

WIND LOAD ANALYSIS FOR DIFFERENT CONFIGURATION OF STRUCTURES

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Abstract - The main intention of this project is to find the effect of wind while designing a multi-storey Building of G+6 floors in 3D frame by using Staad-pro software. This design uses Dead load and Live load by Staad-pro load generator and wind load and wind pressure was calculated by using IS 875; part 3. We have used Staad pro in this analysis because this software has incredibly interactive interface for user which permits user to design structural frame and to input the size of members as well as additional load values. The design procedure used in this software analysis are Indian standard code of practice associated with limit state design method. The least requirements for structural protection of buildings are being covered by way of putting down the minimum design loads which should have to be understood for imposed loads, dead loads and further external loads. Hence after design in post processing mode, we can perform analysis on structure and study about bending moment, shear force, axial loads, and deflections on different part of the structure. In this study we focused on deflection values on different nodes situated on different part of the structure like interior, edge and corner.

Key Words: Wind Pressure, Displacement, Multi-storey, Dynamic load, Structural design, Staad pro.

1. INTRODUCTION

Wind load acts as lateral weight on multistory. As per Indian standard Code 875 (part 3) 1987, the basic wind speed are specified in map as well as categorized in several zones. Wind pressure mainly depends on exposed area of multistory or buildings in opposite to wind direction.

Wind pressure or force is exerted homogeneously on all faces on the building. The higher the structure, the greater the force as wind influences lesser by friction with respect to the earth and nearby topography, therefore analyzing wind load is a greater contest for high-rises. Often for shorter houses situated in densely populated locations wind loads can even be ignored, while for high-rises wind load calculation is an absolute must.

1.1 High rise buildings

According to Indian National building code (2005), a building is called high if its height is more than 15 m.

Type of effects of wind load on structures:

Wind load impacts on structures may be categorized as :

- 1.1.1 **Static effect**- Static wind effect mainly induces elastic twisting and bending of the high rise multistoried buildings.
- 1.1.2 **Dynamic effect**- For tall, thin and long span structures dynamic analysis is essential. Wind gusts produce unsteady forces on the building which stimulates large dynamic movements, including oscillations.

1.2 Wind load and pressure calculations

IS: 875 (Part iii) of Indian standard and practice is used to check and design loads for structures, this standard code govern wind forces and their effects which ought to be thought into consideration while planning design of building and structures. The sustainability of any building or any other structure to high wind pressure depends on geographical location, air flow direction and obstruction as well as buildings characters itself.

Design Speed of wind (V_z): Basic speed of wind (V_b) for any area or location can be found and adjusted to take wind effects to determine designed velocity of wind at any elevation (V_z) for the selected buildings:

- a) Risk or Hazard level;
- b) Topography roughness, size and height of the structure
- c) Local topography.

These factors are expressed mathematically as follows:

$$\text{Basic speed of wind } V_z = V_b \times k_1 \times k_2 \times k_3$$

Where: V_z = designed speed of wind at any elevation z at chosen location;

K_1 = probability/Risk coefficient or factor

K_2 = topography, structure dimension factor and height factor

K_3 = topography (terrain) factor

In our case the basic wind speed (V_b) = 47 m/sec.

Design wind pressure: The design wind pressure for any elevation above mean ground level can be determined by the succeeding connection between wind pressures along with wind velocity;

$$P_z = 0.60V_z^2$$

Where

P_z : designed wind pressure at any given elevation z in N/m^2

V_z : designed wind velocity at any given elevation z in m/s

2. LITERATURE REVIEW

Anupam Rajmani et al. (2015) they performed seismic and wind analysis of G+14, G+29 and G+44 storey building having circular, square, rectangular and triangle shaped plan by using STAAD-Pro software. In case of G+29 storied building, rectangular shaped plan is most stable for maximum earthquake and wind load. In case of G+ 44 storied building circular shapes & rectangular shape is most stable for maximum earthquake and wind load respectively.

Akash S. Waghmode et al. (2016): They carried out the wind analysis of G+15 shear wall structure with J shape and rectangular shape using Etab software & IS 875:1987 (part-3). It was been found that displacement and drift in J shape is more so need to be analyzed to minimize the wind load & rectangular structure in wind prone zone is preferred.

Megha Kalra et al. (2016): This analysis was conducted to study about wind analysis of G+49 storied building having different uniform and non-uniform plan shapes by using STAAD Pro software & IS 875-Part III. The comparison has been done by taking into consideration different parameters such as storey drift, node displacement, intensity of shear & bending moment. It came to the conclusion that L-shape and U-shape was more efficient while dealing with the wind force.

