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Analysis of High Rise building under Static and Dynamic Wind Conditions Considering Various Aspects

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Abstract - *Now a days multistory buildings are common as well as essential part of modern and developing cities worldwide due to density and space like issues in urban society .very tall buildings are being constructed due to development and advancement in construction industry. However the safety of high rise building due to the action of lateral load such as wind and earthquake is very important .These high rise buildings are highly susceptible to wind. Therefore we need to estimate the effect of wind with high degree of precision. And if needed, apply measures to reduce its effect on tall buildings.*

This study focuses on the effect of wind load on high rise buildings with different storey height and various loading conditions in different terrain category and then comparing all these results with structure having inverted V bracings. The analysis is conducted using STAAD pro. Results have been collected in terms of axial force, storey drift, and displacement using STAAD pro.

Key Words: **Multi-storey building, terrain category, bracings, static, dynamic effect, STAAD pro.**

1. INTRODUCTION

Need of high rise building in construction industry is increasing day by day because of scarcity of land. for high rise building, calculation of wind pressure and analysis of it is essential as it can be critical at a time. wind load is one of the most essential loads to consider for high rise buildings . The effect of wind varies with the change in space and time. Because of its highly unpredictable and uncertain nature it is important to take into account the critical effect of wind in tall structures . Usually when the speed of the wind is high, wind travels horizontally and the vertical movement of wind is relatively small. Hence we can say that the word 'wind' exclusively represents the horizontal component.

Wind can cause both static and dynamic effect depending upon the building dimension and some other factors. In IS:875(part3)2015,the criteria weather to check the building for dynamic effects or not is given. Manual designing of it is highly time consuming and there is a possibility of human error. Hence it becomes essential to use some computer based software for this purpose which saves our time and gives accurate result.

STAAD pro provides enough facilities regarding wind load analysis .Hence we have used STAAD pro v8i software for this project and have done analysis of G+16 , G+21 and G+26 storey buildings.

1.1 Wind effects

Wind effects- wind can cause both static and dynamic effect depending upon the building dimension and some other factors.
Static effect: Most of the structure met with in practice does not suffer wind induced oscillation hence do not require checking dynamic effect of wind in this case .for such structures static wind analysis is sufficient.
Dynamic effect: on the other hand, there are some slender structures which require investigation of wind induced oscillations. Gust factor method is used for determining the influence of dynamic velocity fluctuations.

There is a guideline mentioned in IS 875 (part 3) : 2015 on fulfilling of which any building or structure needs to be examined for dynamic effects. According to which if any structure has height to minimum lateral dimension ration of more than 5,or structure whose first mode natural frequency is less than 1 Hz. Then the structure will be analysed for dynamic effects of wind.

1.2 Models for analysis

1 .G+16 storey model:
Static wind analysis(static analysis method) in terrain category1 and terrain category 3 without bracings
Static wind analysis(static analysis method) in terrain category1 and terrain category 3 with bracings
Dynamic wind analysis(gust factor method) in terrain category1 and terrain category 3 without bracings
Dynamic wind analysis(gust factor method) in terrain category1 and terrain category 3 with bracings.

2 .G+21 storey model:
Static wind analysis(static analysis method) in terrain category1 and terrain category 3 without bracings
Static wind analysis(static analysis method) in terrain category1 and terrain category 3 with bracings
Dynamic wind analysis(gust factor method) in terrain category1 and terrain category 3 without bracings

dynamic wind analysis(gust factor method) in terrain category1 and terrain category 3 with bracings.

3 .G+26 storey model:
Static wind analysis(static analysis method) in terrain category1 and terrain category 3 without bracings
Static wind analysis(static analysis method) in terrain category1 and terrain category 3 with bracings
dynamic wind analysis(gust factor method) in terrain category1 and terrain category 3 without bracings
dynamic wind analysis(gust factor method) in terrain category1 and terrain category 3 with bracings.

