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Comparative Study of Wind Dynamic Effect on High Rise Building with Different Wind Speeds

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ABSTRACT

Now a days there is rapid growth in population, and the land is not sufficient to provide shelter to everyone with low and midrise buildings. So that everyone is opting for high rise buildings for more comforts. But the major thing to be considered in High rise building design is wind effect. The main objective of this paper is to compare the wind forces with different wind speeds for dynamic loading on G+24 storey high-rise building for different zones with terrain category 2 using ETABS Software. It is performed on a building to identify the Gust factor, Lateral force, Inter story drift and Lateral displacement, Comparison of results which obtained from the software after assigning the data along both X and Y directions are plotted in graph.

KEY WORDS: Low-rise buildings, Mid-rise buildings, High-rise buildings, Gust factor, Inter story drift, Lateral force, Lateral displacement

INTRODUCTION

Dynamic wind load gives rise to vertical motion, creating oscillations in any direction. Like the breaking of an overused violin string, oscillations are vibrations that can cause a building to fail. High rise building is designed to act as vertical cantilever beam/cylinder & it's possible that tall structures will be affected by wind. Climatic changes are unpredictable & it may change, So that in all building designs it's necessary to consider wind effect especially in High rise buildings. Dynamic wind effect cause heavy loss at cyclonic time.

LOAD CALCULATION:

Dead Load:

Dead load is the intrinsic weight of a structure which is immovable. Dead load has been considered

Floor finish = 1 kN/m², Additional Dead load = 0.5 kN/m² from IS 875: Part-1 1987 Code

Live Load:

Live load is a civil engineering term that refers to a load that can change over time, Live load has been considered 3 kN/m² as per IS 875: Part-2 1987 Code

WIND LOAD:

As per IS 875 (PART-3) 2015

Design wind speed

Basic wind speed Vb = 33 m/sec in Bangalore, 39 m/sec in Trivandrum, 44 m/sec in Mumbai, 47 m/sec in Delhi, 50 m/sec in Vijayawada Risk Coefficient K1 = 1 Terrain, height and structure size factor K2 = 1.205 Topography factor K3 = 1 Importance factor for the cyclonic region K4 = 1

Gust Factor from IS-875 (part-3) 2015: (Along 'X and Y' direction)

$$G = 1 + r\sqrt{g_v^2 B_s (1+g)^2 + \frac{H_s g_R^2 SE}{\beta}}$$

	33 m/s	39 m/s	44 m/s	47 m/s	50 m/s
Peak factor for Upwind gv	3	3	3	3	3
Height factor Hs	2	2	2	2	2
Background Factor Bx	0.94	0.94	0.94	0.94	0.94
By	0.86	0.86	0.86	0.86	0.86
Turbine intensity factor gx	0.53	0.53	0.53	0.53	0.53
gy	0.51	0.51	0.51	0.51	0.51
Peak factor for resonant response gRx	3.91	3.91	3.91	3.91	3.91
gRy	3.78	3.78	3.78	3.78	3.78
Size reduction factor Sx	0.11	0.14	0.16	0.17	0.19
Sy	0.13	0.16	0.19	0.20	0.21
Spectrum of Turbulence Ex	0.05	0.06	0.06	0.06	0.07
Spectrum of Turbulence Ey	0.07	0.08	0.09	0.09	0.09
Damping Coefficient β	0.02	0.02	0.02	0.02	0.02
Gust Factor Gx	5.02	5.25	5.45	5.57	5.70
Gust Factor Gy	5.18	5.52	5.80	5.96	6.13

METHODOLOGY:

Mathematical model, Section properties and Material properties are defined. Loading are given, Support conditions given and Analysis carried out. Wind forces have been calculated for the structure. Wind forces has been assigned as per IS guidelines and analysis carried out. Earthquake forces have been calculated for the structure. Earthquake forces has been assigned as per IS guidelines and analysis carried out.

