EFFECT OF WIND ON HIGH RISE BUILDINGS IN DIFFERENT TERRAIN CATEGORY

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ABSTRACT: Any building can vibrate in both the directions of “along wind” and “across wind” caused by the flow of wind. Modern Tall buildings designed to satisfy lateral drift requirements, still may oscillate excessively during wind storm. These oscillations can cause some threats to the Tall building as buildings with more and more height becomes more vulnerable to oscillate at high speed winds. Sometimes these oscillations may even cause discomfort to the occupants even if it is not in a threatening position for the structural damage. So an accurate assessment of building motion is an essential prerequisite for serviceability. There are few approaches to find out the Response of the Tall buildings to the Wind loads. Wind is a perceptible natural motion of air relative to earth surface, especially in the form of air current blowing in a particular direction. The major harmful aspect which concern to civil engineering structures is that, it will load any and every object that comes in its way. Wind blows with less speed in rough terrain and higher speed in smooth terrain. This paper will presents story drift, storey shear, and support reactions that occur in different storey Buildings (Low Rise Buildings, Medium Rise Buildings, and High Rise Buildings) due to wind in different terrain category under two different wind speed . Totally 24 models for G+5, G+10 and G+15 are analyzed using ETABS package. after analysis paper will be provides a good source of information about variation in drift, shear with change in height of model, percentage change in drift, shear of same model in different terrain category.

KEY WORDS: Tall Buildings, drift, storey shear, ETABS, different terrain category, wind load,

INTRODUCTION

In India, in recent decades, the application of wind engineering to civil engineering structures has become popular and the state-of-the-art has improved considerably. Wind engineering requires a multifaceted approach to provide solutions to various wind-sensitive problems. It involves various fields such as (i) Fluid dynamics (ii) Probability and statistics and (iii) Structural dynamics. Wind, in general, has two main effects on tall buildings: First, it exerts forces and moments on the structure and its cladding, and second, it distributes air in and around the building, mainly termed as wind pressure. Wind pressures on buildings are influenced by the building geometry, angle of wind incidence, surroundings and wind flow characteristics. There are many situations where available database, codes/standards and analytical methods cannot be used to estimates the wind pressure coefficients and wind loads on the claddings and supporting system of buildings, for example, the aerodynamic shape of the building is uncommon.

Wind load/pressure information (i) does not account the aerodynamic effect of the actual shape of the structure since they are based on box like buildings and (ii) do not allow for any detailed directional effects and assume that the design wind speed will always occur from the aerodynamically severe wind direction. High-rise buildings are generally wind sensitive structures. Their dynamic response dominates the total response, which affects the structural design with regard to both structural safety and serviceability. In addition to this, because of their height, cladding loads are substantial. The wind flow around the high-rise buildings also affects the comfort of pedestrians in the surrounding area, the ventilation of the building etc. Buildings and their components are to be designed to withstand the code specified wind loads. Calculating wind loads is important in design of the wind force-resisting system, including structural members, components, and cladding against shear, sliding, overturning and uplift actions.

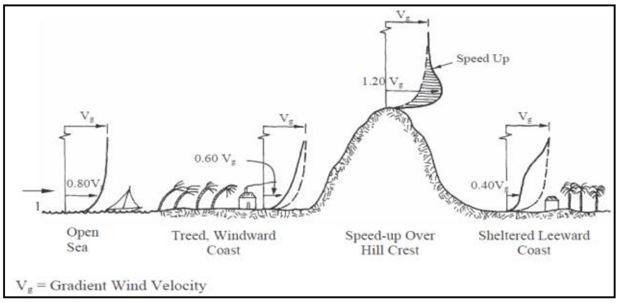


Fig. 1: Influence of terrain and topography

(Source: An Explanatory handbook on proposed IS 875 (Part 3) wind loads on buildings and structures)

METHODOLOGY

The methodology worked out to achieve the above-mentioned objectives is as follows:

- Extensive literature survey by referring books, technical papers or research papers carried out to understand basic concept of topic.
- Identification of need of research.
- Formulation of stages in analytical work which is to be carried out.
- Data collection.
- three different storey building is considered for the analysis.
- The model has prepared on ETABS for the various shapes of the buildings.
- Manual calculation of wind loads for the building according to IS 875(part3)-1987 has done by using the various parameters of the wind.
- Application of calculated wind loads on the modeled buildings is to be done.
- Comparative studies done for axial loads on column, storey shear, lateral story displacement, story drift, wind intensity for the various shapes of buildings and determination of structurally efficient shape of building is to be done.
- Interpretation of results and conclusion.

