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Primary Examination of a Tall structure Major areas of strength for under Utilizing ETABS

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ABSTRACT
Bangladesh, a thickly populated country in South Asia, is situated in the north eastern piece of the Indian subcontinent at the top of the Cove of Bengal. Geological area of Bangladesh makes it obviously fit to quake and wind pressure. Thus, the information on unique investigation is fundamental for structural specialists to plan a protected construction for lessening the harms of design during horizontal stacking. This paper addresses a near investigation of the seriousness impact of wind powers on a tall structure applying BNBC 2006.To accomplish this objective an arrangement of 10 celebrated elevated structure has been thought of. The review performed with 12 variety of wind speed from 150 km/hr to 260 km/hr. The examination has been finished by utilizing PC programming ETABS. After the examination the greatest dislodging was found 12.9 inch at 260 km/hr wind speed with popular narrative float was viewed as 0.0191 at 110ft while the most reduced removal and float esteem was found 8.875 inch and 0.0153 at wind speed of 150 km/hr considering comparable level of 110ft. This paper outlines the whole impact of various breeze speed on skyscraper design to foresee the sidelong developments like removal and between story float as well as functionality of a RC building.
Keywords:-*Lateral load analysis, Wind Speed, Displacement, Inter-storey drift, BNBC 2006*

INTRODUCTION

Due to the scarcity of land there has been increased demand for land. So there has been a considerable increase in the number of tall buildings, both residential and commercial and the modern trend is towards the taller structures. Considering the increasing population as well as lack of horizontal expansion is not a reasonable solution. If high rise buildings are constructed than many structural problems arise, such as lateral load effect, lateral displacement and stiffness etc. Generally, for high rise structure not only earth quake load effects are dominant but also wind load effects are dominant. Therefore, for high rise buildings it is essential to have knowledge of various loads and its effect on buildings. The effect of lateral load is very important to consider such as earthquake and wind loads.

In some cases, the wind load is dominant than earthquake load which depends on area and zone factor defined by codes. Wind as a moving air has an effect on effect on building structures. Wind actions fluctuate with time, hence its effect on different situations and structures should be carefully analyzed. Wind act directly on the external surfaces of enclosed structures, through porosity of the external surface, internal surface through opening. Wind pressure act on areas of the surfaces producing forces perpendicular to the surface of the structure or on individual cladding components. The effect of wind on structures is significant on light and dynamic structures. It does have considerable effect on vertically standing

walls, columns and beams etc.

There are two methods for wind load analysis, namely, the quasi-static method and detailed dynamic analysis. The former is applied to structures whose structural properties do not make them susceptible to dynamic exaltation. The latter is applied to structures which are likely to be susceptible to dynamic excitation. The choice of the above two methods depends on the value of the structure of their dynamic coefficient he dynamic coefficient depends on the type of structure, the height of the structure and its breadth. This wind effect will cause and produce wind induced motion in the structure. As high-rise buildings push the envelope to greater heights, the structural designers are not only faced with problem to choosing a structural element to carry the lateral load such as wind load and earthquake load but also insuring the design criteria that meets stability and serviceability requirement under complex wind environment.

In addition, the high-rise structures should meet more stiffness under lateral loads. This calls for the use of an established and tested building code so as to ensure the safety of the structure and its occupants against the natural hazard. Bangladesh National Building Code (BNBC) was first organized in the year of 1993 but published in the year 2006 and known as BNBC 2006. The shape of buildings is very important in wind analysis, because the wind pressure is mainly depending on the exposed area of building against wind.

The objective of the present study is to investigate the response of variation of wind load in RC structures in 10 storied building where the structure exhibits nonlinear behavior. Wind analysis has performed for different wind speed like coastal areas. Here, story displacement, story stiffness, base reaction, maximum bending moment in columns are examined for different wind variation.

METHOD

The displacement and drift comparison of RC structures models, due to different wind speed variation according to BNBC 2006 are illustrated in this paper. Three-dimensional modeling of the structures was generated using ETABS software (version 9.6.0) is shown in Figure 1.

Idealization of the Structure

The analysis was carried out by the code of BNBC 2006. The story height was chosen as 110ft. The ground floor height was taken as 10ft. The typical height of each story was 10ft as regular practice in Bangladesh for residential building. In Bangladesh the lowest wind speed is 150 km/hr in Agarpota and Dahagram whereas the maximum wind speed is 256 km/hr in Barisal. Therefore, the study performed with 12 variation of wind speed from150 km/hrto260 km/hr viz. 150km/hr, 160km/hr, 170km/hr, 180km/hr, 190km/hr, 200km/hr, 210km/hr, 220km/hr, 230km/hr, 240km/hr, 250km/hr, 260km/hr respectively. All structures are considered as Special Moment Resisting Frame (SMRF) as lateral force-resisting system.

