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Study and Behaviour of Wind - Structural Interaction at Terrain Category Ii using Ansys

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ABSTRACT: -
In this paper, the approach of wind-structure interaction for tension, compression members of structures with displacements and stresses are presented with different varying load conditions. The first component can be regarded as steady interaction process. The suitable method for static and steady reciprocal action of structure is CFD simulation, in which intensity of wind changes deformation of the structural is considered for a model having a 5m x 5m plan along with the structural members like columns, beams, and slabs having 5 floors with a height of 3m each floor is carried out finally.
KEYWORDS: wind-structure interaction, CFD simulation, compression and tension members.

INTRODUCTION: -

The long span structural members are mostly used as compression & tension members. As being characterized by self-weight, dead load, live load and wind loads, Structural members are highly responsive to the wind intensity. To determine the susceptible of the structure, deflections due to the wind intensity is a dominant problem for the reinforced concrete structures design. The wind pressure on structure is always having great complexity, this is due to many flow situations arising while interacting. When wind is interacting with structure, eddies of various sizes having rotational characteristics along the flow of air relative to the surface of the earth. These eddies have breezy nature, the breeziness of strong winds in the lower level of atmosphere can arise largely when interacts with surface. The average speed of wind over a period of 10 minutes or even more will increase with height and vice versa. The influence of turbulence on structure by dynamic load depends on the size of the eddies. if eddies are large, dimensions are comparable with the structure leads to envelop with the well correlation pressures. If eddies are small, results in pressure on various structural parts will become unpredictable. the goal is to differentiate the methods which are selected & assess the accuracy and efficiency of them. Figure shows eddies which are generated around the structure

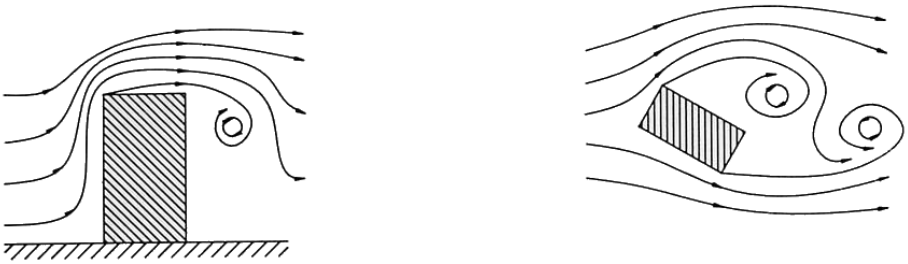


Fig 1

Slender members are likely to be unstable to wind, the problem correlates with wind induced of buildings is bothered with human response to reverberation, so that motion may be uncomfortable to the extent even if the members imposed to relatively lower stresses and strains on high raise buildings. Therefore, most of the tall buildings design govern by serviceability and stability considerations.

WIND INTENSITY: -

From surface of the earth at larger elevations, the frictional interactions are not considered, pressure gradients which are occurred by wind moments in atmosphere are due to consequences of variable solar heating of the earth. The higher altitude wind intensity is known as gradient wind velocity. These are categorized as different terrains according to the roughness length. the codes such as IS: 875 (Part 3) –2015.

Wind data

1	basic wind speed	Vb	55	m/s
2	Probability factor	k1	1.08	
4	Typography factor	k3	1	
5	Importance factor (cyclone)	k4	1.3	
6	Wind directionality factor	kd	0.9	m/s
7	Area averaging factor	ka	0.8	
8	Combination factor	kc	1	
9	Design wind speed at Z	Vz	77.22	m/s
	$V_z = V_b*k1*k2*k3*k4$			

height	Terrain and height multiplier(K2)	wind pressure(Pz)N/m^2	Pd (kN/m^2)	0.7*Pz (kN/m^2)	Pd max of 0.7Pz and P(kN/m^2)
3.45	1	3577.76	2.58	2.50	2.58
6.9	1	3067.35	2.21	2.15	2.21
10.35	1.05	3381.75	2.43	2.37	2.43
15	1.05	3381.75	2.43	2.37	2.43

Wind speed, design wind pressure, loads to the building are calculated using standard IS codes.

Design Considerations:

In terms of structural design, the lateral wind loads are need to be satisfied.

