A COMPARATIVE STUDY USING ETABS SOFTWARE ON THE WIND ANALYSIS OF G+10 AND G+15 REGULAR AND IRREGULAR VERTICAL HIGH-RISE STRUCTURES SUBJECT TO DIFFERENT WIND GUSTS

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Abstract - *To compete in the ever-expanding competent market, a structural engineer must save time. Etabs software was developed in order to assess and build vertical high-rise structures in front of this. Extended Three-dimensional Analysis of Building Software is known as ETABS. Skyscrapers, concrete and steel structures, as well as low- and high-rise buildings, are commonly analyzed using ETABS. The present project deals with a comparative study using etabs software on the wind analysis of g+10 and g+15 regular and irregular vertical high-rise structures subject to different wind gusts. In this study total, ETABS V20 is used to develop and analyses of 24 building models for wind loads. The wind analysis is performed at different heights, such as 35.2 m and 51.2 m, with velocities of 33, 39, 44, 47, 50, and 55 m/s. The comparison of the plan configuration also shows how measures like storey displacement, storey drift, storey shear, and overturning moment response interact. Identifying the most economic regular and irregular structure in a prone zone is the aim of this research.*

Key Words: regular structure, irregular structure, wind gusts, displacement, drift, storey shear, overturning moment, Etabs v20.

1 INTRODUCTION

India is coming to understand the value of wind engineering as the need for bigger, more efficient structures develops. In metropolitan regions in particular, horizontal development is no longer a practical solution due to population growth and the scarcity of land. Extremely massive structures can be built because of modern technology, although we in India are still not as efficient at utilizing it as other areas of the world are. Due to the scarcity of land available, constructing high-rise structures is becoming a necessity. The traditional method of manual high-rise building design involves a lot of time and runs the risk of human error. Therefore, using computer-based software that speeds up the process and produces more precise results is important. Today's structural engineers utilize E TABS software, which can solve common issues like static analysis and wind analysis while using various loading combinations to verify different codes.

In India, wind engineering is commonly mistaken for wind energy. However, wind engineering is a special branch of engineering where the effects of wind on buildings and their surroundings are researched. Wind loads on structural frames must be taken into account when designing beams, columns, lateral bracing, and foundations, while wind loads on claddings must be taken into account when selecting cladding systems for structures. When a structure exceeds 150 meters in height, wind often influences the design. However, lateral forces generated by earthquakes are the other force that has an impact on the majority of high-rise structures. Buildings migrate away from the high-frequency earthquake waves as they get higher and more flexible. In different wind pressure areas of the Indian subcontinent, this study gives wind analyses of high-rise structures. G+10 and G+15 regular and irregular story reinforced concrete framed structures are used for the investigation. IS 875 (Part 3)-2015, an Indian code, is used to assess wind loads.

1.1 Need of research

In developing countries, like India, there is a lot of demand to develop the cities because more people are moving towards cities due to employment. Due to the growing population and scarcity of land, tall buildings are required with different requirements. In tall buildings, different forces are acting. We must analyze all of the forces acting on the building to ensure its stability

1.2 objective of this study

here we have considered 24 models of high-rise buildings i.e., g+15, g+10 regular and irregular buildings with different wind speed 33,39,44,47,50,55 m\s. the compare to the structures' wind analysis results by using the cladding method.

- To study the structural performance of RC high rise multi storey buildings.
- to use the ETABS V20 software to analyses both regular and irregular buildings in accordance with IS 875 Part -3 while considering wind speeds of 33, 39, 44, 47, 50, and 55 m/s.
- To evaluate the effect of wind force on a number of building-related parameters, such as maximum

displacements, maximum storey drift, shear force, and a bending moment.

- To study the comparison of different heights and different shapes of the building based on their result.

2 Literature review

Holmes, john (et.al) the article compares three components of the Asia-pacific regions wind load estimations using various wind loading standards and regulation. He analyzed the low, medium, and high-rise structures. The hug amount of resonant dynamic response to wind present in the structures makes it more challenging to detect base shear, bending moments, and acceleration at the top of the tall building. The coefficients of variation for the along-wind and cross wind responses, which varied from 14% to 18%, were both relatively low.

