent modelling approach and multi-zone comparative analysis. The findings emphasize that aerodynamic shapes, increased structural stiffness, and advanced analysis tools significantly improve wind performance. Furthermore, this study extends the discussion by outlining the importance of standardized design methodologies that can be uniformly applied across varying geographical wind conditions. It also underscores the role of hybrid modelling techniques that integrate BIM with FEM to enhance accuracy, efficiency, and data interoperability during analysis and design stages. The paper highlights the necessity for incorporating real-time environmental data and dynamic loading conditions to achieve more reliable predictions of structural behaviour. Additionally, future research directions are proposed, focusing on performance-based design approaches, optimization of structural configurations, and the development of resilient and sustainable high-rise structures capable of withstanding extreme wind events.

Keywords: Wind Load, High-Rise Buildings, BIM, FEM, Storey Drift, Displacement, Wind Zones

***Author for Correspondence**
Pratibha Namdev Khillare
E-mail: khillarepratibha1992@gmail.com

[1]M.Tech Student, Department of Civil Engineering, Chh. Shahu College of Engineering. Chh. Sambhajinagar, Maharashtra, India
[2]Assistant Professor, Department of Civil Engineering, Chh. Shahu College of Engineering. Chh. Sambhajinagar, Maharashtra, India

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INTRODUCTION

The increasing demand for vertical development in urban areas has led to a rapid increase in the construction of high-rise buildings. As the height of a structure increases, the influence of lateral loads, such as wind, becomes more significant than that of gravity loads. Among these, wind load is a critical factor that governs the serviceability performance of tall buildings, particularly in terms of story drift, lateral displacement, and structural stiffness.

Wind loads act horizontally and vary with the height of the structure. These loads are influenced by various factors, including wind speed, terrain category, building height, and structural configuration. In India, wind loads are evaluated according to IS 875 (Part 3):2015, which classifies the country into different wind zones, such as Zone III, Zone IV, and Zone V. Buildings located in higher wind zones are subjected to greater wind pressures, resulting in increased deformation and reduced structural stability.

Recent advancements in structural engineering have introduced modern computational tools such as building information Modelling (BIM), the Finite Element Method (FEM), and Computational Fluid Dynamics (CFD). BIM enables accurate three-dimensional modelling of buildings, whereas FEM provides a precise analysis of structural behavior under loading conditions. The integration of BIM and FEM ensures consistency between modelling and analysis, reduces errors, and improves the reliability of the results.

Despite numerous studies on the wind behavior of tall buildings, most research has focused on single wind zones or specific structural systems. There is limited research on comparative analyses across different wind zones using a consistent building configuration. Therefore, a comprehensive literature review is necessary to understand existing research trends and identify gaps for further studies.

Wind Behaviour in High-Rise Buildings

Wind load acts as a dynamic lateral force on high-rise buildings and varies significantly with the height of the structure. Unlike gravity loads, wind pressure increases with elevation because of higher wind velocities at greater heights, resulting in a non-uniform distribution of forces. The structural response of buildings to wind loading is generally evaluated in terms of lateral displacement, story drift, and stiffness. It was observed that the lateral displacement increased progressively from the base to the top of the building. This occurs because the structure behaves like a vertical cantilever fixed at the base and free at the top, where the cumulative effect of the wind forces acting on all the storeys leads to the maximum displacement at the roof level.

Storey drift, which represents the relative displacement between consecutive floors, did not follow the same trend as the displacement. Instead, the maximum drift typically occurs at the mid-height or slightly above the mid-height of the building. This is due to the interaction between the increasing wind shear forces from the top to the bottom and the reduction in structural stiffness with height. At lower levels, higher stiffness restricts deformation, whereas at upper levels, the difference in displacement between adjacent storeys is relatively smaller. However, at mid-height, the combination of a significant shear force and moderate stiffness results in maximum drift, making this region critical for structural design and serviceability checks.

Furthermore, the wind effects increase significantly with the building height because the wind speed increases with the elevation, and the wind pressure is proportional to the square of the wind velocity. Consequently, taller buildings experience greater lateral forces, higher displacements, increased drifts, and larger overturning moments. Slender and flexible structures are particularly sensitive to these effects, and dynamic phenomena such as vortex shedding and cross-wind oscillations become more prominent in tall buildings than in short buildings.

