WIND SPEED ANALYSIS OF G+10 BUILDING USING STAAD-PRO

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ABSTACT

Wind is the motion of air. At earth surface it has very low velocity but as we move higher up the velocity increases as well as wind pressure also. So the Indian code of practice for wind load on buildings and structures, (IS-875 Part3-1987) gives a procedure to determine along wind response of tall structure. This paper deals with the G+10 multi-storied building (residential building) for average wind speed 7.5mph and basic wind speed 35kmph using Staad-pro. In this project we will consider Wind load along with dead and live load in designing the high rise building as the wind load exerts horizontal load on building. This load on the structure induces large dynamic motions, including oscillations. Results will be drawn for all critical load design and design for column, beam, slab, shear wall, foundation for the residential building. All the above results will be studied thoroughly to draw conclusion.

Keywords- Average wind speed, Basic wind speed, Dynamic motion including oscillation, Staad-pro.

INTRODUCTION

A building has to perform many functions satisfactorily. Amongst these functions are the utility of the building for the intended use and occupancy, structural safety, fire safety and compliance with hygienic, sanitation, ventilation and daylight standards. The design of the building is dependent upon the minimum requirements prescribed for each of the above functions. The minimum requirements pertaining to the structural safety of buildings are being covered in loading codes by way of laying down minimum design loads which have to be assumed for dead loads, imposed loads, wind loads and other external loads, the structure would be required to bear.

Wind is the motion of air. At earth surface it has very low velocity but as we move higher up the velocity increases as well as wind pressure also. Due to uneven heating of earth hot air rises up as on heating they expand and create a pressure difference due to which air move from high pressure to low pressure area causing wind to blow. Trade wind, polar wind, monsoon wind has its high intensity. Cyclone, tornado are the worst case of moving wind. These high velocity winds create vibration effect on the upper portion of high rise building whereas the lower portion is stationary which has to bear all the loads of structure. The wind pressures are assumed to act horizontally on the building area protected on a vertical plane normal to the wind direction. Unusual wind conditions often occur over rough terrain and around ocean promontories Basic wind speeds applicable to such regions should be selected with the aid of methodologists and the application of extreme-value statistical analysis to anemometer readings taken at or near the site of the proposed building. The design wind load can be obtained from the summation of this equivalent static wind load and the mean wind load. Introduction of the wind directionality factor requires the combination of wind loads in along-wind, across-wind and torsional directions. Hence, it is decided to adopt the regulation for the combination of wind loads in across-wind and along-wind directions, or in torsional and along-wind directions explicitly. Furthermore, a prediction formula for the response acceleration of the building for evaluating its habitability to vibration, which is needed in performance design, and information of 1-year-recurrence wind speed are newly added. Besides, information has been provided for the dispersion of wind load.

Ambikapur is situated at 23.1355 ^{0}N & 83.1818^{0}E in surguja district of Chhattisgarh state it is surrounded by mountain terrain from all sides. The Average wind speed is 7.5 mph and Basic wind speed is 35 Km/h according to Meteorological office, Ambikapur.

VARIATION OF WIND VELOCITY WITH HEIGHT

Near the earth's surface, the motion is opposed, and the wind speed is reduced, by the surface friction. At the surface, the wind speed reduces to zero and then begins to increase with height and at some height, known as the gradient height, the motion may be considered to be free of the earth's frictional influence and will attain its 'Gradient Velocity'.

