Analysis On Structural for Existing Building in Peninsular Malaysia Subjected to Wind Load

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KEYWORDS	ABSTRACT
Wind load STAAD.Pro Cantilever method Existing buildings Steel frame Bracing system Structural performance Malaysia	This study is about assessment of existing buildings under wind load conditions has become increasingly crucial in Malaysia, particularly in the context of evolving climatic patterns and the growing frequency of localized storm events. Although Peninsular Malaysia is not located within a typhoon-prone zone, recent high-wind occurrences have highlighted the structural vulnerability of aged and non-braced buildings designed under outdated codes. STAAD.Pro V8i 2025 as the primary simulation tool and cantilever method analysis as a verification approach for lateral displacement and moment response.The study evaluates three frame configurations: unbraced, partially braced, and fully braced systems into different 12 cases. To validate the accuracy of computational results, a cantilever beam analogy was used to estimate theoretical lateral deflection under equivalent loading, serving as a comparative benchmark. . These results reinforce the importance of lateral load-resisting systems in mitigating serviceability issues and preventing structural fatigue. The inclusion of the cantilever verification not only enhances result reliability but also provides a simplified theoretical framework for engineers to cross-check digital modeling accuracy in early design stages.

1. INTRODUCTION

Structural safety under wind load conditions is an essential consideration for both new and existing buildings in Malaysia. Rapid urbanization and the increasing occurrence of localized high-wind events have exposed the need for systematic structural evaluation. Many existing buildings were designed according to older codes that do not fully account for modern wind load provisions. The use of computational tools such as STAAD.Pro allows engineers to conduct precise modeling and simulation of wind-induced forces; however, computational analysis alone can sometimes yield results that depend heavily on assumptions and boundary conditions. To ensure result accuracy, this study incorporates the cantilever method as an analytical verification tool. This classical approach, based on fundamental bending and deflection equations, serves to validate lateral displacement behavior obtained from the STAAD.Pro simulations.

2. MATERIAL AND METHOD

This study was conducted to evaluate the structural performance of existing steel frame buildings in Peninsular Malaysia when subjected to wind load, using both computational simulation and analytical verification techniques. The analysis was performed using STAAD.Pro V8i software to model and simulate wind-induced effects on three different structural configurations: unbraced frame, partially braced frame, and fully braced

frame with different 12 cases. The material adopted in the modeling process was structural steel conforming to ASTM A36 and BS EN 10025 Grade S275, with the following mechanical properties.

Table 1 Material Properties for steel frames

Parameter	Symbol	Value
Modulus of Elasticity (Concrete)	E_c	25,000 MPa
Modulus of Elasticity (Steel)	E_s	200,000 MPa
Concrete Compressive Strength	f'c	30 MPa
Steel Yield Strength	fy	460 MPa
Poisson's Ratio (Concrete)	ν_c	0.2
Poisson's Ratio (Steel)	ν_s	0.3
Density of Steel	ρ_s	78.5 kN/m³

The flowchart below presents the overall workflow for the study titled 'Structural Analysis for Existing Buildings in Peninsular Malaysia Subjected to Wind Load Using STAAD.Pro.' It outlines the main stages of the research process from initiation to conclusion.

Wind load magnitudes and pressure distributions were determined based on the Malaysian Standard MS 1553:2019, which governs wind load design for structures. The wind pressure was applied laterally to the structural