Excessive wind-induced deformation can lead to serious structural and nonstructural issues. Structurally, it may cause cracking in beams, columns, and slabs, whereas non-structural elements, such as glass panels, partitions, and cladding systems, may suffer damage. Additionally, excessive building sway can cause discomfort to occupants, affecting both safety and usability. Therefore, controlling wind effects is a key aspect of high-rise building design, which can be achieved using appropriate structural systems, aerodynamic shaping, and advanced analysis techniques.

LITERATURE REVIEW

[1] Mazarakou & Papalou (2025) This study investigated the influence of building geometry on the wind response of tall structures using finite element modelling techniques. The authors developed multiple high-rise building models with different geometric configurations, including rectangular, tapered, and twisted forms, to evaluate their behavior under wind loading conditions.

This study focused on key response parameters, such as story displacement, inter-story drift, base shear, and acceleration. The results indicated that aerodynamic modifications to the building shape significantly reduced wind-induced forces. In particular, tapered and twisted buildings demonstrated lower wind pressure owing to reduced vortex shedding and smoother airflow around the structure. The study also found that modifications at the upper storeys were more effective in reducing wind effects than changes at lower levels.

Furthermore, the study highlighted that conventional rectangular buildings are more susceptible to wind-induced vibrations owing to sharp edges, which cause flow separation and increased pressure zones. In contrast, aerodynamic shapes distribute wind pressure more uniformly, resulting in improved structural performance and reduced deformations.

The authors concluded that architectural design plays a crucial role in wind resistance, and that incorporating aerodynamic features can enhance both structural safety and occupant comfort. This study emphasizes the importance of integrating architectural and structural designs to optimize the wind performance of high-rise buildings.

[2] Singh & Verma (2025) Singh and Verma conducted a comprehensive review of various techniques used to reduce wind loads on tall buildings. This study analyzed different strategies, including aerodynamic modifications, structural control systems, and advanced computational methods.

The authors found that aerodynamic modifications, such as chamfered corners, rounded edges, setbacks, and tapering, can reduce wind forces by approximately 20–40%. These modifications helped minimize vortex formation and improve airflow around the building. In addition to geometric changes, the study explored the use of structural control systems, such as Tuned Mass Dampers (TMD) and Tuned Liquid Dampers (TLD), which are effective in reducing vibrations and improving occupant comfort.

This research also highlighted the importance of using advanced tools, such as CFD and FEM, for the accurate prediction of wind behavior. CFD simulations provide detailed insights into wind flow patterns and pressure distribution, whereas FEM analysis helps evaluate the structural response.

The authors concluded that a combined approach involving aerodynamic design and structural control systems is the most effective method for reducing wind effects on high-rise buildings. This study provides valuable guidelines for engineers and designers to enhance wind performance through integrated design strategies.

[3] Sudarshan Suryanarayan & Prof D.M Pandit (2025) presented a comparative analysis of high-rise RCC buildings with and without shear walls using BIM–FEM integration. The building models were developed using Autodesk Revit and analyzed using Autodesk Robot Structural Analysis software.

This study focused on evaluating structural performance parameters such as storey drift, displacement, bending moment, and axial forces under lateral loading conditions. The results showed that the building without shear walls exhibited significantly higher displacements and drifts than the building with shear walls.

Shear walls provide additional stiffness to the structure, resulting in reduced lateral deformation and improved load distribution. This study also highlighted the advantages of BIM-based modelling, which ensures accurate geometry, eliminates modelling errors, and improves analysis efficiency.

Another key finding of this study was that BIM–FEM integration reduces manual intervention and ensures consistency between architectural and structural models. This approach enhances the reliability of the results and facilitates better decision-making in the design process.

The authors concluded that shear walls are essential for improving the performance of high-rise buildings under lateral loads and that BIM–FEM integration is a powerful tool for modern structural analysis.

[4] Reddy (2024) conducted a comparative study between STAAD.Pro and ETABS for the wind load analysis of multi-storey buildings. This study aimed to evaluate the accuracy and efficiency of these software tools in predicting the structural behavior under wind loading.

The research involved modelling a multi-story RCC building in both STAAD.Pro and ETABS and applying wind loads as per the IS 875 provisions. The results showed significant differences in the storey drift and displacement values obtained from the two software.

ETABS provided lower and more realistic drift values owing to its advanced stiffness modelling and better representation of structural behavior. By contrast, STAAD.Pro required more manual adjustments and showed higher drift values, particularly for irregular structures.

The study also found that ETABS offers better visualization of results and easier interpretation of the structural response. Additionally, ETABS requires less time for modelling and analysis than STAAD.Pro.