LITERATURE REVIEW

(Juan et al., 2022) (1), This paper conducts a detailed evaluation of the impacts of the building arrangement and height for a 2 × 2 array with a building height-to-street width ratio of 30 on the mean wind velocity and the wind energy potential along the passages between both upstream and downstream buildings as well as on their roofs. The following parameters are analyzed: (i) the passage width between the two upstream buildings (w), (ii) the stream wise distance between the upstream and downstream buildings (d), and (iii) the height difference between the upstream and downstream buildings (ΔH). The 3D steady Reynolds-averaged Navier-Stokes (RANS) equations are solved using the Reynolds stress model (RSM) turbulence model for closure. The CFD results are validated using wind-tunnel measurements of mean wind speed and turbulence intensity performed for the same building array. The results show elevated wind power density along the upstream passages for small w (=0.15B), high d (=0.6B), and equal building height (ΔH = 0). High-fidelity CFD simulations are performed to investigate the effect of the building arrangement and height for a 2 × 2 array of high-rise buildings in close proximity. The following parameters are studied: (i) the passage width between the two upstream buildings (w), (ii) the streamwise distance between the upstream and the downstream build- ings (d), (iii) the height difference between the upstream and the downstream buildings (ΔH) and (iv) the type/orientation of the wind turbine for wind energy harvesting. The analysis focuses on the wind speed and the wind power density along the upstream and the down- stream building passages as well as on the building roofs.

(Pimpalkar & Padmawar, 2022) (2), The main objective of this project is to compare Indian Standard code i.e. IS-875 (part 3) 2015 and American standard code (ASCE-7) for basic wind speed and static loading on G+12 storey building using STAAD-Pro software. Analysis will be performed on building to identify the lateral force, intensity, storey drift, displacement, wind load, dead load, and combination of wind load and comparison of results which is obtained from software after assigning data. The main aim of this research is to understand provision of international standards (ASCE-7) and compare it with Indian standard. So it concluded that Node displacement in x-direction and z- direction is greater in case of Indian Standard as compare to ASCE Standard , Maximum story drift is higher for IS-875 code as compare to ASCE-7 code, Quantity of concrete required for construction in IS Standard is higher than ASCE Standard. Quantity of Concrete for IS=1369.4 m^3 Quantity of Concrete for ASCE=1198.3 m^3.

(Jeong et al., 2021) (3), Performance-based wind design (PBWD) allowing inelastic behavior under extreme wind load has only been recently considered for design of high-rise buildings. However, conducting wind tunnel tests for preliminary structural concepts may not be practical due to changes in design and cost. To address these concerns, the following topics were studied: initial design using an RW factor to introduce inelastic behavior; generation of time-history wind loads from power spectral density (PSD) functions for inelastic analysis including vertical distribution and maximum directional load occurrence, and a case study for wind resistance performance evaluation of a reinforced concrete building design using an RW factor of 1, 2, and 3. Preliminary PBWD of the case study RC building was carried out using time-history wind load generated from PSD functions. The resonant component was reduced by the RW factor to introduce inelastic behavior during the initial elastic design.

(Vita et al., 2020) (4), One of the main challenges of urban wind energy harvesting is the understanding of the flow characteristics where urban wind turbines are to be installed. In the present paper, flow pattern characteristics are investigated for a typical high-rise building in a variety of configurations and wind directions in wind tunnel tests. The aim is to improve the understanding of the wind energy resource in the built environment and give designers meaningful data on the positioning strategy of wind turbines to improve performance. In addition, the study provides suitable and realistic turbulence characteristics to be reproduced in physical or numerical simulations of urban wind turbines for several locations above the roof region of the building. The study showed that at a height of 10 m from the roof surface, the flow resembles atmospheric turbulence with an enhanced turbulence intensity above 10% combined with large length scales of about 200 m. Results also showed that high-rise buildings in clusters might provide a very suitable configuration for the installation of urban wind turbines, although there is a strong difference between the performance of a wind turbine installed at the centre of the roof and one installed on the leeward and windward corners or edges, depending on the wind direction. Hence in this study, the flow above the roof of a high-rise building is investigated under various wind directions to assess the wind energy resource at several locations.

(Mariyam & Jamle, 2019) (5), In high rise multistory building there is a big problem to resist the lateral forces which are acting over it such as wind forces so it is important to make the structure more stiff. In this paper, the approaches for finding the objectives which the researchers have already defined in their research, but no one have first designed the structure manually and then analyze the worst wind effects by software approach. Equivalent frame method is selected for the further analysis and data collection for software approach. After studying various research papers having different themes and reviewing the papers related to flat slab that it is designed for multistory buildings for eliminating the projection of beams, providing the shear wall to offer the stiffness to the building. The conclusion are : 1. There are two methods for finding out the design of flat slab manually.2. The panels are selected and divided as per different loading conditions.3. The analysis can be done on simple flat slab, flat slab with added drop to it.4. Worst wind condition should be defined as per wind zone selection or by city as per Indian Standards.5. The study should conduct by both manual approaches as well as by software approach.