2. Methodology

This research deals with the comparative analysis of the effect of wind load on high rise building frames. For the analysis we have prepared three building model of G+16, G+21 and G+26 storey .The analysis and designing of high rise building frames has been done using STAAD pro v8i software which is based on finite element analysis method.

High rise building frames of different storey height have been designed as RCC framed structure as per IS:875(part 3):2015 and analysed using STAAD pro under the effect of both static and dynamic loading and each for terrain category 1 and 3 without bracings and then again with bracings.

Table -1: Building frame specifications

Column size	0.5m X 0.5m
Beam size	0.4m X 0.5m
Bracing	150x150X20
Slab	0.20m
Live load	3 KN/m^2
Floor finish	1 KN/m^2
Grade of concrete	M30
Grade of steel	Fe550
Length	21m
Width	18m
Height	51m,66m,81m
Storey	G+16,G+21,G+26
Floor to floor spacing	3m
Bay spacing in x	3m
Bay spacing in z	3m

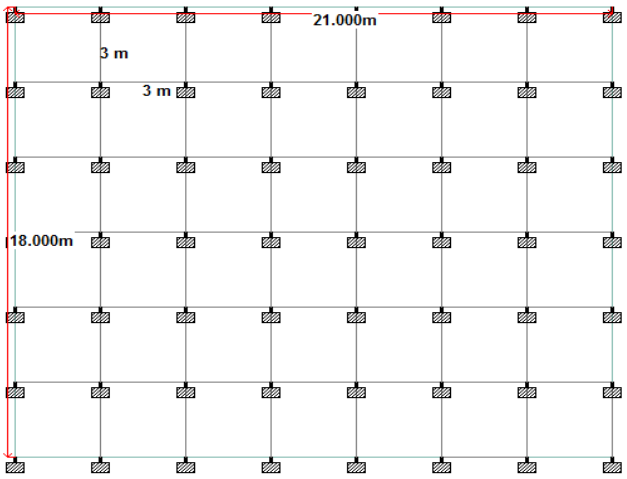


Fig -1: Plan view of frame

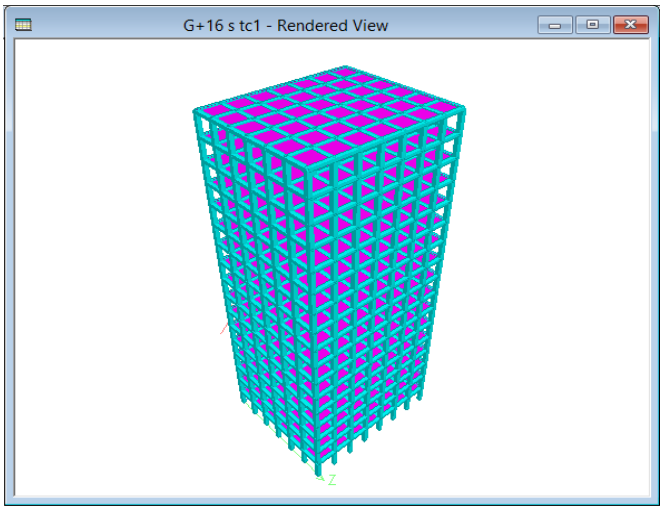


Fig -2: Rendered view of frame

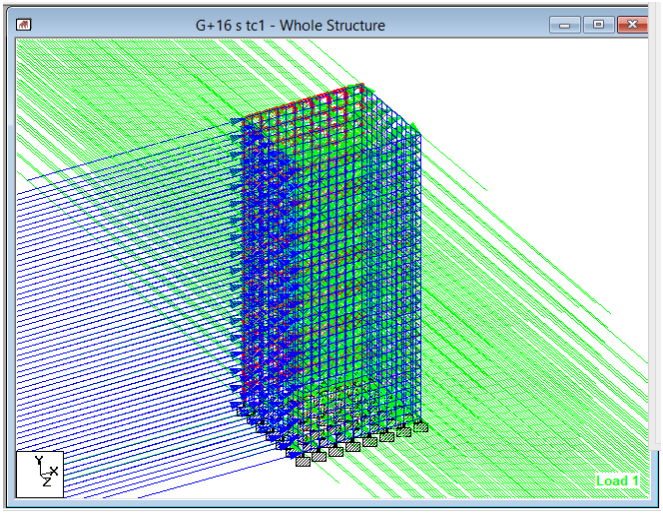


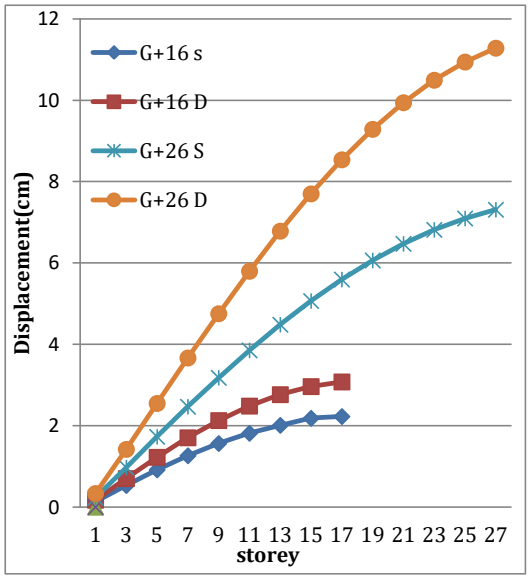
Fig -3: Application of wind load

Table -2: Wind data

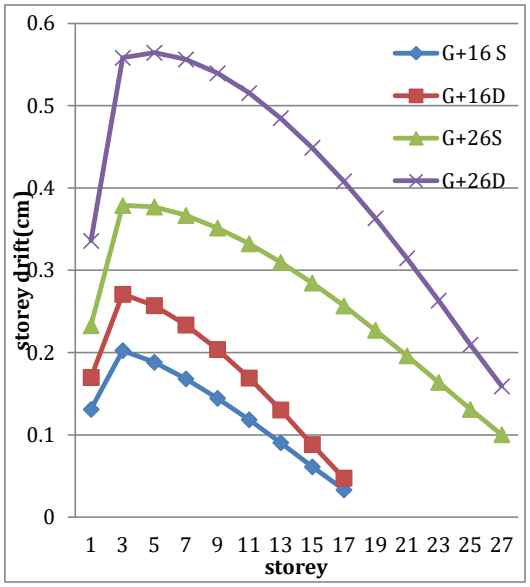
Wind zone	2(Raipur) 39m/s
Life of structure	50 years
Terrain category	1
	3
Class of structure	B
Topography	Flat

3. Results and discussion

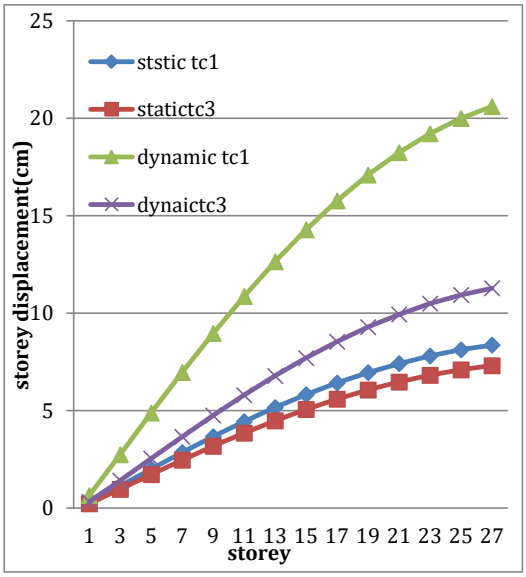
First of all three model cases are analysed statically in terrain category 1 and terrain category 3 with bracings and without bracings conditions and all of the three model satisfies the criteria mentioned in Is: 875(part3) 2015 for examining the problems of wind-induced oscillations .Hence we analysed the structures dynamically in terrain category 1 and terrain category 3 with bracings and without bracings conditions in STAAD pro v8i. Results of which is graphically presented below.