Pavan p s, seyiekrunuo kire (et.al) when the system beings to move in one direction, a noticeable natural air movement known as wind occurs. This paper presents a comparative study of wind studies. Loads that determine a multistorey buildings design load. According to is 875 (part III):1987, two model are analyzed using the E TABS programme with varying wind speeds. For both high-rise and low-rise structures, a comparison of maximum displacements and story shear has been done. After a thorough investigation, it has been shown that high rise structures are more vulnerable to wind forces than low rise building.

Suma devi (et.al) has completed the research for this thesis. The provisions that may reduce the effects of pounding, like the separation distance, addition of shear wall, lateral bracings, and variation in storey height of the building, have been taken into consideration for analysis. In this study, E-TABS of 15 and 10 stories. And conclusion is derived bye taking into account both fixed-base and base-isolated situations.

Kishore Chandra Biswal floating columns are a basic design element in modern structures in metropolitan India. This study light on the significance of the floating columns presence in the building analysis. Alternative measures, such as stiffness balancing of the first and second storey, are suggested to reduce the irregularity caused by the floating columns. Fem codes are created for 2D multi-store frame with and without floating columns in order to analyses how the structure responds to various earthquake excitations with varying frequency contents while maintaining a constant page and time duration factor. Using etabs, the time period of floor displacement, drift, base shear, and overturning moment are calculated for frames with and without floating column.

3 METHODOLOGY AND ANALYSIS

The current study considers that support conditions for their G+10 and G+15 models of structures with a foundation depth of 3 m are fixed at the bottom of the supports and footings. The buildings are 41.1 meters long, 16.75 meters wide, and 35.2 and 51.2 meters high. M30-grade concrete and Fe415-reinforced steel bars with and without irregularities are evaluated as material qualities for the constructions that were simulated using the ETABS V20 programme. Wind speeds of 33, 39, 44, 47, 50, and 55 m/s are also taken into consideration. The elevations and floor plans of the construction are shown in the figures below.

Model 1: regular structure with G+10 considering wind gusts of 33, 39, 44, 47, 50, and 55 m/s

Model 2: irregular structure with G+10 considering wind gusts of 33, 39, 44, 47, 50, and 55 m/s

Model 3: regular structure with G+15 considering wind gusts

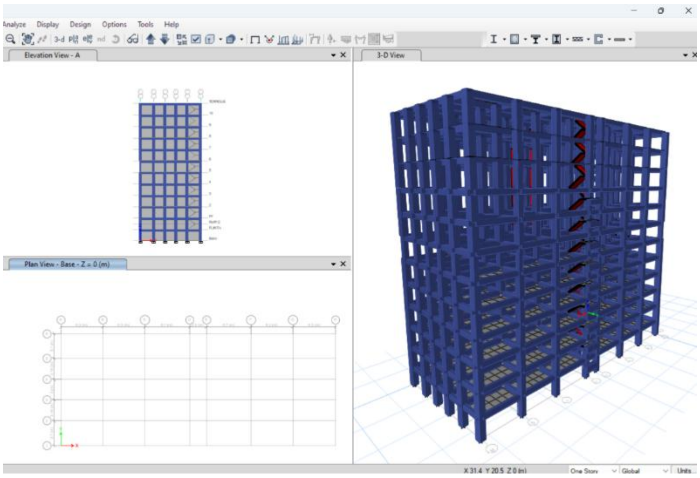


Figure 1 plan and elevation and 3D model

of 33, 39, 44, 47, 50, and 55 m/s

Model 4: irregular structure with G+15 considering wind gusts of 33, 39, 44, 47, 50, and 55 m/s

3.1 DESIGN PARAMETERS

Table 1 PARAMETERS OF STRUCTURE

S NO	PARAMETERS	VALUES
1	Materials	M30, Fe415
2	consider loads	Live, dead, wind, & seismic
3	Heights of building	G+10= 31.2, G+15=51.2
4	Depth of the foundation	3 m
5	Height from floor to floor	3.2m

6	Velocity of wind	33, 39, 44, 47, 50, 55m/s
7	Seismic Zone	IV
8	Software	E TABS V20
9	Size of columns	800X800 and 600X600
10	Size of beam	600x380
11	Thickness of the slab	150mm
12	thickness of the wall	230mm
13	type of the soil	medium
14	Dead load	11.73 kN/m^3
15	Live load	3 kN/m^3