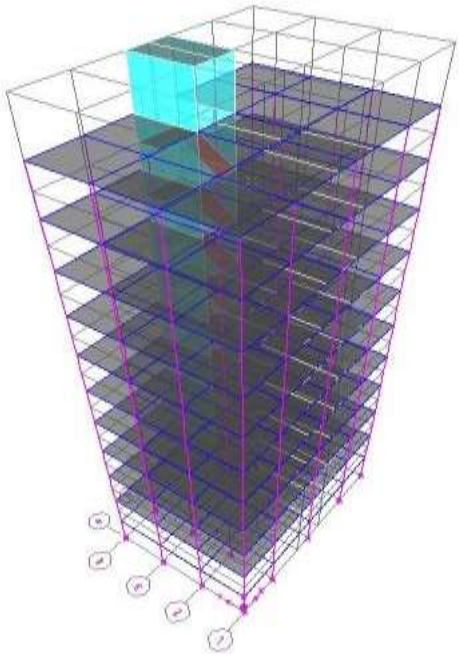


Fig.1:-*3D Model of a 10 storied building (Fixed supported)*

Properties of the Structural Elements

Analyzing the variation of wind load on RC building, the dimensions of reinforced concrete columns are considered for gravity load with some factor of safety due to lateral load and the thickness of the slab element is taken as 5.5 inches. The columns have uniform cross sections along their height. These variations in dimensions are arrived based on the variation in base shear for different storied structure. The concrete strength (f'_c) considered for design is 4000 psi. The design loads including Dead Load (DL), Partition Wall (PW), Floor Finish (FF), and Live Load (LL), have been determined according to the provisions of the general design requirements provided in BNBC. The earthquake force is assigned as lateral load on the structures based on seismic zone of BNBC 2006. The sectional, material properties and design loads of structure elements have been summarized in Table 1, Table 2 and Table 3 respectively.

Dimensions of footing were calculated with respect to safe bearing capacity. Footing area was analyzed using Terzhagi's bearing capacity for cohesive soils**.** To make the analysis most general, translation of foundation in two mutually perpendicular principle horizontal directions and vertical directions as well as rotation of the same about these three directions were considered here.

Table 1:-*Sectional Properties of the Structures*

Story	Column			Beam		Slab (in)	Shear wall thickness (in)
	Corner column (in)	Periphery column (in)	Interior column (in)	Internal (in)	Periphery (in)		
10	15"X20"	15"X25"	20"X25"	10"X18"	10"X15"	5.5"	10"

Table 2:-*Material Properties of the Structural Elements*

SL	Material	Properties	Symbol	Unit	Value
1.	Concrete	Unit weight	*γc*	pcf	150
2.	Concrete	Compressive strength	*f'c*	ksi	4
4.	Mild steel	Yield strength	*fy*	ksi	60

Table 3:-*Loads on Typical Slab*

SL	Load Type	Location	Unit	Value
1.	Live load (LL)	Typical slab	psf	40
2.	Partition wall (PW)	Typical slab	psf	25
3.	Floor finish (FF)	Typical slab	psf	20

