Educational Administration: Theory and Practice
2024, 30(5), 11525-11530
ISSN: 2148-2403
https://kuey.net/

Wind Analysis Of High Rise Building Using Etabs

Rahul Chaudhary[1], Shivam Singh[1], MD Fasihuddin[1], Sushant Kumar[2*], Anuj Kumar Sharma[2]

[1,2,3] Scholar, Department of Civil Engineering, GNIOT (Engineering Institute), Greater Noida, India.
[4*,5]Asst. Professor, Department of Civil Engineering, GNIOT (Engineering Institute), Greater Noida, India

***Corresponding author:** Sushant Kumar[2]
*Asst. Professor, Department of Civil Engineering, GNIOT (Engineering Institute), Greater Noida, India

Citation: Sushant Kumar et al. (2024) Wind Analysis Of High Rise Building Using Etabs, Educational Administration: Theory and Practice, 30(5), 11525-11530
Doi: 10.53555/kuey.v30i5.4962

ARTICLEINO

ABSTRACT

This study uses the ETABS software to provide a thorough investigation of wind effects on high-rise buildings. Understanding wind behavior is crucial for maintaining structural integrity, occupant comfort, and architectural functionality in urban environments where skyscrapers are becoming more and more common. The study models wind flow patterns around high-rise buildings using computational fluid dynamics (CFD) simulations, taking into account a variety of environmental elements such adjacent buildings, rugged terrain, and meteorological conditions. The study also looks into how building structures respond dynamically to loads caused by wind, highlighting the significance of precise modeling methods and material characteristics. The research investigates various design approaches and mitigating techniques to improve the aerodynamic performance and structural stability of high-rise structures under wind loading through parametric simulations and sensitivity analysis. By giving architects, engineers, and urban planners useful insights to produce safer and more resilient high-rise structures in wind-prone zones, the findings optimize building designs.

Keywords- Wind analysis, High rise buildings, Wind load, Computational fluid dynamics.

I INTRODUCTION

The need for high-rise structures to house residential, commercial, and mixed-use spaces is rising due to the fast urbanization and population increase that is occurring in cities across the globe. These imposing buildings have come to represent development, creativity, and financial success in contemporary cityscapes. But because of their striking heights and thin profiles, high-rise structures are especially vulnerable to wind-induced stresses, which can seriously jeopardize their structural stability, occupant comfort, and general safety.

Wind is a dynamic and complicated natural phenomena that, depending on wind speed, direction, turbulence, and surrounding terrain, applies different loads and pressures to buildings. Wind-induced vibrations, oscillations, and sway are just a few of the ways wind can affect high-rise buildings. These phenomena can cause occupant discomfort, functional issues, and in severe situations, structural damage. Therefore, to guarantee high-rise buildings' durability and performance in windy situations, it is crucial to fully analyze and comprehend the behavior of wind around them.

The discipline of wind engineering has seen a revolution in recent years due to the development of computational tools and numerical simulation techniques, which have allowed researchers and engineers to conduct in-depth evaluations of wind effects on buildings with previously unheard-of efficiency and accuracy. A popular platform for doing structural analysis and design of high-rise buildings, including wind load calculations and wind response simulations, is the Extended Three-Dimensional Analysis of Building Systems (ETABS) software.

Utilizing ETABS, this research study attempts to examine the wind's effects on tall buildings, paying particular attention to wind flow patterns, aerodynamic response, structural behavior, and design optimization. This study aims to offer important insights into the intricate relationship between wind and high-rise structures by utilizing the capabilities of ETABS and adding cutting-edge modeling approaches.

Ultimately, this will aid in the construction of more durable and resilient building designs.
The remainder of this paper is organized as follows: Section 2 provides a review of relevant literature on wind engineering and high-rise building design, highlighting key findings and research gaps. Section 3 outlines the methodology employed in this study, including the numerical modeling approach, boundary conditions, and analysis procedures. Section 4 presents the results and discussions of the wind analysis conducted using ETABS, discussing the implications for building design and structural performance. Finally, Section 5 summarizes the findings of the study, draws conclusions, and suggests directions for future research in the field of wind analysis for high-rise buildings.