The authors concluded that ETABS is more suitable for the wind analysis of high-rise buildings because of its accuracy and efficiency. However, proper modelling and input data are essential for obtaining reliable results in any software.

[5] Jani & Patel (2024) Jani and Patel studied the performance of diagrid structures under wind loading using ETABS. This research focused on high-rise buildings ranging from 36 to 80 stories.

The study evaluated parameters such as story drift, displacement, and structural efficiency. The results showed that diagrid structures significantly reduced lateral displacement and drift compared with conventional framed structures.

The diagonal members in diagrid systems efficiently transfer loads through axial forces, resulting in improved stiffness and reduced bending. The study found that the drift was reduced by approximately 30% in the diagrid structures.

Another important finding was that diagrid systems reduce material consumption by eliminating the need for internal columns, making them structurally efficient and economical.

The authors concluded that diagrid structures are highly effective for high-rise buildings subjected to wind loads and are particularly suitable for regions with high wind intensities.

[6] Chaithanya & P. Sarika (2024): Chaithanya and P. Sarika carried out a comparative study to evaluate the wind behaviour of multi-storey buildings using two widely used structural analysis software tools, namely STAAD.Pro and SAP2000. The primary objective of this study was to analyze the variation in the structural response when the same building is modeled and analyzed using different computational platforms, particularly focusing on wind-induced effects.

In this study, a 30-storey reinforced concrete building was modeled in both STAAD.Pro and SAP2000, and wind loads were applied according to the relevant codal provisions. The analysis focused on important parameters such as the storey displacement, inter-storey drift, torsional response, and overall deformation patterns. The comparison between the two software platforms allowed the authors to identify differences in analytical capabilities and result accuracies.

The results obtained from the analysis indicated that SAP2000 produced comparatively lower values of displacement and drift than STAAD.Pro. This difference was attributed to the more refined finite element formulation and better stiffness modelling capability of SAP2000. Additionally, SAP2000 was found to capture the torsional effects more accurately, especially in cases where wind loads were applied at different angles or when the structure exhibited irregular geometry.

The study also observed that buildings with irregular configurations exhibited higher drift and torsional behaviors owing to the uneven distribution of mass and stiffness. However, STAAD.Pro has some limitations in accurately representing these complex behaviors, particularly in capturing the torsional coupling effects.

Based on their findings, the authors concluded that SAP2000 is more suitable for analyzing the wind behavior of high-rise and irregular buildings owing to its advanced analysis features. However, they emphasized that accurate modelling, proper load definition, and understanding of software capabilities are essential for obtaining reliable results in any structural analysis tool.

[7] Ranch & Gupta (2024): Ranch and Gupta conducted a detailed study on the wind behavior of irregular high-rise buildings, specifically focusing on L- and C-shaped plan configurations. The primary objective of this study was to evaluate the influence of plan irregularity on wind-induced forces, torsional effects, and overall structural performance.

In this study, models of L- and C-shaped multi-story buildings were developed using ETABS software. Wind loads were applied as per the provisions of IS 875 (Part 3), and the structural response was evaluated in terms of storey displacement, inter-storey drift, torsional moment, and pressure distribution along the height of the building. The authors paid special attention to the behavior of re-entrant corners, which are common in irregular structures.

The results indicated that irregular plan configurations experience significantly higher torsional effects than regular rectangular buildings. In particular, L-shaped buildings showed approximately 22% higher torsional drift owing to the uneven distribution of stiffness and mass. The presence of re-entrant corners caused a concentration of wind pressure, resulting in localized stress and increased deformation.

The study also found that wind flow separation occurred more prominently at sharp edges and corners, leading to vortex formation and suction forces. This phenomenon increases the lateral displacement and instability of the structures. Additionally, the distribution of the story stiffness was non-uniform, which contributed to irregular deformation patterns along the building height.

The authors concluded that irregular buildings are more vulnerable to wind-induced effects and require additional structural measures, such as shear walls, bracing systems, or optimized design configurations, to improve their performance. This study emphasizes the importance of considering the plan geometry in the design of high-rise buildings subjected to wind loads.

[8] Zia & Khan (2024): Zia and Khan conducted a comprehensive study on the wind response of high-rise steel buildings using SAP2000 software. The main objective of this study was to investigate the behavior of steel structures under wind loading and compare their performance with that of conventional reinforced concrete buildings.

In this study, a 30-storey steel building model was developed and subjected to wind loads as per IS 875 (Part 3). The analysis focused on key structural parameters, such as lateral displacement, story drift, natural frequency, and vibration characteristics. The authors also examined the effects of dynamic wind forces, including vortex shedding and cross-wind excitation.