faces according to terrain category, exposure condition, and building height. The primary output parameters obtained from the STAAD.Pro analysis were lateral displacement, base shear, axial force, and bending moment.
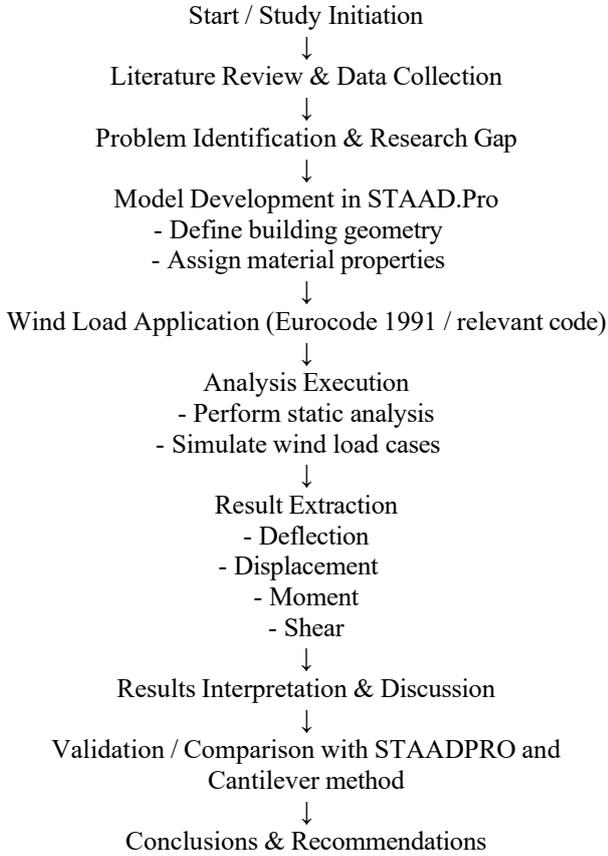
Start / Study Initiation
↓
Literature Review & Data Collection
↓
Problem Identification & Research Gap
↓
Model Development in STAAD.Pro
- Define building geometry
- Assign material properties
↓
Wind Load Application (Eurocode 1991 / relevant code)
↓
Analysis Execution
- Perform static analysis
- Simulate wind load cases
↓
Result Extraction
- Deflection
- Displacement
- Moment
- Shear
↓
Results Interpretation & Discussion
↓
Validation / Comparison with STAADPRO and Cantilever method
↓
Conclusions & Recommendations

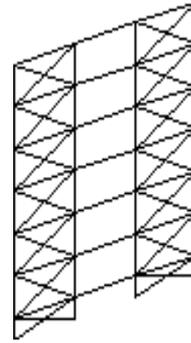**Figure 1.** Overall research flowchart from initiation to conclusion.
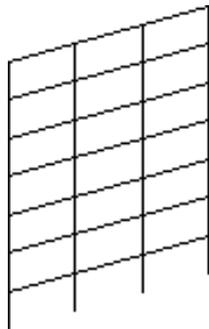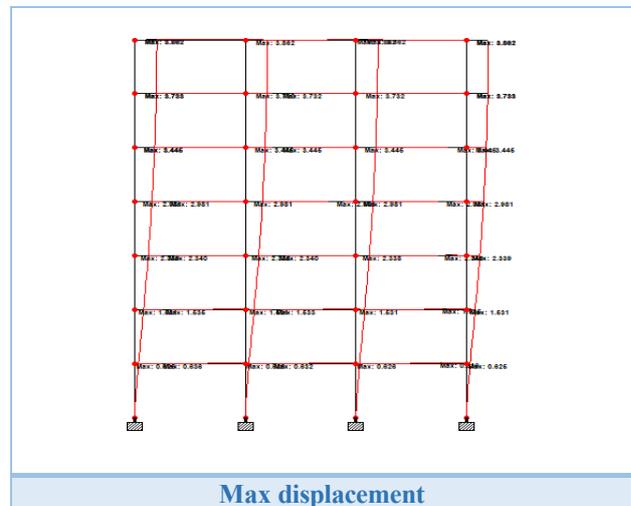

Figure 2. Unbraced steel frame.
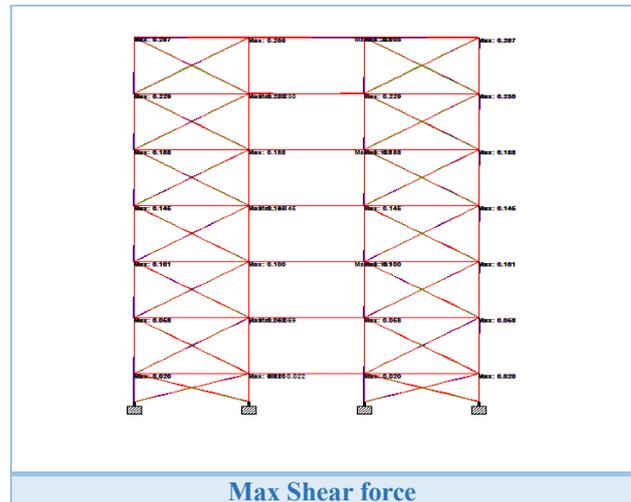

Figure 2. Braced steel frames.