Architectural plan –

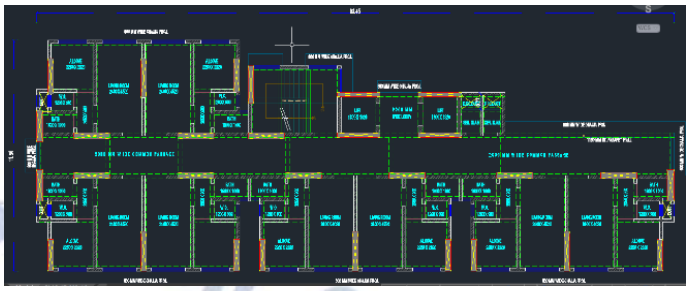

Fig 1: Architectural plan of G+24 Building

Architectural Plan is created using AutoCAD Software.

ETABS Model –

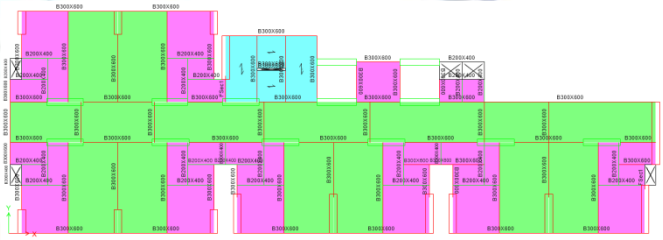

FIG 2: Structural plan of G+24 Building

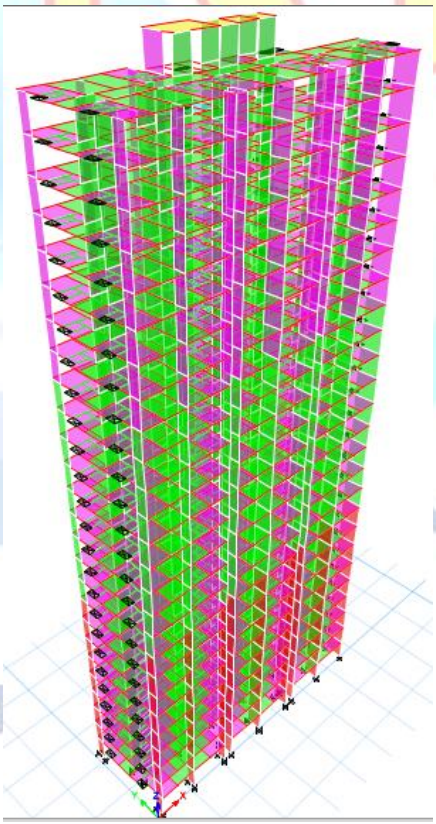

FIG 3 : Structural 3D view of G+24 Building

RESULTS AND DISCUSSION

Results of different parameters such as Gust factor, Lateral force,Lateral displacement, Inter storey drift are shown below with the help of graphs.

The Gust factor method is easy to study the dynamic effect on the structure and critical path of the wind loads for the high-rise buildings. Maximum Gust factor along X - direction and Y-direction are mentioned below.

	X-dir	Y-dir
33 m/sec	5.027	5.188
39 m/sec	5.259	5.521
44 m/sec	5.458	5.802
47 m/sec	5.578	5.969
50 m/sec	5.700	6.135