The results showed that steel buildings exhibited higher lateral displacement and drift than RCC buildings because of their lower stiffness. The flexibility of steel structures renders them more sensitive to wind-induced vibrations, particularly at higher stories. The study observed that the maximum displacement occurred at the top of the building, whereas significant drift was concentrated at the mid-height levels.

Another important finding was the effect of vortex shedding, which caused oscillatory motion in the structure. This dynamic behavior is more pronounced in slender steel buildings, leading to discomfort for occupants and potential structural issues if not properly controlled.

To address these challenges, the authors recommended the use of damping systems, such as Tuned Mass Dampers (TMD) and bracing systems, to reduce wind-induced vibrations. They also emphasized the importance of considering the dynamic analysis of steel structures subjected to wind loads.

The study concluded that although steel structures offer advantages in terms of construction speed and reduced weight, they require additional design considerations to control wind effects and ensure structural stability.

[9] Patel & Mishra (2024): Patel and Mishra conducted a comparative study to evaluate the effect of plan shape on the wind performance of high-rise buildings. The objective of this study was to analyze how different geometrical configurations influence the wind pressure distribution, structural response, and overall stability.

The authors developed three building models with different plan shapes, namely square, hexagonal, and circular, using the ETABS software. Wind loads were applied according to the IS 875 (Part 3) guidelines, and the structural response was analyzed in terms of story displacement, inter-story drift, and base shear.

The results revealed that circular buildings performed the best under wind loading conditions. Owing to their smooth and continuous surfaces, circular shapes allow uniform airflow around the structure, reducing wind pressure and minimizing vortex formation. This resulted in lower displacement and drift values than those of the other shapes.

Hexagonal buildings exhibited moderate performance, with better wind resistance than square buildings but less efficiency than circular structures. Square buildings exhibited the highest wind pressure owing to their sharp edges, which caused flow separation and increased drag forces. The study found that the base shear in square buildings was approximately 15% higher than that in circular buildings.

The authors concluded that the aerodynamic shape plays a crucial role in improving wind performance. Buildings with smooth and curved surfaces experience lower wind forces and better structural behavior. This study recommends adopting circular or rounded geometries for high-rise buildings in wind-prone areas.

[10] Singh & Kumar (2023): Singh and Kumar conducted an advanced study combining Computational Fluid Dynamics (CFD) and the Finite Element Method (FEM) to analyze the wind behavior of buildings with different shapes. The objective of this study was to understand the interaction between wind flow and the structural response of high-rise buildings.

In this study, various building models, including rectangular, L-shaped, and circular configurations, were analyzed. CFD simulations were used to study the wind flow patterns, pressure distribution, and vortex formation around the buildings. The structural response was evaluated using FEM analysis.

The results indicated that rectangular and irregular buildings experience higher wind pressure owing to sharp edges, which cause flow separation and vortex shedding. These effects lead to increased displacements and torsional responses. In contrast, circular and streamlined shapes allow smooth airflow, reducing pressure concentration and improving stability.

This study also highlighted the importance of cross-wind effects, which can cause significant oscillations in tall buildings. CFD analysis showed that turbulence and vortex formation were more pronounced in buildings with irregular shapes.

Another key finding was that combining CFD and FEM provided a more accurate analysis of wind behavior than using either method alone. CFD captures aerodynamic effects, whereas FEM evaluates the structural response.

The authors concluded that aerodynamic design and integrated analysis techniques are essential for improving the wind performance of high-rise buildings.

[11] Rao, Ali, Thomas & Roy (2023): Rao, Ali, Thomas, and Roy conducted a comprehensive study to evaluate the effect of façade shape and building orientation on wind behaviour of high-rise buildings. The objective of this study was to analyze how external geometry and orientation influence wind pressure distribution, structural response, and overall performance under wind loading conditions.

In this study, multiple high-rise building models with different façade shapes, including rectangular and curved configurations, were developed and analyzed using a combination of Computational Fluid Dynamics (CFD) and ETABS software. Wind loads were applied in different directions to assess both along-wind and cross-wind effects. The analysis focused on parameters such as the storey displacement, drift, pressure coefficients, and torsional response.

The results indicated that buildings with curved façades experience lower wind pressure than those with rectangular façades. It was observed that the curved surfaces reduced the wind pressure by approximately 18% owing to the smoother airflow and reduced vortex formation. In contrast, rectangular buildings exhibited higher suction forces at the corners owing to sharp edges, which caused flow separation and increased turbulence.