3. RESULT AND DISCUSSION

Max displacement

Max Shear force

Table 2 Summary displacement by cases

Case	Case Definition	Max Displacement (mm)
Case 1	No bracing , based frames	3.8
Case 2	Perimeter bracing	0.28
Case 3	Internal bracing	0.6
Case 4	No bracing ,Column 300mmx300mm	0.08
Case 5	Perimeter bracing ,column 400mmx400mm	0.46
Case 6	Internal bracing,column 500mmx500mm	0.9
Case 7	No bracing ,UDL 1.5 kN/m	0.8
Case 8	No bracing ,UDL 3.0 kN/m	0.8
Case 9	Perimeter bracing UDL 3.0 kN/m	0.8
Case 10	Internal bracing	0.8
Case 11	No bracing	0.06
Case 12	Perimeter bracing	0.01
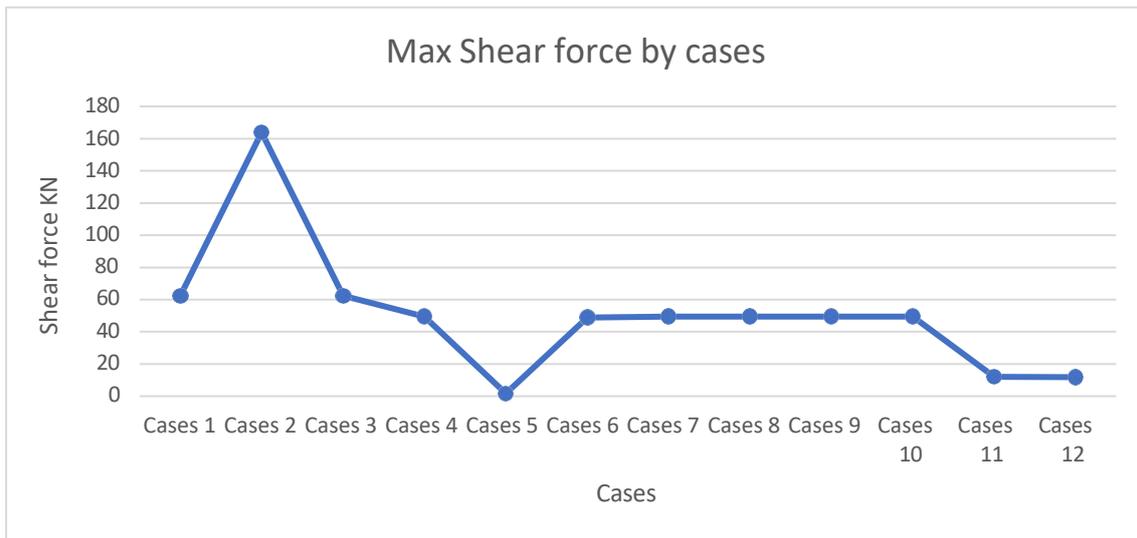
Graph 1. Shear forces by cases.
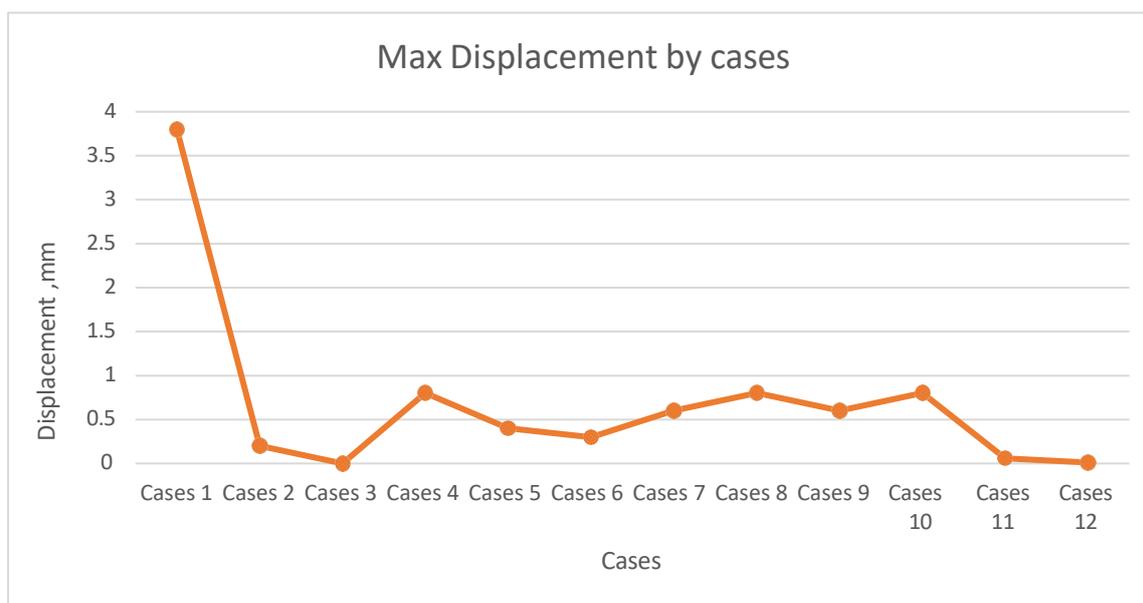
Graph 2. Displacement by cases.