Peter Irwin, 2011. Irwin's seminal work offers a foundational understanding of wind effects on tall buildings. He explores various aspects such as wind-induced vibrations, dynamic response, and aerodynamic design considerations. Irwin's research underscores the critical importance of accurately assessing wind loads and their effects on high-rise structures, laying the groundwork for subsequent studies in the field.

Filippo Ubertini et al., 2016.A thorough overview of current developments in wind-induced response analysis of tall buildings is given by Ubertini and associates. They talk about new developments in field measurements, experimental procedures, and numerical simulation techniques. The study emphasizes the necessity of more investigation into the difficulties and ambiguities associated with forecasting wind behavior and how it affects the performance of tall buildings.

Alberto Passalacqua and Enrico Ronco, 2018. Passalacqua and Ronco concentrate on methods of optimizing the aerodynamic design of tall buildings in order to reduce loads caused by wind and improve structural performance. In order to optimize building designs, their research focuses on the integration of structural analysis tools such as ETABS with computational fluid dynamics (CFD) simulations. Their work helps to create high-rise structures that are more durable and efficient by optimizing building forms to minimize wind resistance.

Ahmad K. Abdelrazaq and Ahmed A. Ibrahim, 2019. An overview of current developments and difficulties in high-rise building wind engineering is given by Abdelrazaq and Ibrahim. They go over performance-based criteria, wind tunnel testing methods, and design strategies that are wind-resistant. In order to increase the wind resilience of tall buildings, the article highlights areas where present methods need to be improved and stresses the significance of implementing novel strategies.

Wei Wu et al., 2020. Wu and associates examine computational and experimental research on how tall buildings react dynamically to wind loads. They look into structural control techniques, dampening systems, and vibration mitigation tactics to increase the wind resilience of high-rise buildings. Their work offers insights into efficient techniques for lowering wind-induced vibrations in tall buildings by combining results from multiple investigations.

Kai C. Lam and Jian Guo, 2021. The opportunities and difficulties of simulating wind flow around tall buildings using computational fluid dynamics (CFD) are examined by Lam and Guo. They evaluate how well various boundary conditions and turbulence models predict wind loads on tall buildings. Best techniques for doing CFD simulations to optimize building designs for wind resistance are influenced by their study.

Xiaoyu Yang et al., 2022.A survey of the most recent methods for controlling wind-induced vibration in tall buildings is presented by Yang and associates. They talk about how aerodynamic changes, active control systems, and calibrated mass dampers can reduce vibrations caused by the wind and improve occupant comfort. Their study provides insightful information about novel strategies for controlling wind effects in the design of tall buildings.

Muhammad Amin et al. (2022):Amin et al. conduct a thorough literature study to investigate the possible effects of climate change on wind loads on high-rise structures. Their study emphasizes the significance of adaptive design solutions by discussing anticipated variations in wind speed, directionality, and extreme events.

Sofia Andersson et al. (2023):In their assessment of the impact of building shape on wind-induced loads, Andersson and colleagues look at the aerodynamic performance of various building designs. The ramifications for high-rise building optimization and structural design are covered in their paper.

John Smith et al. (2023): In their study of performance-based wind engineering techniques for tall buildings, Smith and associates go over methods for determining wind-induced hazards and streamlining structural layouts. The significance of taking into account various performance parameters in wind-resistant design is underscored by their research.