The model has prepared on ETABS for the rectangular shape of the buildings.

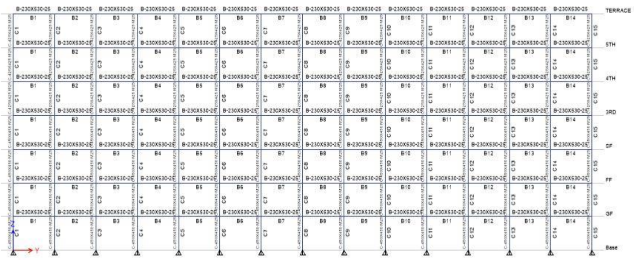


Fig. 2: (G+5) Elevation view

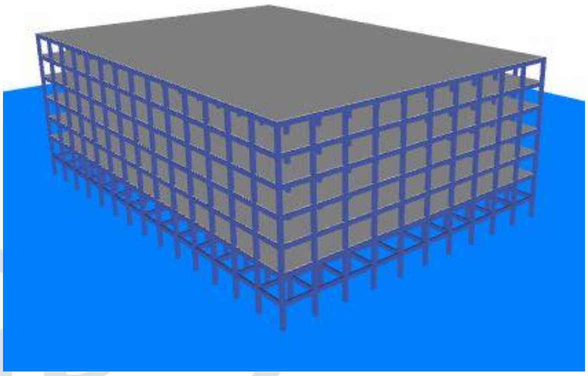


Fig. 3: (G+5) 3D view

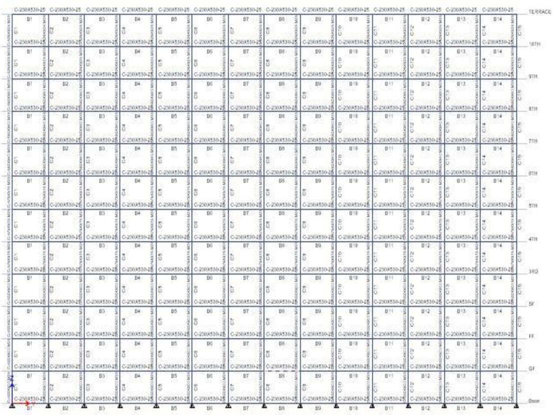


Fig. 4: (G+10) Elevation view

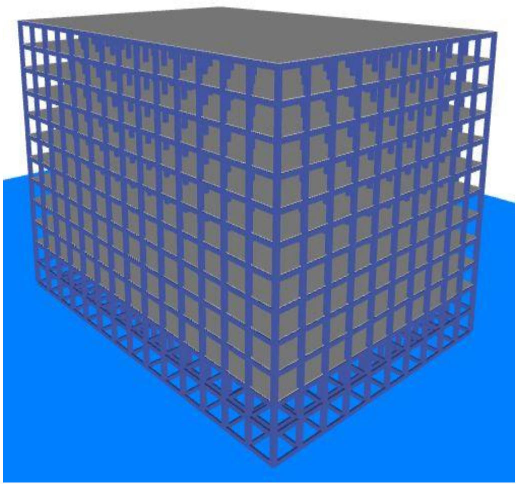


Fig. 5: (G+10) 3D view

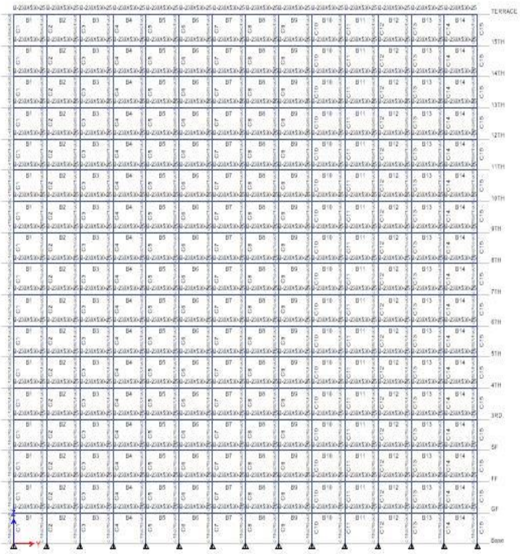


Fig. 6: (G+15) Elevation view

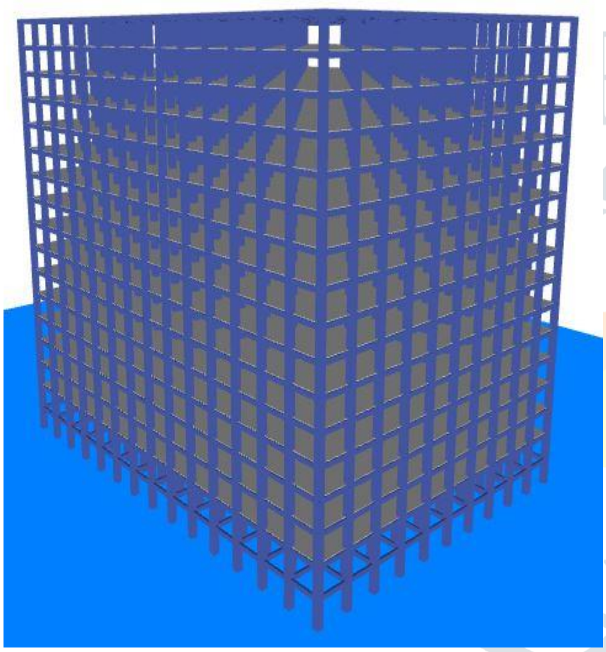


Fig. 7: (G+15) 3D view

ANALYSIS RESULTS

1. The following table shows the analysis results obtained with the help of Etabs for models M1 and M2 and M3.
2. Model M1 is a 5 storey building and model M2 is a10 storey building and model M3 is a 15 storey building.
3. The table shows lateral displacement due to wind force caused in the building and the displacement are storey wise and the next table shows analysis results for drift.