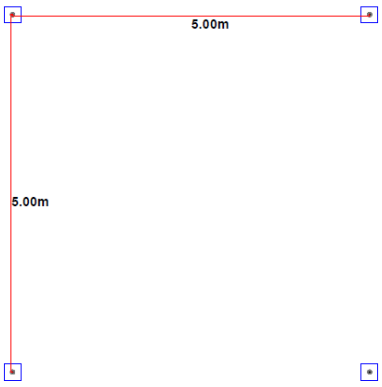
- **Stability** against overturning, uplift and/or sliding of the structure.
- **Strength** of the structural components of the building is required to be sufficient to withstand imposed loading without failure of structure during its life time.
- **Serviceability:** buildings where overall deflections are expected to remain within acceptable limits control of deflection and drift is imperative for tall buildings with the view to limiting damage and cracking of nonstructural members.

Project Methodology: -

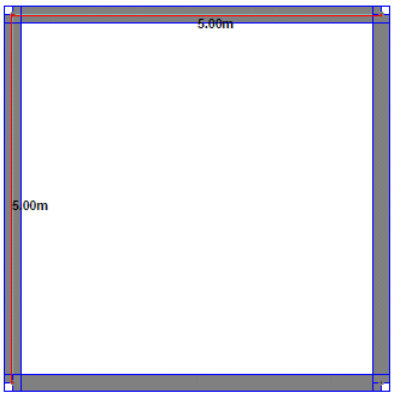
This project presents how the wind will interact with the structure, where the maximum stress will create, the behavior of the structure and how it will act if the wind is continuously flow on the earth surface.

In wind structural interaction, issue arises in multiple structural elements with an internal and external wind intensity. A study on such issues always challengeable, as they are in multidisciplinary and strong nonlinearity nature. Lot of problems in structural interaction seeks analytical solutions to obtain model equations. The laboratory test having limited scope for investigation which involves fundamental physics with complicated wind solid interaction. So CFD simulations are help full.

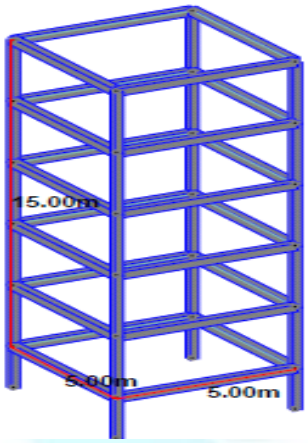
In and around Visakhapatnam city having a basic wind intensity of 55 m/s. so, by this wind intensity the framed structure is analyzed for the model building of dimension 5 m x 5 m with a height of 15 m.



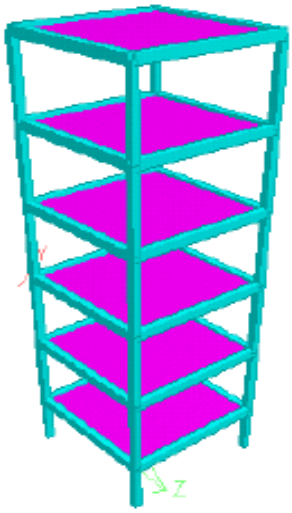
Plan of a building 5 x 5 m



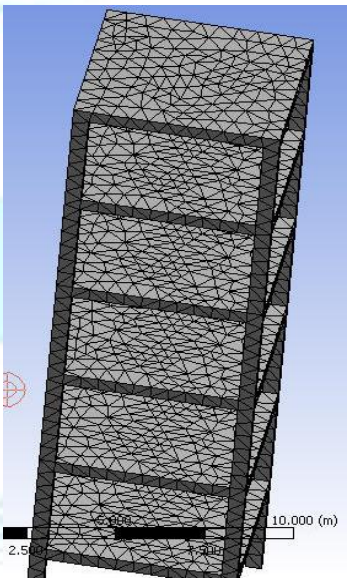
beams of building 5 x 5 m



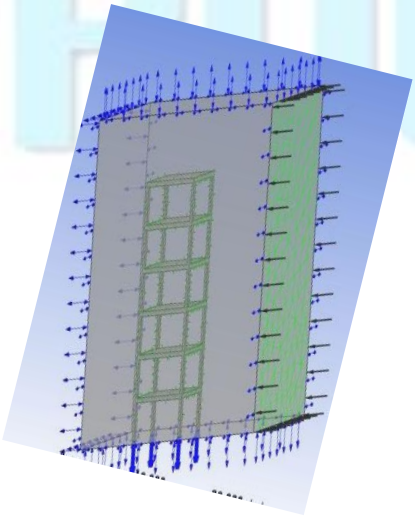
Structure members of building: Columns & beams