3.2 DESIGN DATA

AS PER IS 875 (PART-III) 2015

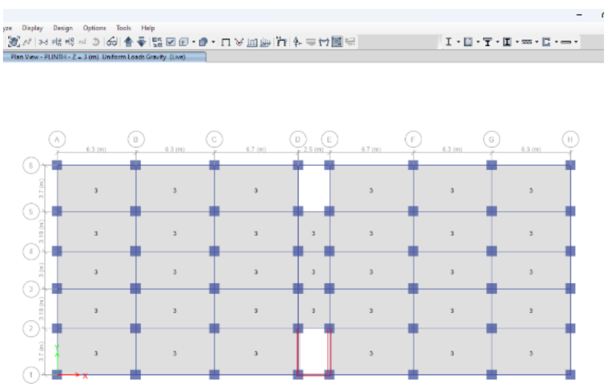
Type of building: RCC building with terrain category 1 at G + 10 and G + 15.
Height = 38.2, width = 16.5 and length = 41.6.
33, 39, 44, 47, 50, and 55 m/s are the standard wind speeds **(VB).**
VZ = (VB * K1 * K2 * K3)Design wind speed
K1 is the risk coefficient for significant structures or towers.
K2 stands for the height and size components of the terrain.
K3 = Topography Factor (upwind slope 3^0)
PZ = 0.6 Vz² is the design wind pressure.
The leeward wind speed is 0.5 and the windward wind speed is 0.8.

WALL LOAD CALCULATIONS

Thickness of wall * height of wall *density of brick masonry = 0.23*2.6*20=11.73kn/m^3

Live load

a live load of -3K n/m is considered. According to IS 875 Part 2, live loads are calculated.



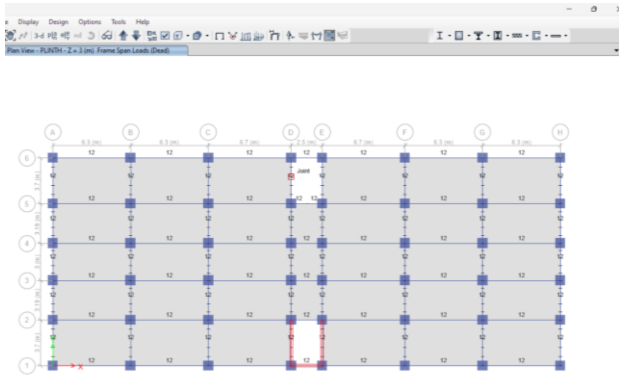


Figure 2 assigning of live load and dead load

4 RESULT AND DISCUSSION

A graphical representation is generated to display these forces and is used to study by comparing the lateral forces, storey displacement, storey shear, overturning moment.