4. The wind speed considered in the first case is 33m/s, in second case its 39m/s, in third case its 44m/s in fourh case its 47m/s in fifth case its 50m/s and in sixth case its 55m/s.
5. The terrain category considered is four.

Table 1: Displacement M1-1 to M1-6

	M1-1	M1-2	M1-3	M1-4	M1-5	M1-6
TERRACE	1.5	2.1	2.7	3.1	6.2	3.5
5TH	1.5	2.1	2.6	3	6	3.4
4TH	1.4	1.9	2.5	2.8	5.7	3.2
3RD	1.3	1.8	2.2	2.6	5.1	2.9
SF	1.1	1.5	1.9	2.2	4.4	2.5
FF	0.9	1.2	1.6	1.8	3.5	2
GF	0.6	0.9	1.1	1.3	2.4	1.4
Base	0	0	0	0	0	0

Graph 1: Displacement M1-1 to M1-6 (X-direction)

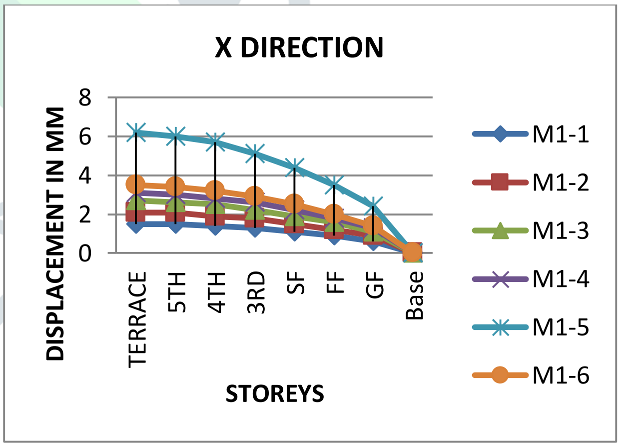


Table 2: displacement M2-1 to M2-6

	M2-1	M2-2	M2-3	M2-4	M2-5	M2-6
TERRACE	2.2	3.1	3.9	4.5	5.1	9.5
10TH	2.2	3	3.9	4.4	5	9.4
9TH	2.1	2.9	3.7	4.3	4.8	9.1
8TH	2	2.8	3.6	4.1	4.6	8.7
7TH	1.9	2.6	3.3	3.8	4.3	8.2
6TH	1.7	2.4	3	3.4	3.9	7.5
5TH	1.5	2.1	2.7	3.1	3.5	6.7
4TH	1.3	1.8	2.3	2.6	3	5.7
3RD	1.1	1.5	1.9	2.1	2.4	4.7
SF	0.8	1.1	1.4	1.6	1.8	3.5
FF	0.5	0.7	0.9	1.1	1.2	2.3
GF	0.3	0.4	0.4	0.5	0.6	1.1
Base	0	0	0	0	0	0

Graph 2: Displacement M2-1 TO M2-6 (Y-Direction)