Structure members of building
Columns, beams& slabs



Structure members of buil ding
after messing



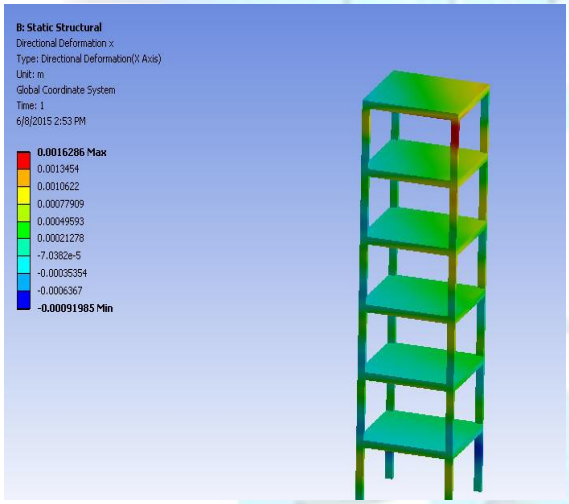
Structure members subjected to static wind load.

A model is generated using CATIA software and it is imported to ANSYS. The analysis is carried out using ANSYS software with CFD simulation. As per the IS 875 part 3 the wind load calculations for the structure is different, but in this case the structure is directly exposed to wind from bottom to top. After the analysis, maximum values of stress and displacements are resulted here.

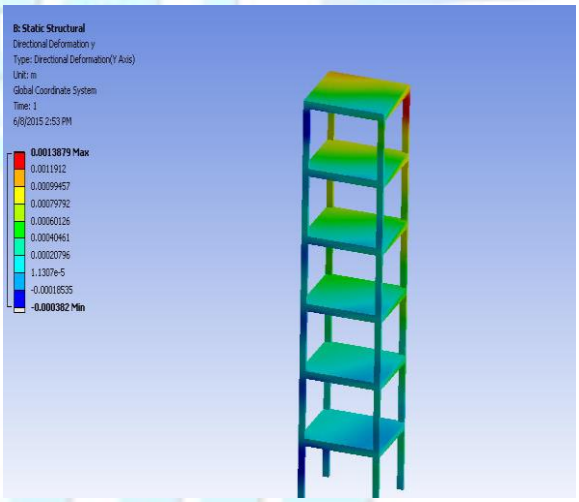
RESULTS AND DISCUSSIONS: -

In this project the behavior of the structural members under the action of external loads are taken into account, the deformations in structure resulting due to the internal forces created are studied.

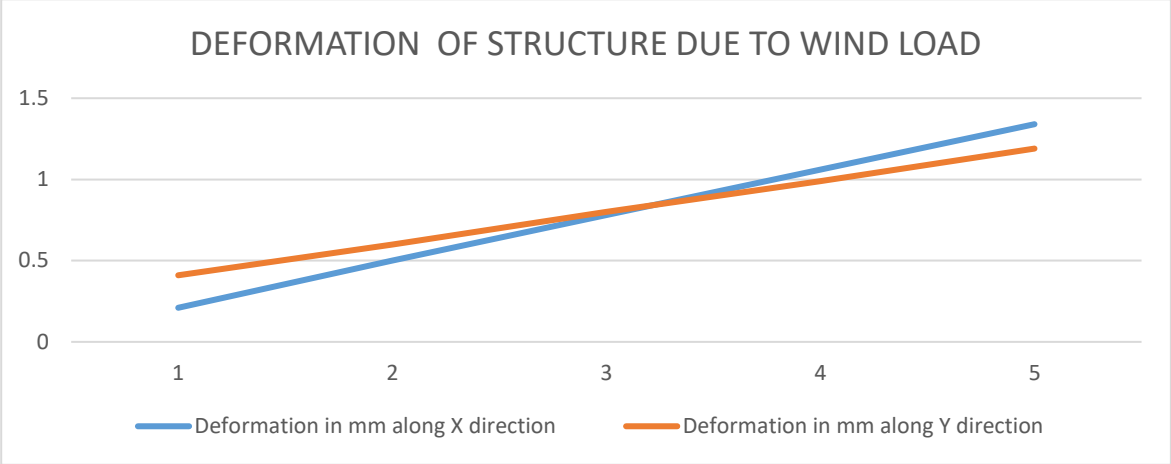
Aim of the analysis is to achieve an acceptable probability that will perform satisfactorily deformations during their life span. With an appropriate factor of safety, the structure should sustain all the loads and deformations of normal construction and have adequate durability. The modulus of elasticity is primarily influenced by the elastic properties. The modulus of elasticity is normally related to the compressive strength of concrete as well as steel materials. The results obtained after the analysis in ansys are