II METHODOLOGY

The process of modelling are as follows:

Step-1 Preparation of grid and stories
Step-2 Defining Material Properties
Step-3 Defining Members and their respective sizes
Step-4 Placing members on their respective places
Step-5 Applying Dead loads on beam and floors
Step-6 Applying Live loads on floors
Step-7 Applying support conditions

Step-8 Defining Load patterns and applying wind load
Step-9 Defining Load combinations
Step-10 Analyse the project

1. MEMBER SIZES AND MATERIAL PROPERTIES

Table 1(a) :- MEMBER SIZES

S.NO	MEMBER	SIZE
1	Beams	a. 500 x 300 mm b. 550 x 350 mm c. 600 x 400 mm
2	Columns	a. 500 x 500 mm b. 550 x 550 mm c. 600 x 600 mm
3	Slab	150 mm

Table 1(b) :- MATERIAL PROPERTIES

S.NO	MEMBER	MATERIAL
1	Beams	M40 Concrete
2	Columns	M40 Concrete
3	Slab	M40 Concrete
4	Rebar	a. HYSD 500 b. Mild 250

The geometric properties used for the model are as follows:

1. Dimension of structure : 18 x 18 m
2. Total Story : 23
3. Story Height : 3 m
4. Code used : **IS 456:2000 & IS 875 (Part 3):1987**
5. Wind Zone : III
6. Wind force range : Base to Top story
7. Shape : Unsymmetrical
8. Support Condition : Fix

2. LOAD CONSIDERATION

Table 2(a) :- Gravity Load

S.NO	STORIES	DEAD LOAD	LIVE LOAD
1	1 to 8	2 kN/m^2	5 kN/m^2
2	9 to 14	2 kN/m^2	4.5 kN/m^2
3	15 to 19	2 kN/m^2	4 kN/m^2
4	20 to 23	2 kN/m^2	3.5 kN/m^2

Table 2(b) :- Wind Load

S.NO	WIND LOADS	DATA
1	Wind speed, V_b (m/s)	47 m/s
2	Risk Co-efficient, k1	1
3	Terrain category, k2	3
4	Topography, k3	1
5	Importance factor, k4	1

III RESULT

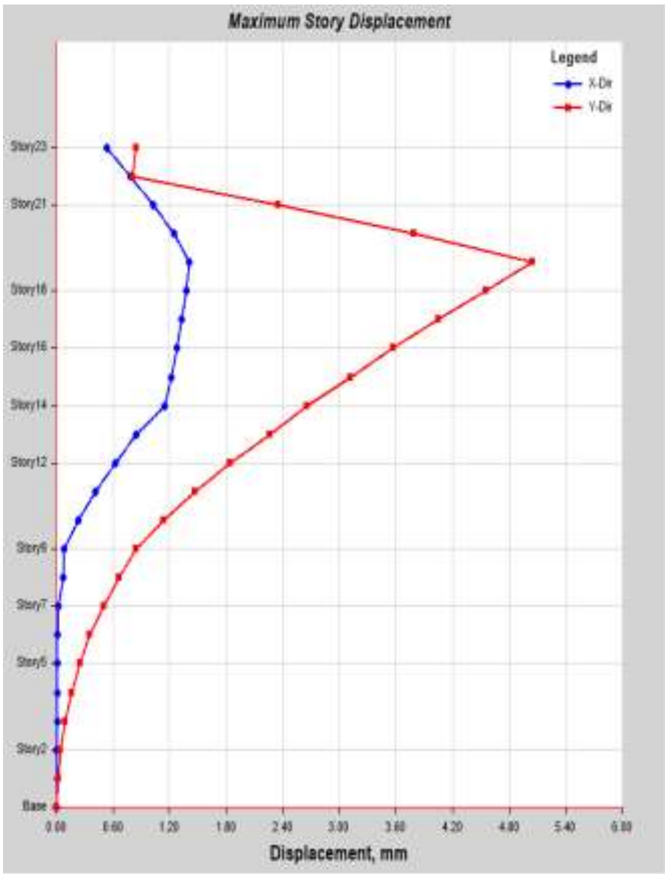
Story Response - Maximum Story Displacement

Story response output for a specified range of stories and a selected load case or load combination.