OBJECTIVE

- The object of this project is to design G+10 residential building (with parking) considering wind load in Ambikapur, Surguja.
- In this project we will consider Wind load along with dead and live load in designing the high rise building because wind load exerts horizontal load on building. This load on the structure induces large dynamic motions, including oscillations.
- We will design column, beam, slab, shear wall, foundation for the residential building.

RESULTS

1. Bending Moment, Shear Force, Deflection in individual Beam and Column

<u>Beam</u>

Member No. - 53

- **Deflection :**
  - Due to Dead Load : -0.770 mm
  - Due to Live Load : -0.652 mm
  - Due to Combination of Dead, Live and Wind Load : -1.707 mm
- **Bending Moment :**
  - Due to Dead Load : 13.98 kNm
  - Due to Live Load : 11.86 kNm
  - Due to Combination of Dead, Live and Wind Load : 31.01 kNm
- **Shear Force :**

- Due to Dead Load : 18.22 kN
- Due to Live Load : 15.50 kN

Due to Combination of Dead, Live and Wind Load : 40.46 kN

Column

Member No. - 85

- **Deflection :**
  - Due to Dead Load : -0.990 mm
  - Due to Live Load : -0.455 mm
  - Due to Combination of Dead, Live and Wind Load : -1.734 mm
- **Bending Moment :**
  - Due to Dead Load : 0.06 kNm
  - Due to Live Load : 0.04 kNm
  - Due to Combination of Dead, Live and Wind Load : 2.75 kNm
- **Shear Force :**
  - Due to Dead Load : 0.05 kN
  - Due to Live Load : 0.02 kN
  - Due to Combination of Dead, Live and Wind Load : 1.47 Kn

2. Beam Detail

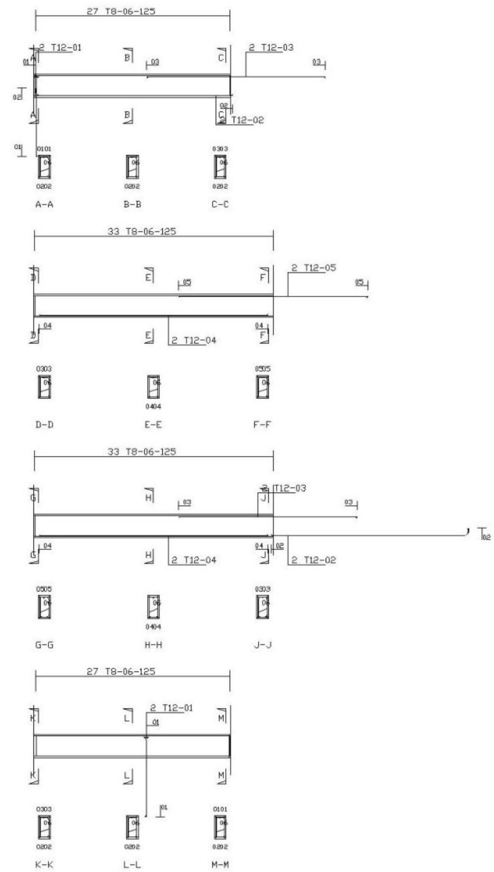
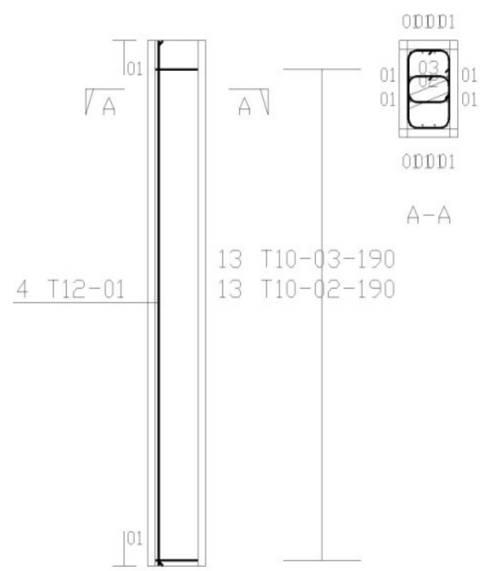