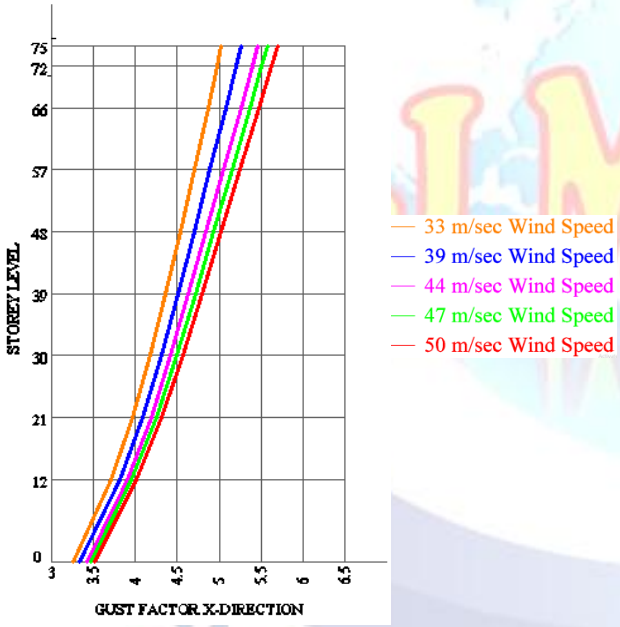

FIG 4: Variance in the Gust factor along X-direction

The Gust factor has increased 11.80% and 15.43% from 33m/sec to 50m/sec respectively X-direction and Y-direction. The **FIG 4** and **FIG 5**show the variance in the Gust factor for different wind speeds.

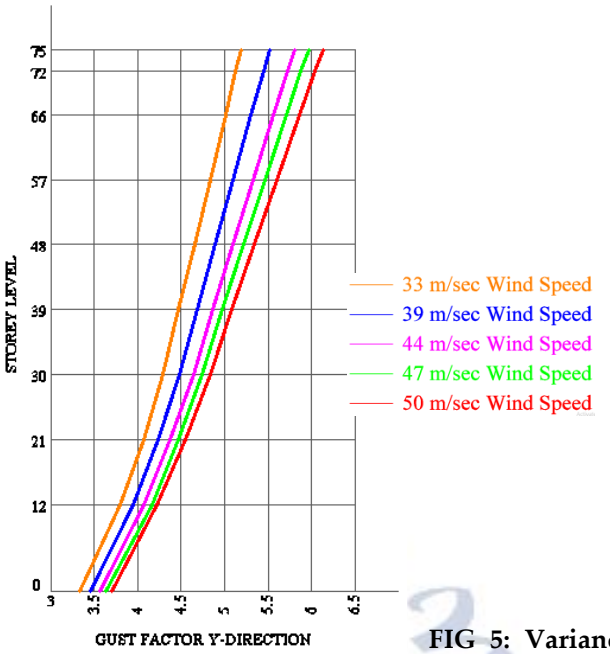

FIG 5: Variance in the Gust factor along Y-direction

MaximumLateral forces of the Structure along X - direction and Y-direction are mentioned below.

	X-dir	Y-dir
33 m/sec	190.22	610.70
39 m/sec	277.55	906.36
44 m/sec	366.29	1210.91
47 m/sec	426.96	1420.74
50 m/sec	493.45	1651.81

The Lateral force has increased 61.45% and 63.02% from 33m/sec to 50m/sec respectively X-direction and Y-direction. The **FIG 6** and **FIG 7** show the variance in the Lateral force for different wind speeds.