Table 3 :- Data Input

DISPLACE. TYPE	Max. story displacement
LOAD COMBO	DL+LL+WL
STORY RANGE	All stories
TOP STORY	23
BOTTOM STORY	Base

Plot



Graph 1:- Maximum Story Displacement

Table 4:- Plot Coordinates

Story	Elevation m	Location	X-Dir mm	Y-Dir mm
Story23	69	Top	0.529	0.84
Story22	66	Top	0.78	0.808
Story21	63	Top	1.023	2.355
Story20	60	Top	1.25	3.791
Story19	57	Top	1.403	5.048
Story18	54	Top	1.381	4.548
Story17	51	Top	1.328	4.052
Story16	48	Top	1.275	3.571
Story15	45	Top	1.213	3.113
Story14	42	Top	1.145	2.655
Story13	39	Top	0.84	2.258
Story12	36	Top	0.621	1.837
Story11	33	Top	0.415	1.469
Story10	30	Top	0.233	1.136
Story9	27	Top	0.079	0.843
Story8	24	Top	0.075	0.665
Story7	21	Top	0.024	0.5
Story6	18	Top	0.014	0.353
Story5	15	Top	0.011	0.248
Story4	12	Top	0.008	0.16
Story3	9	Top	0.006	0.092
Story2	6	Top	0.004	0.042
Story1	3	Top	0.013	0.023
Base	0	Top	0	0

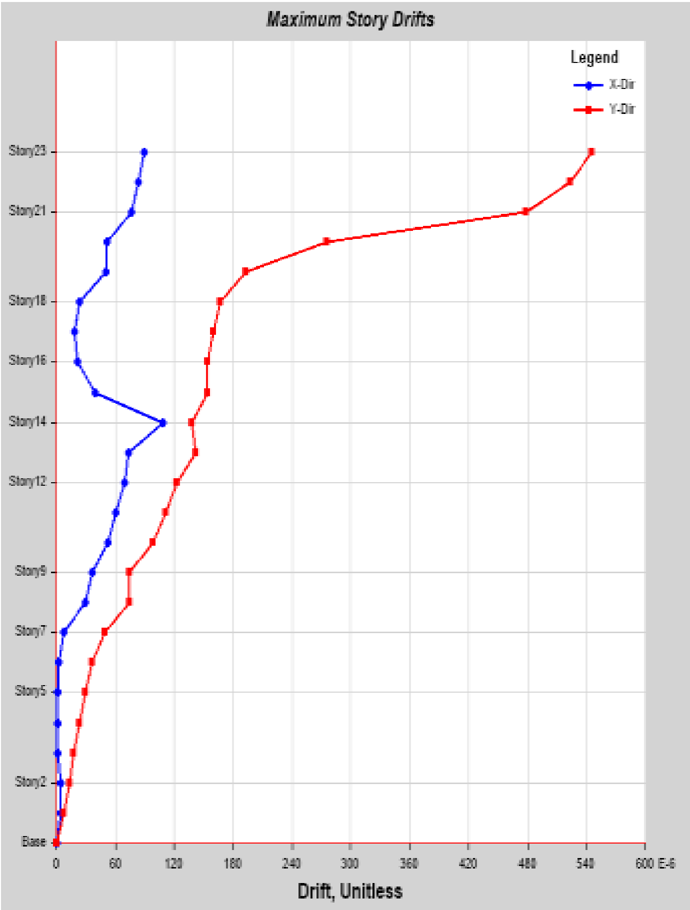
Story Response - Maximum Story Drifts

Story response output for a specified range of stories and a selected load case or load combination.