Shaikh mufassir, L.G.Kalurkar, (2016): This study denotes the variation between RCC and composite structures under the effect of wind force. Their study indicates the difference of non uniform plan configuration and various parameters response such as displacement of storey, storey stiffness and time period under wind force effect.

3. BUILDING GEOMETRY AND STRUCTURAL PROPERTY

- Type of structure : multi-storey fixed jointed frame of G+6 storey
- Seismic zone IV IS 1893 (part 1):2002
- Supports ; Fixed end support

- Number of stories 7, (G+6) .
- Materials Concrete (M 30) and Reinforcement (Fe500).
- Size of column .5m×.5m
- Size of beam .3m×.45m
- Specific weight of RCC 25kn/m3.

For Structure Model 1 (Square plan) :

Length: 10 m Width: 10 m Height: 21 m

For Structure Model 2 (Rectangular plan) :

Length: 20 m Width: 15 m Height: 21 m

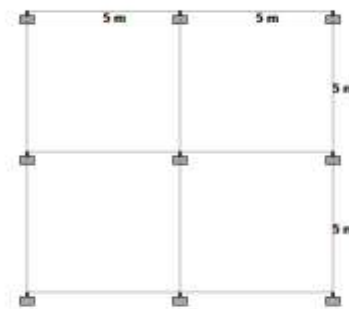


Fig -1: Plan of Model 1



Fig -2: Plan of Model 2

4. METHODOLOGY AND RESULTS

The structure located on Delhi town (Zone 4) was associated to self weight or dead load and intensities of wind loads were generated by taking into account the known wind intensities at diverse elevations and firmly follow by the specifications of IS 875: part iii (1987). After wind pressure manual input we can click on assign to view option on Staad pro to view effect of wind on multistory. Wind force has been applied in X, -X, Z and -Z directions for both structures.

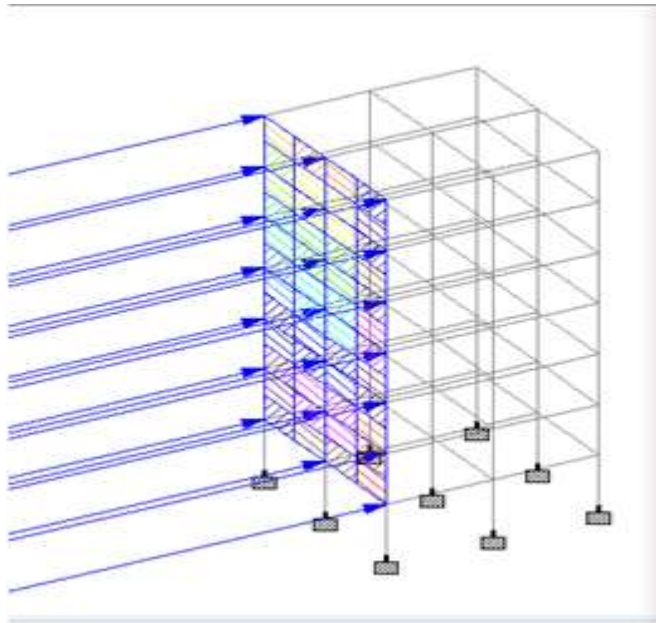


Fig -3: Wind load in X direction for structure 1

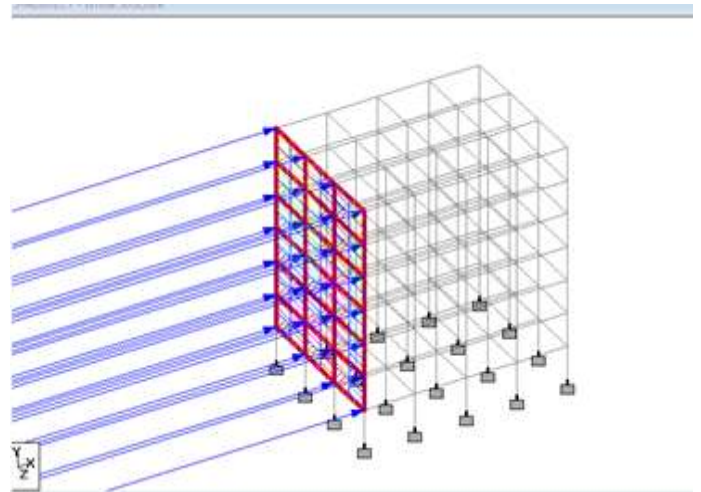


Fig -4: Wind load in X direction for structure 2

After analysing wind load in X and Z direction on both type of structure, value of maximum node displacement, shear force, bending moment of beam were Compared with respect to increasing height of multistorey. Maximum relative node displacement for structure 1 (square plan) and structure 2 (rectangular plan) is as following:

Floor	Level	Max Displacement @ Corner (mm)	Max Displacement @edge (mm)	Max Displacement @Center(mm)
7 th	21 m	11.194 mm	11.728 mm	11.713 mm
6 th	18 m	10.624 mm	11.206 mm	11.182 mm
5 th	15 m	9.602 mm	10.190 mm	10.167 mm
4 th	12 m	8.076 mm	8.625 mm	8.604 mm
3 rd	9 m	6.082 mm	6.549 mm	6.529 mm
2 nd	6 m	3.737 mm	4.066 mm	4.048 mm
1 st	3 m	1.365 mm	1.500 mm	1.495 mm

Table 1: Displacement values in mm at different levels for model 1

Floor	Max Displacement @Corner (mm)		Max Displacement @edge (mm)		Max Displacement @Center/inside (mm)	
	Z-Dir	X-Dir	Z-Dir	X-Dir	Z-Dir	X-Dir
7th	16.492	11.812	17.105	11.796	17.088	12.041
6th	15.475	11.119	16.147	11.095	16.125	11.374
5th	13.825	9.963	14.509	9.938	14.483	10.229
4th	11.445	8.275	12.085	8.253	12.061	8.530
3rd	8.408	6.105	8.946	6.085	8.924	6.323
2nd	4.961	3.624	5.329	3.628	5.311	3.775
1st	1.693	1.246	1.835	1.242	1.830	1.309

Table 2: Displacement values in mm at different levels for model 2

5. CONCLUSIONS

Wind analysis was accomplished out on the G+6 story RCC structural building with two different configuration square and rectangular structure and with the help of analysis it can be concluded that,

- 1) The displacement value was greatest at the top of the edge of the building as compared to corner or center of the building.
- 2) When wind load is applied along the length of the building frame displacement for rectangular frame is very high when compared to square shaped frames and maximum value of displacement was obtained at the edge of the structure.
- 3) When wind load is applied along length of the building the displacement value was increased with increased aspect ratio (length/width) of building.
- 4) As we can see in first case where aspect ratio is 1 the maximum displacement value was found to be 11.728 mm whereas in second case where aspect ratio is 1.33, maximum displacement value was found to 17.105 mm.
- 5) The value of maximum bending moment in top floor beams in z direction was more in case of square plan configuration as compared to rectangular plan configuration when wind load was applied in x direction.
- 6) In rectangular plan configuration the displacement value was 30 to 45% more in z direction as compared to x direction.

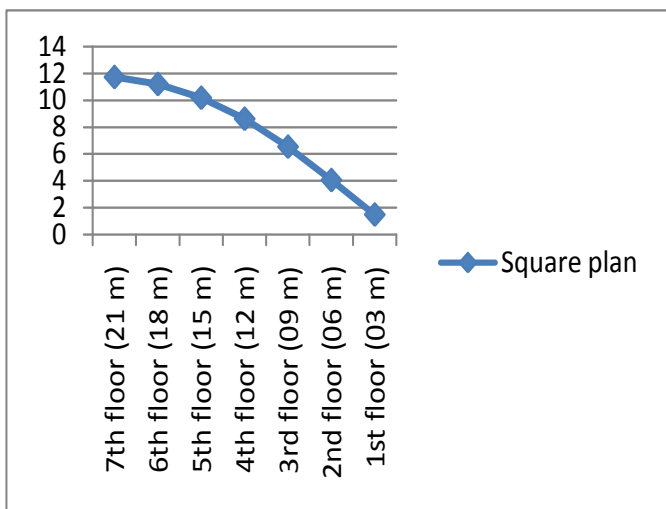


Fig 5; Max Storey Displacement in mm for square plan configuration

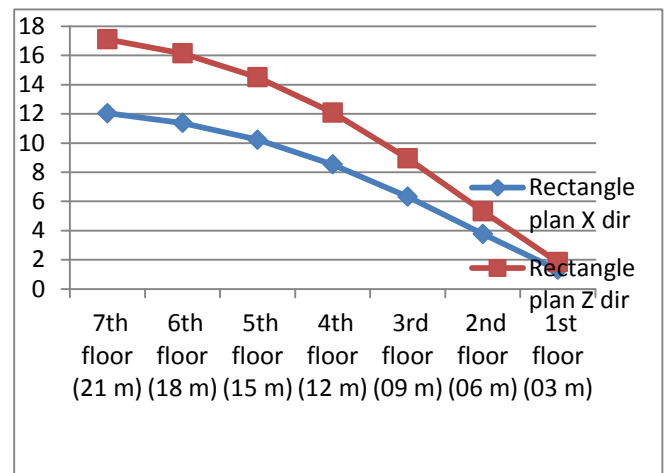


Fig 6 ;Max Storey Displacement in mm for Rectangular plan configuration

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