The study also examined the effect of building orientation and found that rotating a rectangular building by 45° relative to the wind direction increases the cross-wind effects and torsional response. This is due to the increased exposure of building surfaces to diagonal wind flow, which enhances vortex shedding.

Additionally, the study highlighted that irregular façade shapes can lead to uneven pressure distributions, resulting in increased drift and torsional effects. The authors recommended the use of aerodynamic shapes and proper orientation to minimize wind-induced forces.

The study concluded that façade design and building orientation play crucial roles in wind performance, and optimizing these factors can significantly improve the structural behavior and reduce wind effects in high-rise buildings.

[12] Khan & Deshmukh (2023): Khan and Deshmukh carried out a study to compare the wind behaviour of regular and irregular multi-storey buildings using STAAD.Pro software. The primary objective of this study was to investigate the effect of plan irregularity on the structural response to wind loading.

In this study, two building models were developed: one with a regular rectangular plan and the other with an irregular configuration. Wind loads were applied as per IS 875 (Part 3), and the analysis focused on parameters such as story displacement, inter-story drift, and torsional effects.

The results revealed that irregular buildings exhibited significantly higher drift and displacement than regular buildings. The study found that irregular structures exhibited approximately 20–25% higher drift owing to the uneven distribution of stiffness and mass. This imbalance leads to increased torsional effects and nonuniform deformation along the height of the building.

The authors also observed that upper stories are more sensitive to wind loads, particularly in irregular structures, where cross-wind effects become more prominent. The presence of re-entrant corners and asymmetrical geometry contributed to increased pressure concentration and instability of the structure.

Another important finding was that STAAD.Pro requires careful modelling and meshing to accurately capture the torsional behavior. Inaccurate modelling can lead to significant errors in the prediction of wind response.

The study concluded that regular buildings perform better under wind loading owing to their uniform stiffness and load distribution. For irregular buildings, additional structural measures, such as shear walls and bracing systems, are necessary to improve performance and reduce wind-induced effects.

[13] Patel (2023): This study conducted a detailed study on the dynamic wind response of high-rise reinforced cement concrete (RCC) buildings using ETABS software. The objective of this study was to evaluate the effect of wind loads on the structural behavior, particularly focusing on drift, displacement, and modal characteristics.

In this study, a multi-storey RCC building was modeled and subjected to wind loads as per IS 875 (Part 3). The analysis included both static and dynamic wind load conditions to understand variations in the structural response. The key parameters considered were the story drift, displacement, natural frequency, and mode shapes.

The results showed that buildings with stiffness irregularities exhibited higher drift and displacement, particularly at mid-height levels. The study found that the maximum drift occurred at intermediate storeys, whereas the maximum displacement was observed at the top of the building. This behavior is consistent with the general trend of wind responses in tall buildings.

This study also highlighted the importance of dynamic analysis in capturing wind-induced vibrations. ETABS was found to be effective in identifying the mode shapes and evaluating the influence of wind on the structural behavior.

Another key observation was that wind loads govern the design of buildings with more than 25 stories. The authors emphasized that neglecting dynamic effects can lead to an underestimation of the wind response, which may compromise structural safety.

The study concluded that accurate modelling of the stiffness distribution and dynamic analysis are essential for evaluating wind behavior in high-rise buildings.

[14] Sharma (2023): Sharma conducted a study to analyze the wind-induced modal response of high-rise buildings with different plan shapes using SAP2000 software. The objective was to understand how the plan geometry influences the vibration characteristics and torsional behavior under wind loading.

This study considered various building configurations, including regular rectangular and irregular L-shaped structures. Wind loads were applied according to IS 875 (Part 3), and modal analysis was performed to evaluate the natural frequencies, mode shapes, and displacement patterns.

The results indicated that irregular buildings exhibit higher torsional effects owing to the asymmetrical distribution of mass and stiffness. L-shaped buildings exhibited significant rotational motion under wind loading, leading to increased displacement and instability.

The study also found that regular rectangular buildings exhibit a more uniform load distribution and better wind performance. The natural frequency of irregular buildings is lower, indicating higher flexibility and susceptibility to wind-induced vibrations.

Another important observation was that re-entrant corners in irregular buildings caused a concentration of wind pressure, leading to increased stress and deformation. The authors recommended avoiding irregular geometries or providing additional stiffening elements to improve the performance.