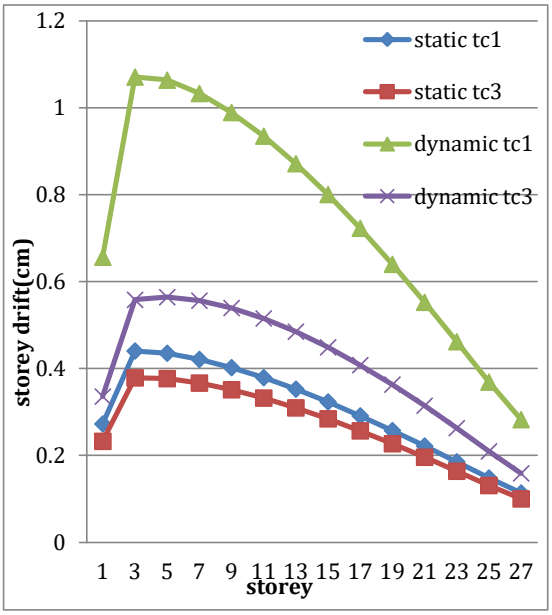
Graph-1: Graph between storey and corresponding deflection comparing G+16 and G+26 model under static and dynamic effect



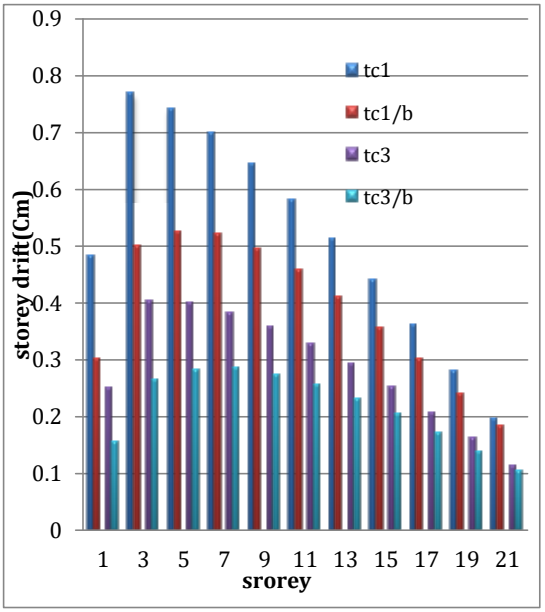
Graph-2: Graph between storey and storey drift comparing G+16 and G+26 model under static and dynamic effect.



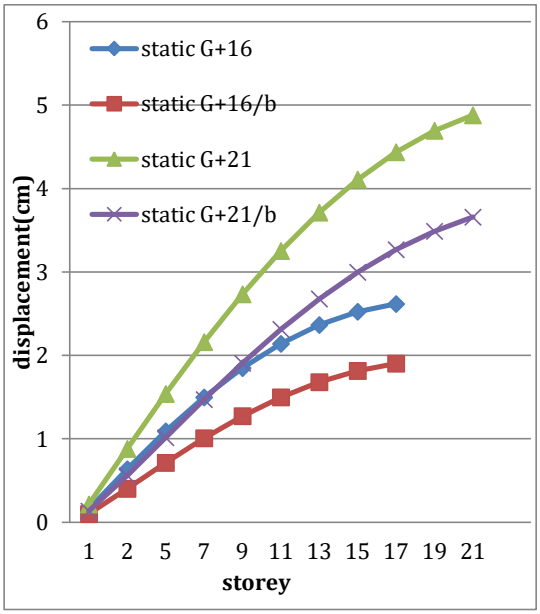
Graph-3: Graph between storey and deflection comparing G+26 model for terrain category 1 and terrain category 3 under static and dynamic effect.