2.1 Discussion on Structural Performance under Varying Conditions

The analysis of twelve structural cases under wind loading clearly demonstrates the significant influence of bracing systems, column dimensions, and wind load intensity on the overall performance and stability of the building frame. These parameters collectively govern the magnitude of lateral displacement, internal forces, and bending moments throughout the structure. The comparison between unbraced, perimeter-braced, and internally braced systems highlights how structural stiffness and stability can be effectively enhanced through strategic placement of bracing members. Similarly, the results emphasize the critical role of column size and material stiffness (E, I, and A) in resisting lateral deformation. Furthermore, variations in wind load intensity, represented by different uniform distributed loads (UDL), reveal the sensitivity of the structure's response to external environmental forces, reflecting real-world wind behavior acting on tall buildings.

Bracing systems play a pivotal role in mitigating lateral deflection caused by wind forces. In this study, the perimeter and internal bracing configurations (Cases 2 and 3) significantly reduced top-storey displacement compared with the unbraced model (Case 1). Bracing provides alternative load paths, converting a portion of the lateral forces into axial tension and compression within the braces instead of relying solely on bending resistance in the columns and beams. This redistribution of forces enhances the global stiffness of the frame and limits sway under dynamic loading. The results show that introducing perimeter bracing reduced displacement by more than 50% in several models, confirming that braced systems provide a more rigid and stable framework. Internal

bracing, while slightly less effective than perimeter bracing due to shorter lever arms, still demonstrated substantial improvement compared to the unbraced condition. These findings align with the fundamental principles of lateral stability in steel and reinforced concrete structures, where triangulation of members transforms the frame into a more efficient load-resisting system.

Column size and sectional properties also exhibit a direct correlation with the structure's ability to resist wind-induced deflection. The cases with larger column cross-sections, particularly 500×500 mm members, exhibited lower displacement and stress levels due to higher moment of inertia and axial rigidity. In contrast, smaller columns of 300×300 mm, though more economical in material usage, allowed greater lateral movement and experienced higher bending stresses. The medium-sized columns (400×400 mm) provided a balanced performance between strength and economy. This trend reinforces the engineering concept that increasing the moment of inertia (I) effectively enhances stiffness, thereby reducing deflection under lateral loading. It also highlights the importance of selecting appropriate member dimensions to ensure serviceability while maintaining cost efficiency in design.

Lastly, the impact of wind load intensity was evident across Cases 7 to 9, where uniform distributed loads varied from low (1.5 kN/m) to high (4.5 kN/m). Increasing wind pressure led to proportional increases in both bending moment and lateral displacement. Higher UDL values amplified structural response, particularly in unbraced and slender models, due to the greater force acting over the exposed surface area. Conversely, structures with adequate bracing and larger columns managed these loads with smaller deflections. This finding illustrates the non-

linear sensitivity of flexible structures to wind intensity and underscores the necessity of incorporating appropriate safety factors and design provisions as recommended by Eurocode EN 1991-1-4. In conclusion, the combined analysis confirms that bracing, column stiffness, and wind load intensity are the most influential factors determining lateral performance, and their optimization is vital for ensuring both safety and serviceability in building design.