The study concluded that the plan shape has a significant influence on wind behavior, and careful design considerations are required for irregular high-rise buildings.

[15] Mehta (2023): This Study conducted a comparative study to evaluate the wind behavior of steel and reinforced concrete (RCC) high-rise buildings using ETABS software. The objective of this study was to understand the influence of material properties on the structural response to wind loading.

In this study, two building models, one steel and one RCC, were developed with identical geometry and loading conditions. Wind loads were applied as per IS 875 (Part 3), and parameters such as story drift, displacement, and base shear were analyzed.

The results showed that steel buildings experience higher displacement and drift than RCC buildings because of their lower stiffness. RCC structures, being more rigid, provide better resistance to lateral forces and exhibit lower deformation.

However, the study also found that steel buildings have lower base shear owing to reduced mass. This makes steel structures advantageous in terms of load reduction but requires additional measures to control the displacement.

This study highlighted that the cross-wind effects are more pronounced in steel buildings owing to their flexibility. To address this issue, the authors recommended the use of bracing systems and damping devices.

The study concluded that material selection plays a crucial role in wind performance, and appropriate design strategies must be adopted based on the structural requirements.

[16] Jitendra Rao (2023): Rao conducted a detailed study using Computational Fluid Dynamics (CFD) to analyze the wind pressure distribution on high-rise buildings. The primary objective of this study was to understand how wind flow interacts with building surfaces and to identify critical pressure zones that influence the structural behavior.

In this study, a 25-storey building model was developed and subjected to simulated wind flow using CFD software. The analysis focused on evaluating the pressure distribution, airflow patterns, vortex formation, and turbulence effects around the building. Special attention was given to the corners, edges, and façade elements, where wind pressure tends to concentrate.

The results showed that the maximum wind pressure occurred on the windward faces, particularly at the building corners and edges. These areas experience high suction forces owing to flow separation and vortex shedding. The study also found that the upper stories are more susceptible to wind fluctuations owing to their increased exposure to wind velocity.

Another important observation was that sharp edges and flat surfaces contributed to strong vortex formation, which increased the cross-wind effects and structural oscillations. In contrast, smoother and curved surfaces allow better airflow, reducing turbulence and pressure concentrations.

The author concluded that CFD is a powerful tool for understanding wind flow behavior and should be integrated with structural analysis for accurate prediction of wind effects.

[17] Farhan Ali (2023): Farhan Ali conducted a study evaluated the effectiveness of wind load calculations based on IS 875 (Part 3) and compared simplified codal approaches with detailed wind analysis.

In this study, a 20-storey building in STAAD.Pro, and wind loads were applied using both simplified and detailed methods. The analysis showed that simplified code-based calculations often underestimate wind effects, particularly at higher stories, where suction and turbulence effects are significant.

The results indicate that detailed pressure modelling provides more realistic values of story drift and displacement. This study emphasized that ignoring the across-wind effects may lead to an unsafe structural design.

The author concluded that although IS 875 provides a standard framework, engineers should use advanced analysis tools for accurate wind load evaluation in high-rise buildings.

[18] Andrew Thomas (2023): This Study conducted a study to analyze the effect of building orientation on wind behaviour of high-rise structures. The objective of this study was to evaluate the influence of rotating a building relative to the wind direction on the displacement and torsional response.

A rectangular building model was analyzed using ETABS under different orientation angles ranging from 0° to 45°. Wind loads were applied according to IS 875 (Part 3).

The results showed that the maximum wind effects occurred at a 45° orientation owing to increased cross-wind interaction and vortex formation. Buildings oriented at 0° exhibited more stable behavior with lower displacement and drift.

The study concluded that building orientation significantly influences wind response and should be considered during the design planning.

[19] Sandeep Roy (2023): Roy conducted a study to evaluate the effectiveness of bracing systems in high-rise buildings subjected to wind loads.

Two models—one with bracing and one without–were analyzed using ETABS. The results showed that the braced structures exhibited up to 50% reduction in storey drift compared to the unbraced structures.

The study found that bracing improves lateral stiffness and ensures a better distribution of wind forces. It also reduces crosswind effects and enhances structural stability.

The author concluded that bracing systems are highly effective in controlling wind-induced deformation and should be used in tall building design.

[20] Bharat Nayak (2023): Nayak conducted a comparative study on wind and seismic loads in high-rise buildings using STAAD.Pro.

The study showed that for buildings above 25 stories, the wind load governs the structural design more than the seismic load. Wind-induced displacement and drift were significantly higher than the seismic response.