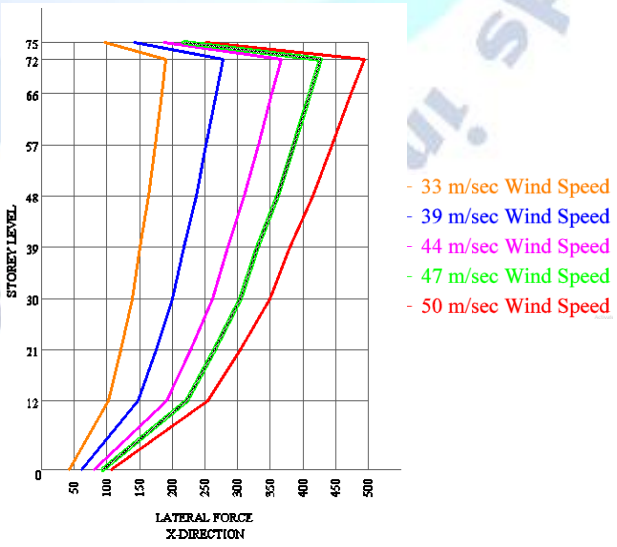

FIG 6: Variance in the Lateral Force along X-direction

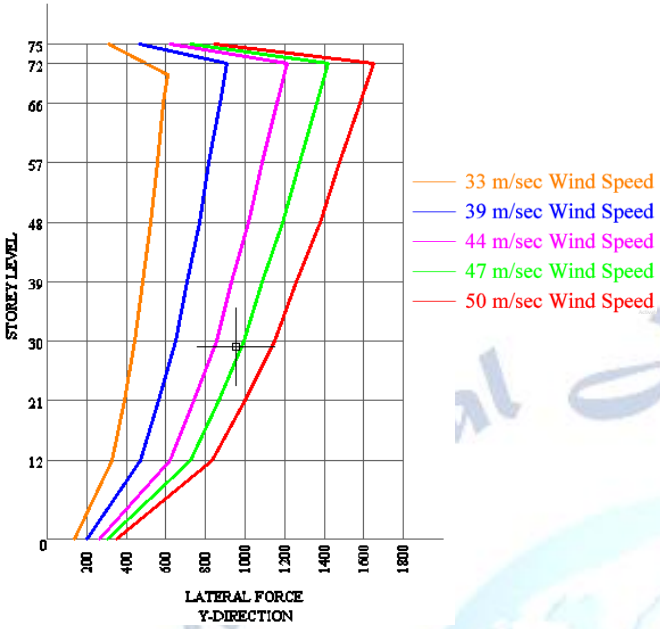

FIG 7: Variance in the Lateral Force along Y-direction

MaximumLateral Displacement of the Structure along X - direction and Y-direction are mentioned below.

	X-dir	Y-dir
33 m/sec	31.72	338.54
39 m/sec	46.01	498.92
44 m/sec	60.45	663.24
47 m/sec	70.28	776.10
50 m/sec	81.04	900.13

The Lateral force has increased 60.85% and 62.38% from 33m/sec to 50m/sec respectively X-direction and Y-direction. The **FIG 8** and **FIG 9** show the variance in the Lateral force for different wind speeds.

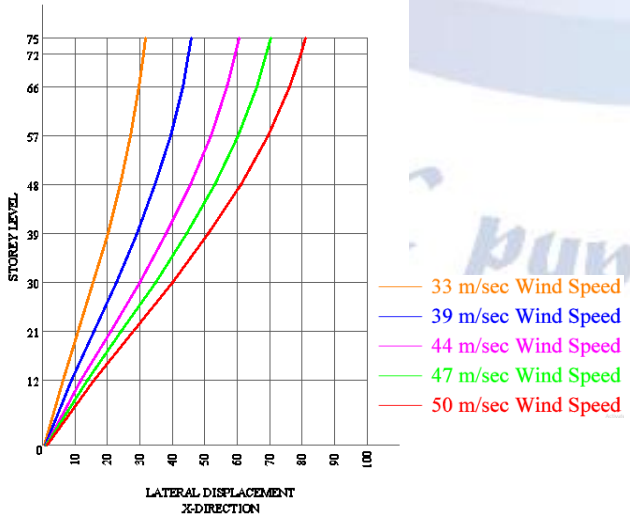

FIG 8: Variance in the Lateral Displacement along X-direction

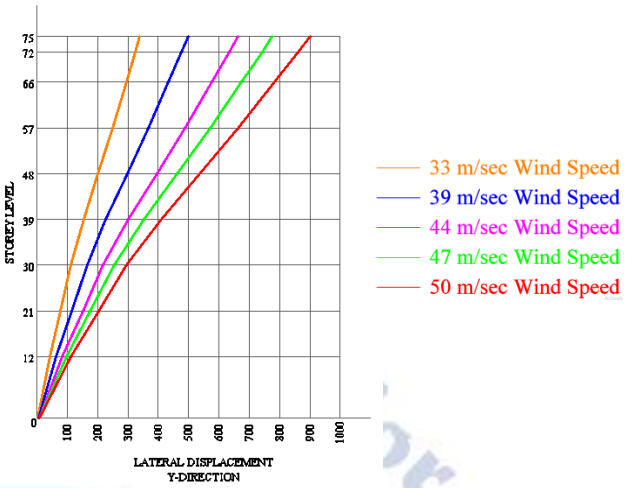

FIG 9: Variance in the Lateral Displacement along Y-direction

MaximumInter storey drift of the Structure along X - direction and Y-direction are mentioned below.