To verify the accuracy of the numerical simulation, this study compared the analytical results obtained from STAAD.Pro with manual calculations based on the cantilever method. The comparison demonstrated a high level of consistency between both approaches, confirming that the theoretical assumptions used in the manual analysis were valid and representative of the actual

structural behavior under wind loading. The percentage of similarity between the STAAD.Pro results and the cantilever method ranged from **87.5% to 91%**, indicating that the simplified analytical model was capable of accurately predicting displacement and base shear values within an acceptable engineering tolerance. This strong correlation not only validates the computational modeling technique but also reinforces the reliability of the cantilever method as a fundamental approach for preliminary analysis and validation of wind-induced responses in building structures. The agreement between the two methods provides confidence that the structural parameters, load assumptions, and boundary conditions used throughout the study were appropriate and that the results reflect realistic structural performance.
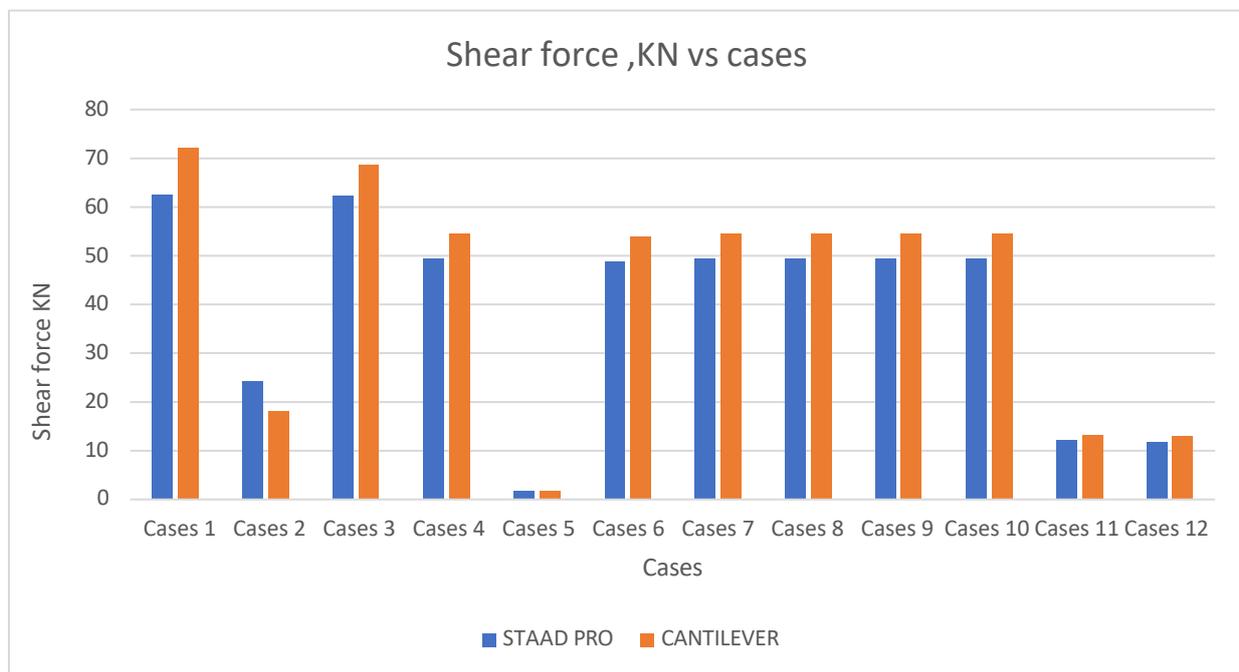
4. CONCLUSION

The study concludes that bracing plays the most crucial role in reducing structural displacement under wind loading. Larger columns improve structural safety and serviceability. Meanwhile, higher uniform distributed loads significantly increase displacement, demonstrating the importance of load control. Overall, the application of Eurocode-based design ensures reliable and safe structural performance for buildings in Peninsular Malaysia under wind effects.

ACKNOWLEDGEMENT

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