The author concluded that wind load is the controlling factor for serviceability design in tall buildings and must be prioritized during analysis.

[21] Kiran Kumar (2023): Kumar conducted a study to evaluate the effect of façade geometry on the wind behavior of high-rise buildings using a combination of Computational Fluid Dynamics (CFD) and structural analysis tools. The main objective of this study was to understand how different façade shapes influence the wind pressure distribution and structural response.

In this study, various building models with flat, chamfered, and curved facades were analyzed. Wind flow simulations were performed using CFD, and the structural response was evaluated using FEM-based software. Parameters such as the pressure coefficients, story displacement, and drift were analyzed.

The results showed that buildings with curved façades experienced approximately 18% lower wind pressure than flat-faced buildings. Smooth geometry reduces vortex shedding and allows better airflow around the structure. Chamfered corners also improved the wind performance by reducing the pressure concentration at the edges.

The study concluded that façade geometry plays a crucial role in improving the aerodynamic performance and reducing wind-induced forces in high-rise buildings.

[22] Sanjay Verma and Kiran Lokhande (2023): Verma and Lokhande conducted a study analyzed the wind behavior of irregular buildings with T-shape- and plus-shaped configurations using ETABS software.

The objective of this study was to evaluate the effects of re-entrant corners and irregular projections on wind-induced responses. The analysis focused on the story drift, displacement, and torsional effects.

The results indicated that the plus-shaped buildings exhibited higher torsional drift owing to multiple projections, which caused an uneven wind pressure distribution. The T-shaped buildings showed drift concentration at the junction areas owing to stiffness imbalance.

The study concluded that irregular shapes significantly increase wind-induced effects and require additional structural measures, such as shear walls or bracing systems, for improved performance.

[23] Hameed Siddiqui and Mohsin Pathan (2023): Siddiqui and Pathan (2023) conducted a comparative study on triangular and rectangular high-rise buildings using SAP2000.

The objective of this study was to evaluate the effect of plan geometry on wind performance. The study analyzed parameters such as the displacement, drift, and torsional response.

The results showed that triangular buildings performed better than rectangular buildings because of their reduced frontal area and smoother airflow. Rectangular buildings experience higher cross-wind effects and vortex formation.

The study concluded that triangular and aerodynamic shapes improve wind performance and reduce the structural demand.

[24] Deepak Rajan and Lawrence Francis (2023): Rajan and Francis studied the wind behavior of steel–composite high-rise buildings using ETABS.

The objective of this study was to evaluate the displacement and drift of composite structures. The study found that composite buildings exhibit higher flexibility, resulting in increased displacement in the upper stories.

The authors observed that the diaphragm action of composite floors helps reduce lateral deformation. However, additional damping systems are required to control wind-induced vibration.

The study concluded that composite structures require careful design to control wind effects.

[25] Vinay Bhashyam and Suresh Kulkarni (2023): Vinay Bhashyam and Suresh Kulkarni conducted a study comparing hexagonal and octagonal building shapes under wind loads using STAAD.Pro.

The results showed that octagonal buildings performed better because of smoother airflow and reduced vortex formation. Hexagonal shapes exhibited a slightly higher base shear.

The study concluded that removing sharp edges improved the aerodynamic performance and reduced wind-induced forces.

[26] Ramesh Krishnan and Parvez Salim (2023): Krishnan and Salim analyzed the effect of bracing systems on RCC buildings under wind loads using ETABS.

The study showed that braced buildings exhibit approximately 50% reduction in drift compared to unbraced structures. Bracing improves the stiffness and reduces the torsional effects.

The authors concluded that bracing is an effective method for improving the wind resistance of tall buildings.

[27] Sandeep Patidar and Jitendra Pande (2023): studied the effect of corner modifications, such as chamfered and rounded edges, on wind performance.

The results showed that rounded corners significantly reduced vortex shedding and wind pressure. Chamfered edges also improve performance but are less effective than rounded edges.

The study concluded that corner modification is an effective method for improving aerodynamic behaviour.

[28] Prakash Adhikari and Thomas Lewis (2023): Prakash Adhikari and Thomas Lewis analyzed the effect of building orientation on wind response using STAAD.Pro.

The study found that the maximum drift occurred at orientations between 30° and 45° owing to increased cross-wind effects. Buildings aligned with the wind direction exhibited better performance.

The authors concluded that orientation plays a critical role in wind design.

[29] Khalid Mohammed and Rashid Ahmed (2023): Khalid Mohammed and Rashid Ahmed compared core-wall and tube structural systems under wind loads using ETABS.