RESULTS AND DISCUSSIONS

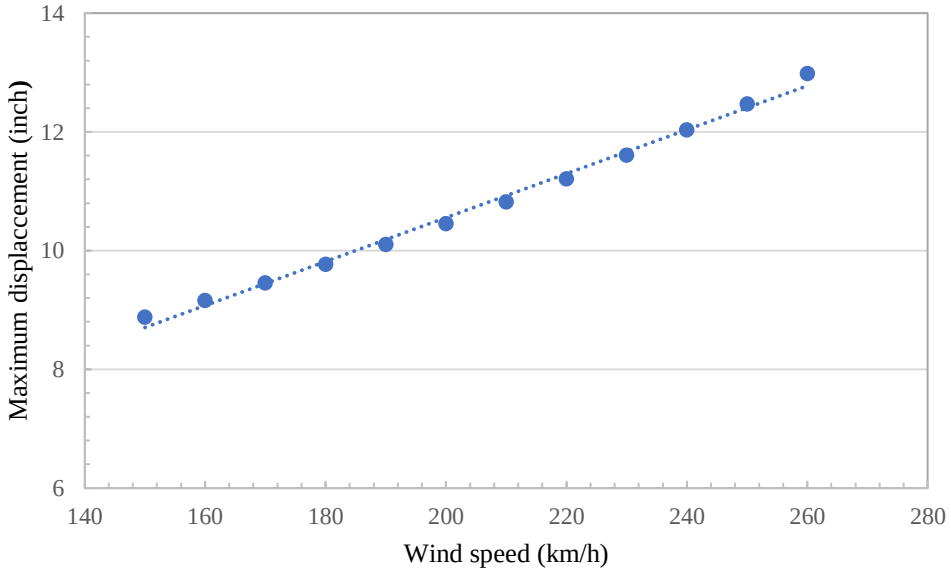
A summary of maximum displacement of RC building has shown in Table 4 for BNBC 2006. All the results for different wind speed with respect to same height (110 ft) of the building structure are studied with graphical representation. The structural displacements due to wind speed 260 km/hr have always found greater in comparison with other wind speeds considering similar height of the structure based on BNBC 2006.

Top deflection increments at different wind speed based on BNBC 2006 is summarized in Table 4. As shown in Table 4 maximum increment in deflection was generated for wind speed260 km/hr about 46.20% with respect to wind speed 150 km/hr. A detailed graphical representation has shown in Figure 2.

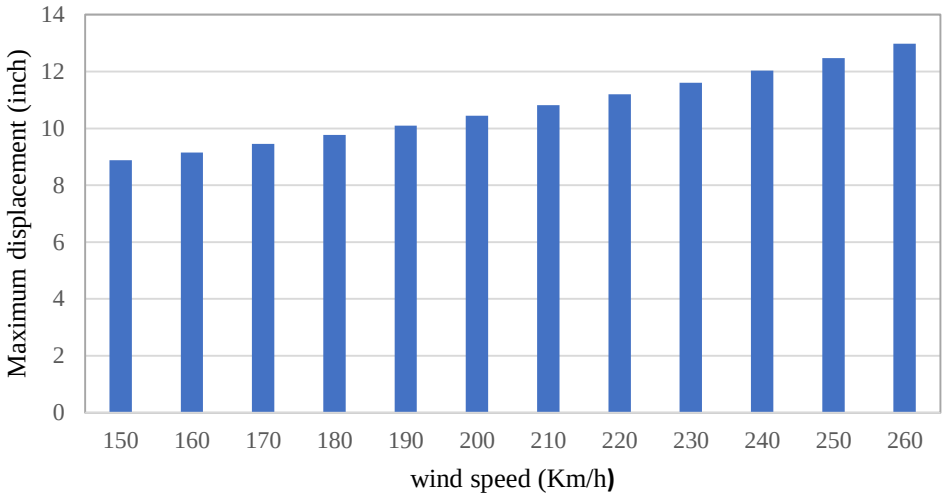
Displacement of Structure

Table 4:-*Result of maximum displacement with different wind speed*

Wind speed (km/h)	Maximum displacement(inch)	(%) Increment
150	8.875538	0
160	9.154046	3.14
170	9.450523	6.50
180	9.764967	10.02
190	10.09738	13.80
200	10.44776	17.70
210	10.81611	22
220	11.20243	26.20
230	11.60671	30.80
240	12.02897	35.50
250	12.46919	40.50
260	12.97738	46.20



(a)



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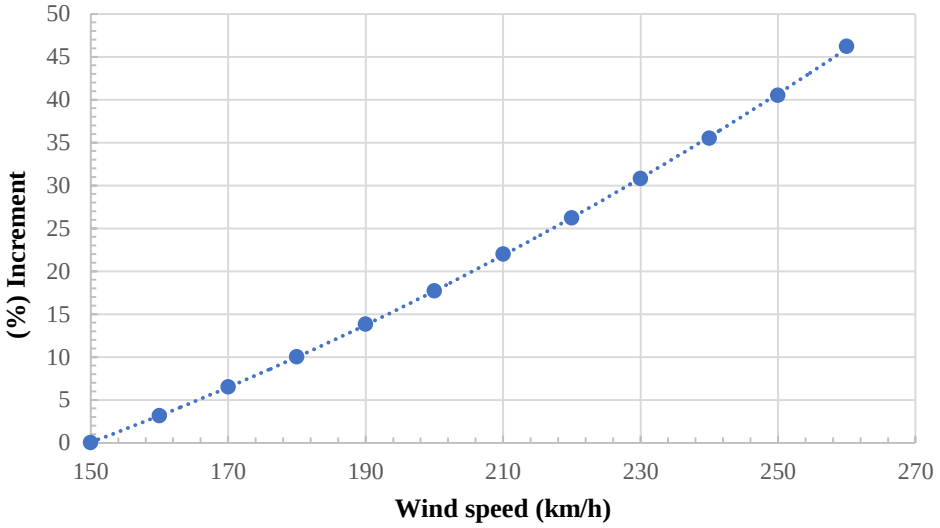