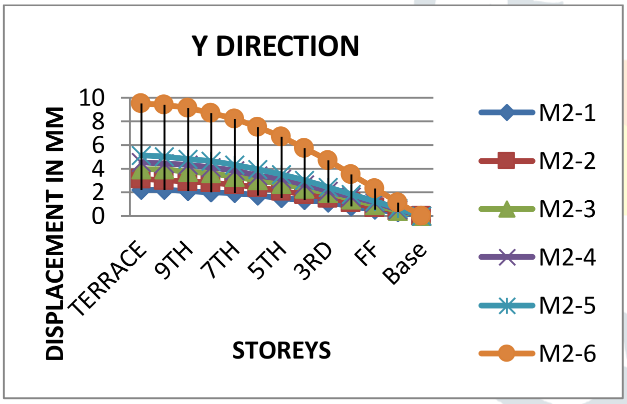


Table 3: displacement M3-1 to M3-6

	M3-1	M3-2	M3-3	M3-4	M3-5	M3-6
TERRACE	7.8	10.9	13.9	15.9	18	21.7
15TH	7.7	10.8	13.8	15.7	17.8	21.5
14TH	7.6	10.7	13.6	15.5	17.5	21.2
13TH	7.5	10.4	13.2	15.1	17.1	20.7
12TH	7.2	10.1	12.8	14.6	16.6	20.1
11TH	6.9	9.7	12.3	14.1	15.9	19.3
10TH	6.6	9.2	11.7	13.4	15.2	18.3
9TH	6.2	8.7	11	12.6	14.3	17.3
8TH	5.8	8.1	10.3	11.7	13.3	16.1
7TH	5.3	7.4	9.5	10.8	12.2	14.8
6TH	4.8	6.7	8.6	9.8	11	13.4
5TH	4.3	6	7.6	8.7	9.8	11.9
4TH	3.7	5.2	6.6	7.5	8.5	10.3
3RD	3.1	4.3	5.5	6.3	7.1	8.6
SF	2.5	3.4	4.4	5	5.7	6.8
FF	1.8	2.5	3.1	3.6	4.1	4.9
GF	1	1.4	1.8	2	2.3	2.7
Base	0	0	0	0	0	0

Graph 3: Displacement M3-1 to M3-6 (X-direction)

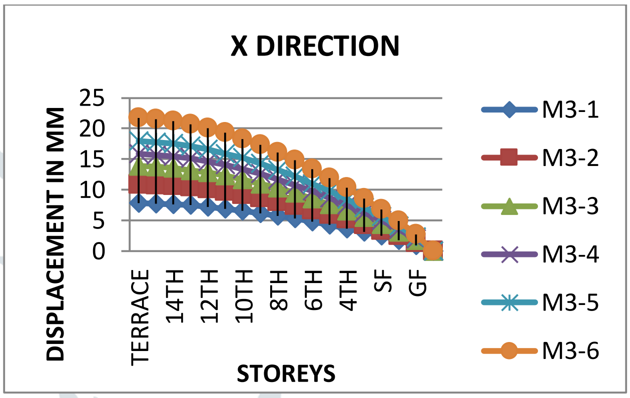


Table 4: Time period M1-1 to M1-6

		M1-1	M1-2	M1-3	M1-4	M1-5	M1-6
Modal	1	1.45	1.45	1.45	1.45	1.45	1.45
Modal	2	1.43	1.43	1.43	1.43	1.43	1.43
Modal	3	1.38	1.38	1.38	1.38	1.38	1.38
Modal	4	0.44	0.44	0.44	0.44	0.44	0.44
Modal	5	0.44	0.44	0.44	0.44	0.44	0.44
Modal	6	0.42	0.42	0.42	0.42	0.42	0.42
Modal	7	0.24	0.24	0.21	0.24	0.24	0.24
Modal	8	0.23	0.23	0.23	0.23	0.23	0.23
Modal	9	0.23	0.23	0.23	0.23	0.23	0.23
Modal	10	0.16	0.16	0.16	0.16	0.16	0.16
Modal	11	0.16	0.16	0.16	0.16	0.16	0.16
Modal	12	0.15	0.15	0.15	0.15	0.15	0.15