The results showed that tube systems provide better resistance to wind forces owing to their perimeter stiffness. The core-wall systems exhibited higher torsional effects.

The study concluded that tube structures are more suitable for high-rise buildings in wind-prone regions than other structural forms.

[30] Anthony D'Souza and Michael Vincent (2023): Anthony D'Souza and Michael Vincent studied wind interference effects in twin-tower buildings using SAP2000.

The study found that closely spaced towers experience increased wind pressure owing to aerodynamic interference. The downstream tower exhibited a drift that was up to 20% higher.

The authors recommended maintaining sufficient spacing between towers to reduce wind effects.

RESEARCH GAP

A detailed review of the existing literature revealed that although numerous studies have been conducted on the wind behavior of high-rise buildings, several important aspects remain unexplored. Most previous studies have analyzed wind effects using conventional structural analysis software, such as ETABS, STAAD.Pro, and SAP2000, and have primarily focused on a single wind zone or limited loading conditions. Very few studies have attempted a comparative analysis of the same building model under multiple wind zones (Zones III, IV, and V), which is essential for understanding the variation in structural response with changing wind intensity.

Although Building Information Modelling (BIM) is increasingly being adopted in the construction industry, its integration with Finite Element Method (FEM)-based structural analysis remains limited. Some recent studies have explored BIM-based workflows, but they are mostly restricted to general modelling or single-case analysis and do not fully utilize the integration between tools such as Autodesk Revit and Robot Structural Analysis for detailed wind load evaluation. Even when BIM–FEM integration is used, issues related to data transfer, material properties, and load application are not fully addressed.

Furthermore, existing research lacks a consistent modelling approach, where the same building configuration is analyzed under different conditions. Many studies use different geometries, materials, or structural systems, making it difficult to compare the results directly. Studies focusing on BIM have highlighted its ability to improve collaboration and accuracy in structural analysis; however, its application specifically for wind load comparison remains limited.

Another critical gap is that most research is concentrated on seismic analysis, whereas wind loads, which govern the serviceability design of high-rise buildings, have not been explored in equal depth. Only a few recent studies have started using BIM-based approaches for the wind performance evaluation of high-rise buildings, indicating that this area is still in its early stages of development.

Therefore, it can be concluded that no comprehensive study has been conducted to analyze the wind behavior of a high-rise building in three different wind zones using an integrated BIM–FEM approach (Revit + Robot Structural Analysis). This gap highlights the need for a systematic and comparative study that uses a consistent building model and advanced integrated tools to accurately evaluate the story drift, displacement, and stiffness under varying wind conditions.

CONCLUSION

A comprehensive review of existing studies shows that wind load plays a dominant role in the analysis and design of high-rise buildings, particularly in governing serviceability criteria such as story drift, lateral displacement, and structural stiffness. The literature clearly indicates that factors such as building geometry, structural systems, material properties, and analysis methodologies significantly influence the wind response of tall structures. Aerodynamic shapes help reduce wind pressure and vortex formation, whereas efficient structural systems, such as shear walls, bracing, and diagrid configurations, enhance stiffness and minimize deformation.

This review also highlights the increasing importance of advanced computational tools in structural engineering. Conventional analysis methods are often inadequate for capturing the complex behavior of wind-induced forces, whereas modern approaches based on BIM and FEM provide more accurate and reliable results. However, despite these advancements, the literature reveals that most studies are limited to single wind zone analyses and do not provide a comparative understanding of the structural behavior under varying wind conditions.

A significant gap identified in the review is the lack of studies that analyze the same high-rise building model in multiple wind zones using an integrated BIM–FEM workflow. In particular, the combined use of Autodesk Revit for modelling and Autodesk Robot Structural Analysis for wind load evaluation has not been extensively explored for comparative analysis across Zones III, IV, and V. Additionally, parameters such as relative story stiffness have not been adequately addressed in previous research.

Therefore, it can be concluded that there is a clear need for a systematic and integrated approach to wind load analysis that considers consistent modelling, multiple wind zones, and advanced software integration. Such an approach will provide a better understanding of the variation in structural behavior due to changes in wind intensity and will support a more efficient and reliable design of high-rise buildings.

Overall, the findings of this review establish a strong foundation for the present study and justify the need for BIM-based comparative wind analysis using Revit and Robot Structural Analysis. This study aims to address the identified research gaps and contribute to the development of more accurate and practical design methodologies for high-rise structures subjected to wind loads.

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