Fig. Beam Detail

3. Column Detail



4. Foundation

The following results were obtained:

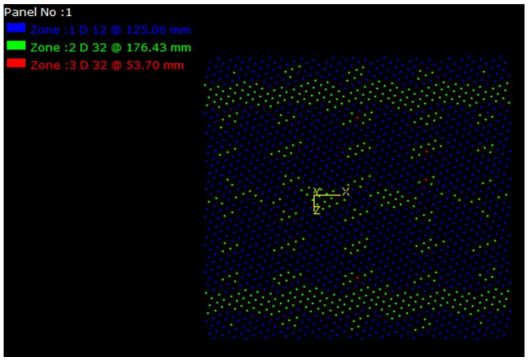


Fig. Longitudinal Top Zoning

Zone reinforcement detailing

Zone	Moment (kN-m/m)	Load Case	X (m)	Z (m)	Area Reqd. (mm2/m)	Area Prod. (mm2/m)	Bar Detail(mm)
1	258.370	201	5.297	3.000	900.000	904.779	12 @ 120 c/
2	1177.572	201	6.536	2.151	4567.767	4584.212	32 @ 170 c/
3	0.000	204	7.343	4.214	14876.784	14878.582	32 @ 50 c/c

Longitudinal Top – Reinforcement Detailing

Zone reinforcement detailing

Zone	Moment (kN-m/m)	Load Case	X (m)	Z (m)	Area Reqd. (mm2/m)	Area Prod. (mm2/m)	Bar Detail(mm
1	-260.954	201	1.718	14.613	900.763	904.779	12 @ 120 c
2	-3818.219	201	14.742	4.376	12778.024	12787.538	32 @ 60 c/c
3	-7535.677	201	7.337	19.266	24808.633	24881.412	40 @ 50 c/c

Longitudinal Bottom – Reinforcement Detailing

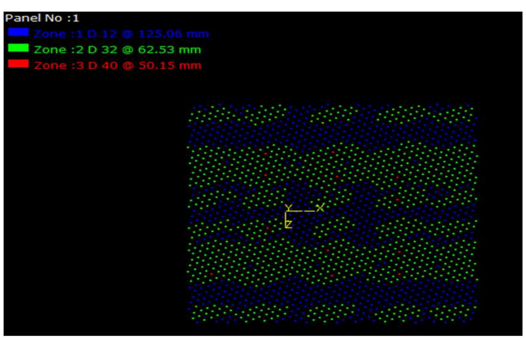


Fig. Longitudinal Bottom Zoning

Plate Stress in foundation

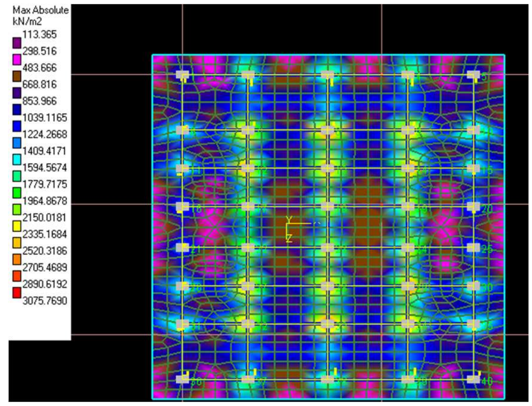


Fig. Max Absolute Stress

CONCLUSION

- The building is safe in all the aspect after designing. There will not be any effect of wind on the structure for such wind speed which is prevailing in Ambikapur.
- The building can be further analyzed and checked against earthquake (Seismic Design)

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