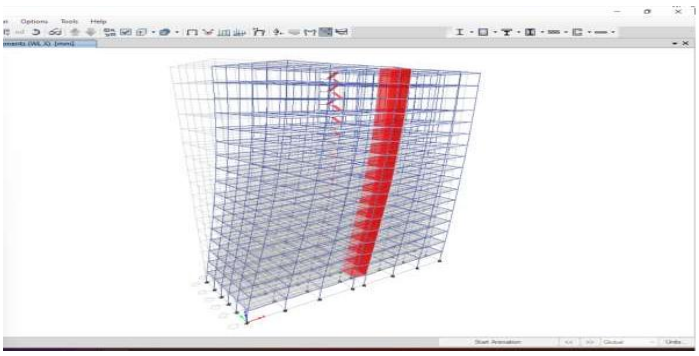


Figure 3 displacement of the structure

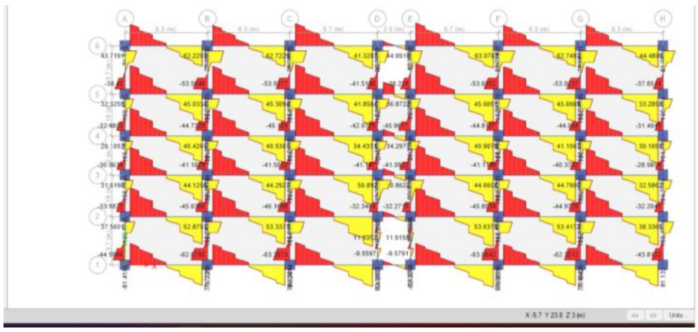


Figure 4 shear force of the structure

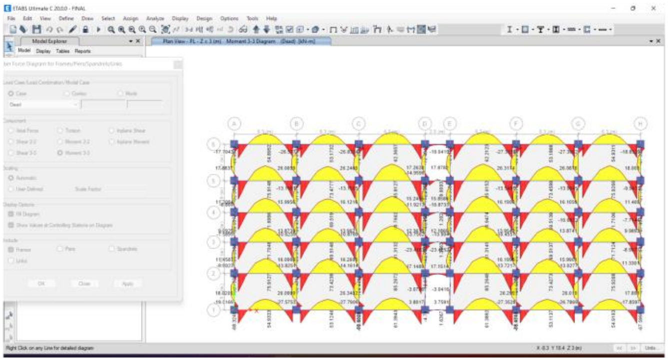


Figure 5 bending moment of the structure

Table 2 : maximum displacement for regular irregular Structures with G+10 and G+15

WIND SPEEDS	G+10		G+15	
(m/s)	REGULAR	IRREGULAR	REGULAR	IRREGULAR
33	0.721	0.928	0.787	2.012
39	0.829	1.296	0.907	2.167
44	0.917	1.65	2.183	2.183
47	1.047	1.883	2.222	2.491
50	1.185	2.131	2.238	2.891
55	1.433	2.578	2.452	3.411

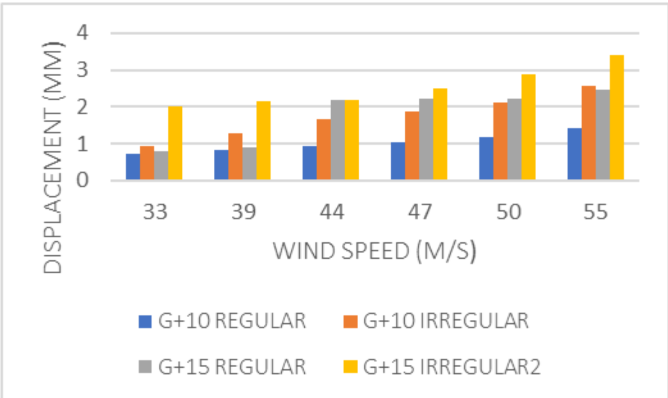


Chart 1: Comparison of the maximum displacement for regular irregular structure with G+10 and G+15.

Table 3: maximum drift for regular irregular structure with G+10 and G+15

WIND SPEEDS	G+10		G+15	
(m/s)	REGULAR	IRREGULAR	REGULAR	IRREGULAR
33	0.000026	0.000033	0.000028	0.000029
39	0.00003	0.000046	0.00003	0.000034
44	0.000031	0.000058	0.000032	0.000058
47	0.000033	0.000066	0.000038	0.000066
50	0.000043	0.000075	0.000059	0.000075
55	0.000052	0.000091	0.000066	0.00009

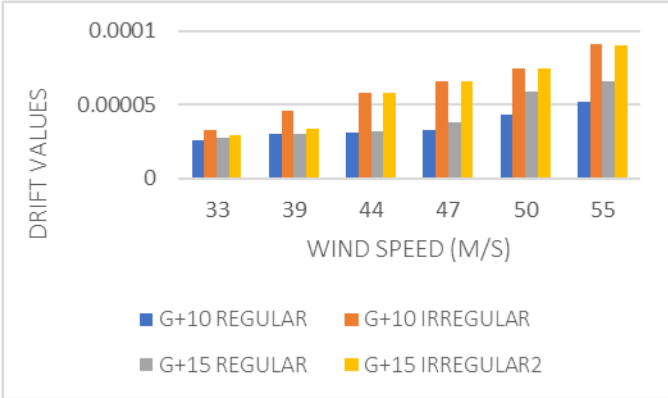


Chart 2: Comparison of the maximum Drift for regular irregular structure with G+10 and G+15