	X-dir	Y-dir
33 m/sec	0.000533	0.0053
39 m/sec	0.000773	0.0078
44 m/sec	0.001014	0.0103
47 m/sec	0.001179	0.0121
50 m/sec	0.001359	0.0141

The Inter storey drift has increased 60.77% and 62.41% from 33m/sec to 50m/sec respectively X-direction and Y-direction. The **FIG 10** and **FIG 11** show the variance in the Inter storey drift for different wind speeds.

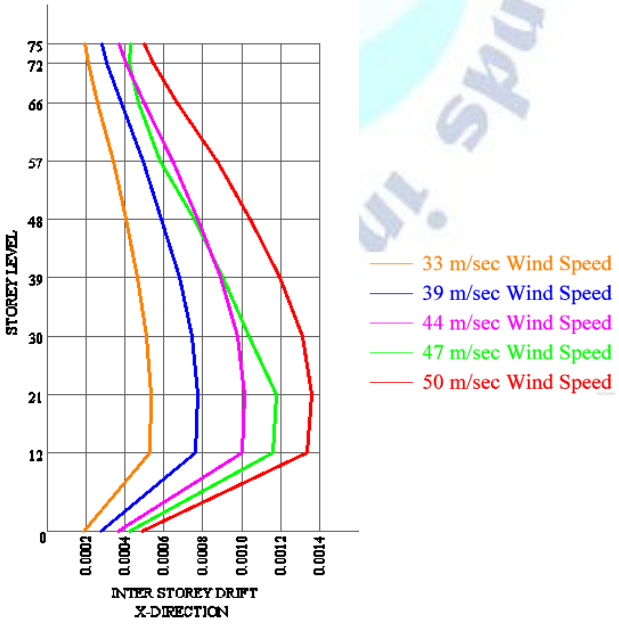

FIG 10: Variance in the Inter storey drift along X-direction

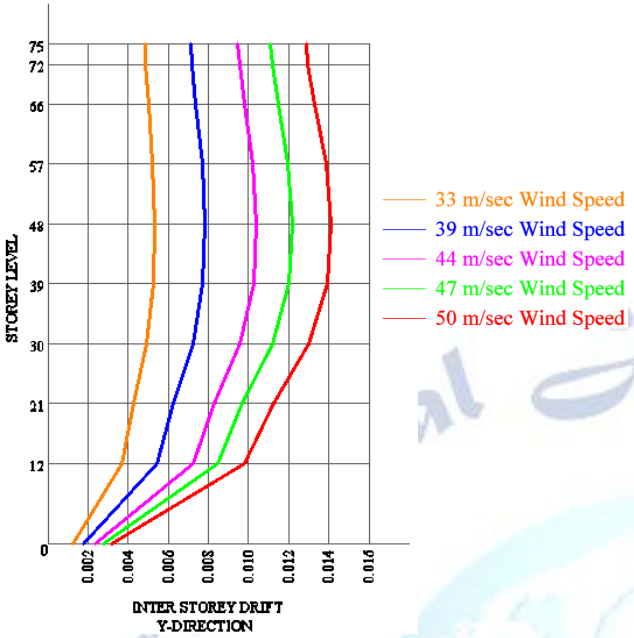

FIG 11: Variance in the Inter storey drift along Y-direction

CONCLUSION:

1. Percentage of Gust factor, Lateral force, Lateral displacement, Inter story drift has been increased from 33 m/sec wind speed to 50 m/sec wind speed.
2. **Gust factor** has been increased 11.80% in X-direction and 15.43% in Y-direction for varies wind speeds
3. **Lateral Force** has been increased 61.45% in X-direction and 63.02% in Y-direction for varies wind speeds
4. **Lateral Displacement** has been increased 60.85% in X-direction and 62.38% in Y-direction for varies wind speeds
5. **Lateral Displacement** has been increased 60.77% in X-direction and 62.38% in Y-direction for varies wind speeds
6. From the obtained results 50 m/sec wind speed is giving more lateral pressure to the building.
7. The structure is economically more at the place where the wind speed is 50 m/sec.

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