(c)

Fig.2:-*Variation in deflection with respect to wind speed 150 km/hr to 260 km/hr for 10 storied RC building (a) Maximum displacement vs. wind speed (b) Comparison between maximum displacement with wind speed and (c) (%) increment with different wind speed.*

The graphs depict the changes in displacement for different wind load in a 10 storied building. Displacement increases with the increment of wind speed.From the Figure 2, it is observed that the maximum displacement was detected at wind speed 260 km/hr, which was 12.97738 inch and the minimum displacement was found at wind speed 150 km/hr, which was 8.875538 inch. Therefore, maximum displacement for 10 storied building was found for wind speed of 260 km/hr.

Storey Drifts of Structure

Storey drift is the displacement of one level relative to the level above or below due to design lateral forces. Wind plays a vital role in lateral deflection of structure. As the structure that has been considered is a large phase in long direction and small phase in short direction, the impact is different due to wind load in different direction. Wind base shear differs for the longitudinal and transverse direction. This is especially true for rectangular buildings with length significantly longer than their

widths.Building phase in short direction is relatively smaller, so impact on this side is comparatively small in that direction. Moreover, Shear wall lessen the drift considerably. A summary of inter-storey drift for different wind speed is shown in Table 5.

Table 5:-*Result of inter-storey drift for different wind speed*

Drift												
Floor no	**Wind speed(km/h)**											
	150	**160**	**170**	**180**	**190**	**200**	**210**	**220**	**230**	**240**	**250**	**260**
10	0.0153	0.0156	0.0158	0.0161	0.0164	0.0167	0.0171	0.0174	0.0179	0.0182	0.0187	0.0191
9	0.012	0.0122	0.0125	0.0128	0.0131	0.0135	0.0138	0.0142	0.0145	0.0149	0.0154	0.0158
8	0.0102	0.0104	0.0107	0.011	0.0113	0.0117	0.012	0.0124	0.0128	0.0132	0.0132	0.0141
7	0.0087	0.0089	0.0092	0.0095	0.0099	0.0102	0.0106	0.0109	0.0113	0.0117	0.0122	0.0126
6	0.0075	0.0077	0.008	0.0083	0.0087	0.009	0.0093	0.0097	0.0101	0.0105	0.011	0.0114
5	0.0064	0.0067	0.0069	0.0072	0.0075	0.0079	0.0082	0.0085	0.0089	0.0097	0.0097	0.0101
4	0.0054	0.0056	0.0059	0.0061	0.0064	0.0067	0.007	0.0074	0.0077	0.0081	0.0085	0.0088
3	0.0044	0.0046	0.0048	0.0051	0.0053	0.0056	0.0059	0.0062	0.0065	0.0068	0.0071	0.0075
2	0.0033	0.0035	0.0036	0.0038	0.004	0.0043	0.0045	0.0047	0.005	0.0052	0.0055	0.0058
1	0.0021	0.0022	0.0023	0.0024	0.0026	0.0027	0.0029	0.003	0.0032	0.0034	0.0036	0.0038

Combined graphical representation of all wind speeds for individual inter-storey drift along with storey height is shown in Figure 3. From the Figure 3, it is observed that the variation pattern is almost similar for all wind speed. As the height of the structure increases, inter-storey drift is rising up simultaneously.