Table 4: maximum storey shear for regular irregular structure with G+10 and G+15

WIND SPEEDS	G+10		G+15	
(m/s)	REGULAR	IRREGULAR	REGULAR	IRREGULAR
33	313.0704	45.1298	372.38	83.75
39	358.0819	63.0325	512.209	116.97
44	398.4907	80.2307	651.964	292.2985
47	454.4907	91.5442	743.899	307.56
50	514.5799	103.6037	841.894	348.085
55	622.6417	125.3604	1018.695	375.6422

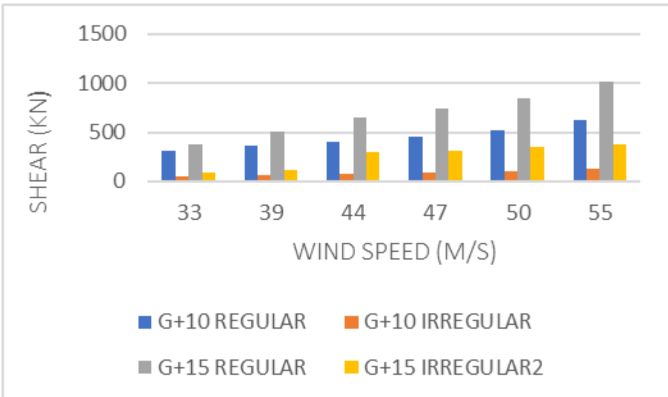


Chart 3: Comparison of the maximum storey shear for regular irregular structure with G+10 and G+15

Table 5: maximum storey moment for regular irregular structures with g+10 and g+15

WIND SPEEDS	G+10		G+15	
(m/s)	REGULAR	IRREGULAR	REGULAR	IRREGULAR
33	-555.047	87.923	-3179.51	519.9635
39	-638.34	122.8024	-3317.76	726.23
44	-706.17	156.308	-10250.1	4691.089
47	-806.87	178.35	-11695.4	6375.089
50	-912.29	201.84	-13236.1	7214.903
55	-1104.02	244.232	-16015.7	17854.21

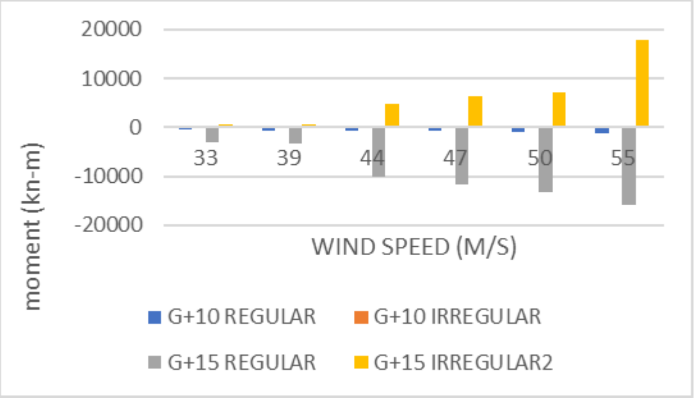


Chart 4 : Comparison of the maximum storey moment for regular irregular structures with g+10 and g+15

5 Conclusion

The multi storey buildings exposed to different wind forces are examined in this study through modelling and analysis of these building, and the following conclusion is drawn:

- Wind speed (55, 50, 47, 44, 39, 33 m/s) is the observed order of the effects when lateral forces are applied to a high-rise structure
- As the wind speed increases, the displacement increases. The wind's influence increases when it has a larger impact on high-rise building.
- It observes that storey drift increases irregular structures when compared to regular structures.
- The storey shear is more in regular structures compared to irregular structures.
- The storey moment decreases in regular structures when compared to irregular structures.
- It has been observed that as wind speed has increased, the lateral forces generated on the structures are becoming more severe.
- Also, it can be concluded that, compared to a regular structure, an irregular structure is more severely affected by wind force.
- A conclusion that can be drawn from this is that high-rise buildings are more exposed to wind forces than low-rise buildings.
- Wind speed (55, 50, 47, 44, 39, 33 m/s) is the observed order of the effects when lateral forces are applied to a high-rise structure

5.1 SCOPE FOR FUTURE WORK

- To compare the study by providing shear wall analysis at a different location.
- Comparative studying by providing bracings and base isolation and dynamic analysis.
- Nonlinear time history analysis can be performed on the high-rise structures

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