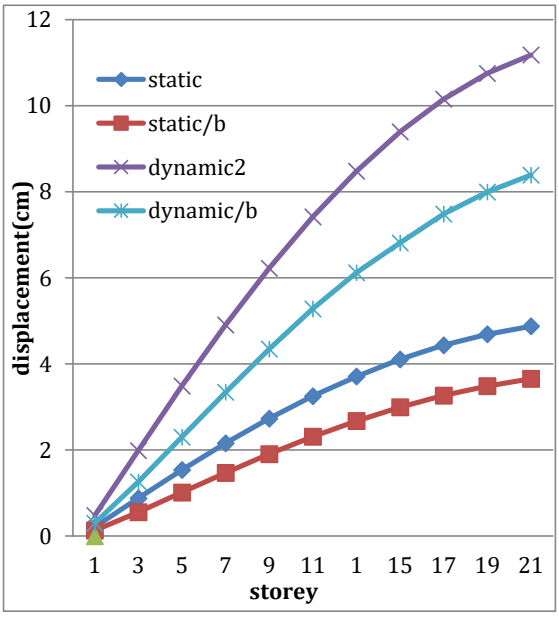
Graph-4: Graph between storey and storey drift comparing G+26 model for terrain category 1 and terrain category 3 under static and dynamic effect.



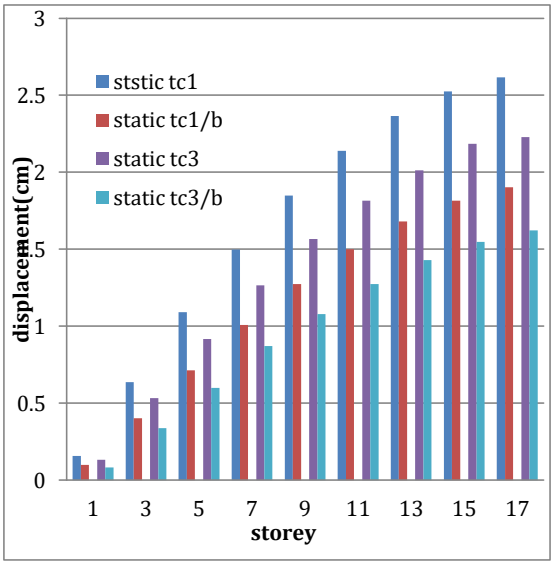
Graph-7: Graph between storey and storey drift comparing G+21 model for bracings and without bracings condition for terrain category 1 and 3 considering dynamic effect.



Graph-5: Graph between storey and deflection comparing G+16 and G+26 model for bracings and without bracings condition under static effect.



Graph-7: Graph between storey and displacement comparing G+21 model for bracings and without bracings condition for static and dynamic loading.



Graph-8:Graph between storey and displacement comparing G+16 model for bracings and without bracings condition for terrain category 1 and 3 considering static effect.

3. CONCLUSIONS

On the basis of present study, the following conclusions are drawn:

- Storey displacement increases with increase in height. More the storey no, more the displacement .Comparing G+16,G+21 and G+26 model at a particular level or point, G+26 model will experience maximum displacement.
- Value of drift and displacement for dynamic wind effect comes out to me more than static wind effect. However for G+16 model this difference in static and dynamic analysis is not significant but it becomes considerable for G+26 storey model. Hence we can say dynamic analysis has to be done for high rise structures only.
- If we compare results in terrain category 1 and 3 then drift and displacement values in terrain category 1 comes out to be more than terrain category 3 for all the loading cases but the margin is more for dynamic effect than static one.
- Structures with bracings tend to experience less displacement than the one without bracings for all loading cases and in all the terrain categories. Drift value in case of bracings increases gradually and attains its peak later than the one without bracing. It provides stability to structure.

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