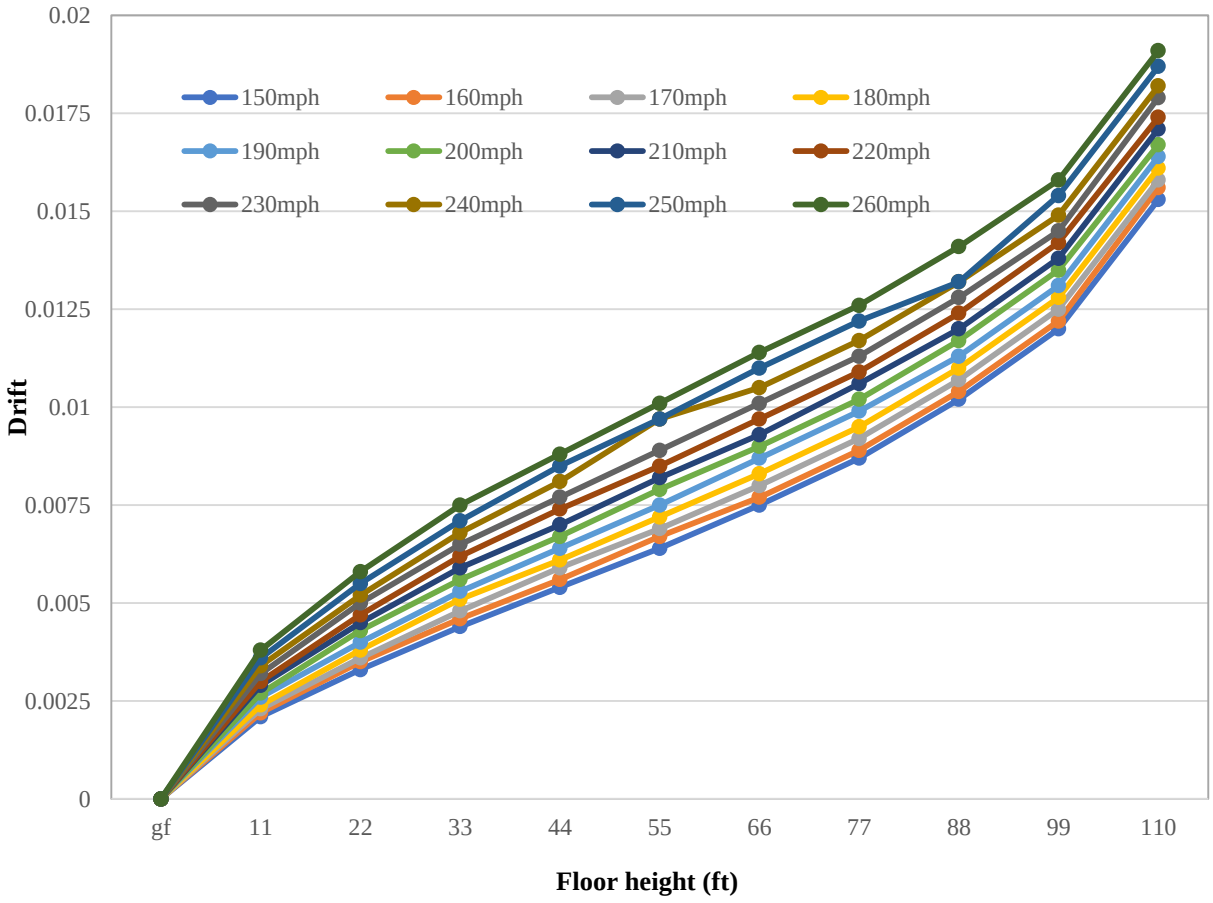

Fig.3:-*Relationship of inter-storey drift with height of the structure for different wind speed*

Figure 3, shows a better representative of linear relation for all the wind speed. Observing all the graphs from 150 km/hr to 260 km/hr wind speed, it can be summarized that the curve that illustrated the relationship between drift and storey height looks similar. For instance, for 150 km/h wind speed inter-storey drift at storey 1 is 0.0021 whereasit was at storey 10 is 0.0153. This trend went similar for all different wind speed i.e. every graph has steadily increased with respect to various wind pressure. Therefore, it can be stated that drift value increases with the increment of wind pressure as well as height of the structure.

From the graphs the displacement and inter-storey drift can be predicted with reasonable accuracy for the RC buildings with wind speed 150 km/hr to 260 km/hr if the design is based on BNBC 2006.

CONCLUSIONS

After analyzing the results, the following outcomes of this study is given below,

- Displacement increment for different wind speed with increasing height shows similar pattern.
- The maximum displacement was found 12.92 inches for 260 km/h wind speed whereas minimum displacement was found 8.87 inches for 150 km/h wind speed.
- The maximum increment of displacement was found 46.2% for 260 km/h wind speed compared to 150 km/h wind speed.
- With the increasing wind speed the inter-storey drifts shows similar trend for the height of structure.
- The maximum top storey drift was observed 0.019085 at height110ft for 260 km/hr wind speed while minimum top storey drift was found 0.0153at height 110ft for 150 km/hr wind speed.

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