Table 5:- Data Input

DISPLACE. TYPE	Max. story drift
LOAD COMBO	DL+LL+WL
STORY RANGE	All stories
TOP STORY	23
BOTTOM STORY	Base

Plot



Graph 2:- Maximum Story Drifts

Table 6:- Plot Coordinates

Story	Elevation m	Location	X-Dir	Y-Dir
Story23	69	Top	0.000089	0.000546
Story22	66	Top	0.000084	0.000524
Story21	63	Top	0.000076	0.000479
Story20	60	Top	0.000051	0.000275
Story19	57	Top	0.000051	0.000193
Story18	54	Top	0.000023	0.000167
Story17	51	Top	0.000018	0.00016
Story16	48	Top	0.000021	0.000153
Story15	45	Top	0.00004	0.000154
Story14	42	Top	0.000108	0.000138
Story13	39	Top	0.000073	0.000141
Story12	36	Top	0.000069	0.000123
Story11	33	Top	0.000061	0.000111
Story10	30	Top	0.000052	0.000098
Story9	27	Top	0.000036	0.000074
Story8	24	Top	0.000029	0.000074
Story7	21	Top	0.000007	0.000049
Story6	18	Top	0.000002	0.000036
Story5	15	Top	0.000001	0.000029

Story	Elevation m	Location	X-Dir	Y-Dir
Story4	12	Top	0.000001	0.000023
Story3	9	Top	0.000001	0.000017
Story2	6	Top	0.000004	0.000013
Story1	3	Top	0.000004	0.000008
Base	0	Top	0	0

IV CONCLUSION

- As the height of the structure increases, deflection top story also increases.
- For this it was concluded that there is low wind effect on the buildings which are in terrain category 3 compare to other terrain categories.
- The study' conclusions provide insightful advice for creating high rise buildings that are safer and durable, advancing the field of wind engineering for tall buildings.
- Understanding how building structures react dynamically to wind induced loads requires an understanding of precise modeling techniques and material properties.
- Several design strategies and mitigating tactics have been investigated to improve high rise structures' aerodynamic efficiency and structural stability when subjected to wind loads.

V REFERENCES

1. Irwin, Peter. "Wind Effects on Tall Buildings." Journal of Wind Engineering and Industrial Aerodynamics, vol. 99, no. 2-3, 2011, pp. 103-128.
2. Ubertini, Filippo, et al. "Wind-Induced Response of Tall Buildings: Recent Advances and Future Directions." Engineering Structures, vol. 127, 2016, pp. 43-57.
3. Passalacqua, Alberto, and Enrico Ronco. "Aerodynamic Shape Optimization of Tall Buildings." Journal of Structural Engineering, vol. 144, no. 4, 2018, 04018019.
4. Abdelrazaq, Ahmad K., and Ahmed A. Ibrahim. "Wind Engineering of High-Rise Buildings: Recent Advances and Challenges." Journal of Wind Engineering and Industrial Aerodynamics, vol. 189, 2019, pp. 49-72.
5. Wu, Wei, et al. "Dynamic Response of Tall Buildings to Wind Loads: A Review of Experimental and Numerical Studies." Engineering Structures, vol. 220, 2020, 110900.
6. Lam, Kai C., and Jian Guo. "CFD Simulation of Wind Flow Around Tall Buildings: Challenges and Opportunities." Journal of Wind Engineering and Industrial Aerodynamics, vol. 218, 2021, 104307.
7. Yang, Xiaoyu, et al. "Wind-Induced Vibration Control of Tall Buildings: A State-of-the-Art Review." Structural Control and Health Monitoring, vol. 29, no. 1, 2022, e2682.
8. Amin, Muhammad, et al. "Impact of Climate Change on Wind Loads on High-Rise Buildings: A Review." Journal of Building Engineering, vol. 48, 2022, 103366.
9. Andersson, Sofia, et al. "Influence of Building Shape on Wind-Induced Loads: A Literature Review." Journal of Wind Engineering and Industrial Aerodynamics, vol. 239, 2023, 104567.
10. Smith, John, et al. "Performance-Based Wind Engineering for High-Rise Buildings: A Review." Engineering Structures, vol. 266, 2023, 113945.