Deformation in x – Directions

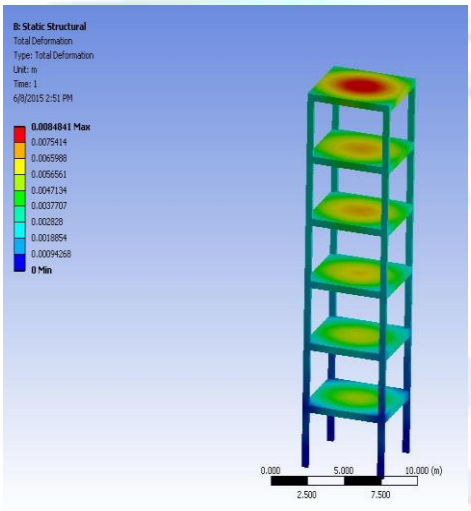


Deformation in y – Directions

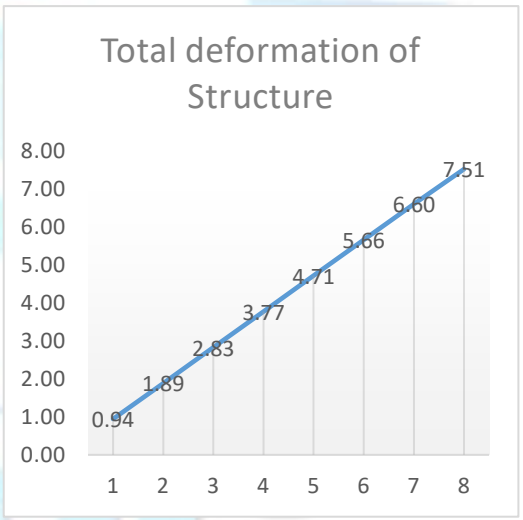


The above result is in the deformations with respect to the floor height Graph -1

It is clearly observed that from the above graph 1 that the structural deformation in x and y direction is very less subjected to wind load, so that the structural interaction i.e. the deflections of the structural members are very less, the structural members will be more Stable and serviceable.



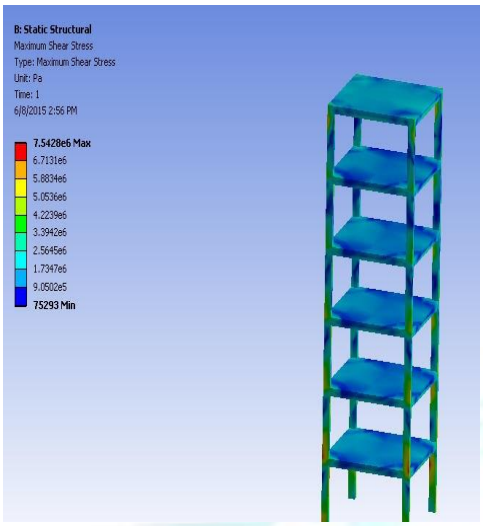
Total deformation of structure



Total deformation of structure in mm Graph -2

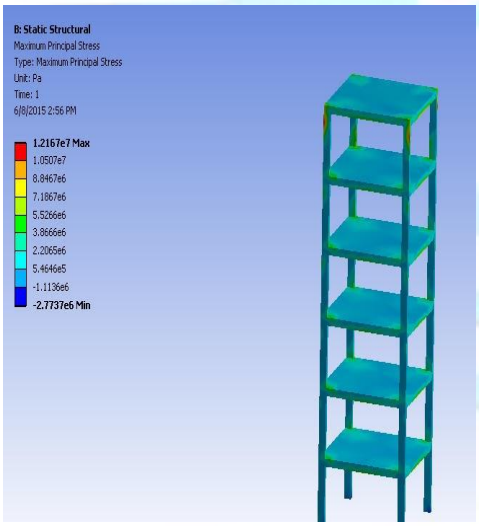
The total deformation of the structure is very less from above graph 2 subjected to wind load the interaction of the structural members is very less so the structure is stable and serviceable.

Shear Stress



Due to shear stress the structure material slide relative to each other and usually result in deformation, here the maximum shear stress in the structure subjected to wind load is 7.542 N/mm^2

Principal Stress



The material fails by fracturing when the members are large. The principal stress exceeds the ultimate strength, in this project the max principal stress in the structure subjected to wind load is 1.216 N/mm^2

Conclusions:

1. The structural deformation in x and y direction is very less subjected to wind load and structural members are Stable and serviceable for the taken design wind speed.
2. Maximum shear stress in the structure subjected to wind load is 7.542 N/mm^2. so it is safe with the above wind load as per clause B2, table no:21, IS456:2000 is 8.5 N/mm^2 .

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