Graph 4: Time period M1-1 to M1-6

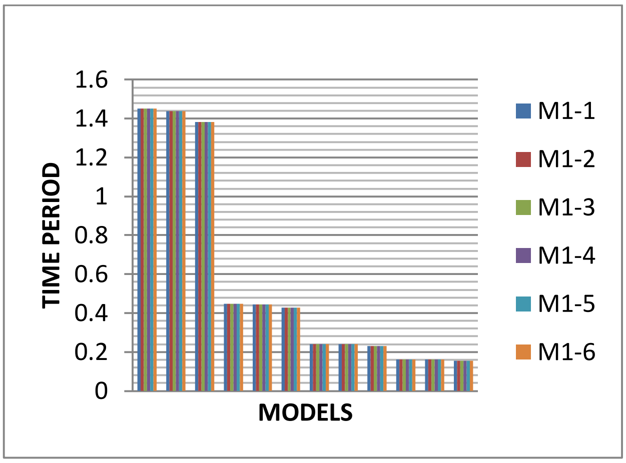


Table 5: Time period M2-1 to M2-6

		M2-1	M2-2	M2-3	M2-4	M2-5	M2-6
Modal	1	1.78	1.78	1.78	1.78	1.78	1.78
Modal	2	1.76	1.76	1.76	1.76	1.76	1.76
Modal	3	1.69	1.69	1.69	1.69	1.69	1.69
Modal	4	0.58	0.58	0.58	0.58	0.58	0.58
Modal	5	0.58	0.58	0.58	0.58	0.58	0.58
Modal	6	0.55	0.55	0.55	0.55	0.55	0.55
Modal	7	0.33	0.33	0.33	0.33	0.33	0.33
Modal	8	0.33	0.33	0.33	0.33	0.33	0.33
Modal	9	0.32	0.32	0.32	0.32	0.32	0.32
Modal	10	0.22	0.22	0.22	0.22	0.22	0.22
Modal	11	0.22	0.22	0.22	0.22	0.22	0.22
Modal	12	0.21	0.21	0.21	0.21	0.21	0.21

Graph 5: Time period M2-1 to M2-6

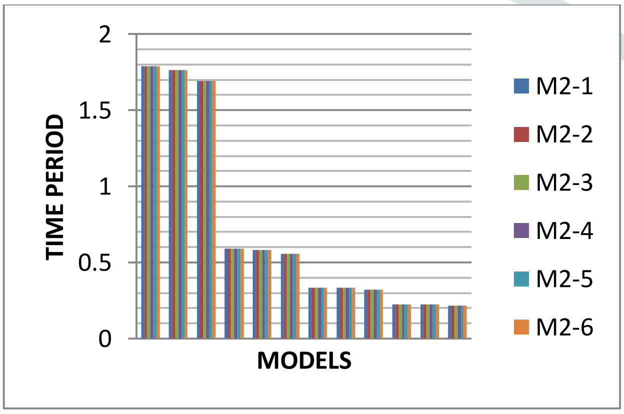
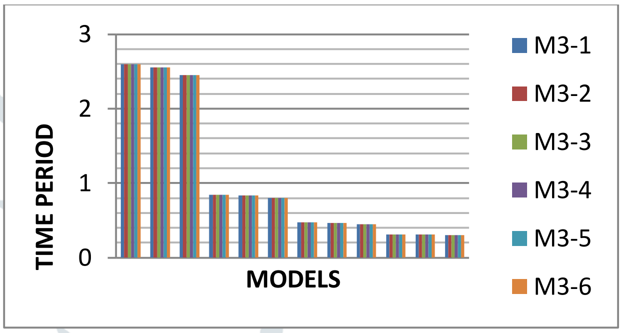


Table 6: Time period M3-1 to M3-6

		M3-1	M3-2	M3-3	M3-4	M3-5	M3-6
Modal	1	2.59	2.59	2.59	2.59	2.59	2.59
Modal	2	2.55	2.55	2.55	2.55	2.55	2.55
Modal	3	2.45	2.45	2.45	2.45	2.45	2.45
Modal	4	0.84	0.84	0.84	0.84	0.84	0.84
Modal	5	0.83	0.83	0.83	0.83	0.83	0.83
Modal	6	0.80	0.80	0.80	0.80	0.80	0.80
Modal	7	0.47	0.47	0.47	0.47	0.47	0.47
Modal	8	0.46	0.46	0.46	0.46	0.46	0.46
Modal	9	0.40	0.45	0.45	0.45	0.45	0.45
Modal	10	0.31	0.31	0.31	0.31	0.31	0.31
Modal	11	0.31	0.31	0.31	0.31	0.31	0.31
Modal	12	0.29	0.29	0.29	0.29	0.29	0.29

Graph 6: Time period M3-1 to M3-6



CONCLUSION

From the work done by analysing the buildings with different number of stories it is observed that with increasing wind speed and increase in number of storey there is displacement.

To overcome this deflection and the risk to the structure design is to be done accordingly.

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