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A STUDY OF WIND FORCE ON A HIGH RISE STRUCTURE

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ABSTRACT

In this research paper a study related to wind effect on a tall building is defined. Earlier in 19th century, there were no structures as tall buildings but with the technological advancement and rise in urbanization, there was a need for vertical expansion of cities. During that period, for design purpose, only static and live loads on buildings were to be considered but with increase in slenderness/height of buildings, transverse loads on structures i.e. wind loads and earthquake loads came into existence which are more important to find out. Wind loads, therefore, important to be studied. CFD is one of the best method to analysis such wind induced response studies. This research is mainly focus on wind induced pressures which would be arises due to wind intensity and how pressure varies according to different shapes of buildings. The intensity of a wind pressure depends on how fast it varies and also on the response and shape of structure.

Keywords: *High Rise, Structure, Wind force, Building, CFD, Indian Code, seismic, Elements.*

I. INTRODUCTION

There is no proper definition for tall building. It is difficult to tell about the characteristics of building which categorize it as tall. A structure cannot be defined as tall using the term of height or number of floors only. A tall building is an enclosed structure that has walls, floors, openings, a roof and usually windows whether it is residential or industrial. "A tall building" is a multi-storey structure in which most residential depend on elevators to reach their destinations. The most of tall buildings are known as high-rise buildings in most countries. There is no absolute definition of what define a tall building. From the structural design point of view, in simple form a building as tall when its structural analysis and design are in some way affected by the lateral forces i.e. wind or dynamic and particularly the sway caused by such lateral loads. As the height increases, the wind pressure begins to dominate. Therefore, structural framework for super-tall buildings is developed around concepts considered entirely with resistance to turbulent wind.

To find out the further developments of wind forces from 1930's to the present. First there have been some major impact in structural elements-mass, stiffness and damping. The densities of high rise buildings is increased from around 20 to 10 lb/ft^3 in case of buildings and from 200 to 100 lb/ft3 of roadway in case of long span bridges. With this a quite increment in material strengths (by factor of 1.15 and 1.5 in case of steel and concrete) has led to reduction in member sizes and a result of stiffness. To this, we can add the much advancement in analysis such as plastic analysis and the contribution of the digital world. At last, there have been a slightly reductions in damping factor due to merely use of welding, pre-stressing and the omission of heavy masonry elements. All of these things change the structural form which cause increase their susceptibility to wind effect and hence the need for better models and design for wind loading. The demand to build taller, larger and lighter buildings has highlighted the need for research in providing accurate estimation of wind load so that the building is significantly saving in the cost of façade and structure in comparison with the use of estimates from wind standards.

High rise structure are also define as building "more than 12 storey's" or in present article, or known as a high rise structure "if height more than 35 meter". The Technology of Steel and concrete composite construction is a more rapid technology which saves lot of time in construction which will help the designers to meet the demand and requirements with minimum time in real estate market. Composite construction also increases the life expectancy of the building.

Tall structures all around the world are becoming popular day by day. With the advance method of construction technology and digital computers, the basic result has been to construct safer and tall buildings keeping in mind the overall economics of the project. A high-rise structure, apartment tower, office tower, apartment block, or block of flats, is a tall structure used as a residential and either public or private or govt. or office use. In some countries they may be called as "Multi Dwelling Element" or "Vertical Town". They have the courage to increase the urban density, housing

higher number of families in lesser area. From these effect they act as a landmarks, create unique skyline and efficient land use.

II. LITERATURE REVIEW

Shraddha J. Patil, R. S. Talikoti: In this article the authors have studied the effect of wind force on high rise structures. Ground with Nineteen floors building was analyzed to study wind load. Elements such as axial force, bending moment and shear force in, stresses in beams, storey shear, storey drift, displacement of Structure etc were considered to study the exact behavior and governing Elements in wind force case.

A.J. Tidke, Prof. Gururaj B.Katti: In this article the authors have studied the performance of high rise reinforced concrete structure with the Comparison on the effect of seismic and wind loads. It presented mathematical study and relation between wind and seismic and its effects on building as all over with respect of moment and shear force. In this article he calculated and discussed many parameters like different floor weights, heights for both wind and seismic such as intensity of wind pressure, gust factor (G), earthquake zone coefficient (Z), the importance factor (I), Response reduction factor(R) and Average response acceleration coefficient (Sa/g) for the purpose of comparison by using IS 456:2000, IS 1893:2002 & IS 875:1987 (part3). The authors found that

1. It was calculated that base shear and base moment is more is in case of wind analysis for G+20, G+25, G+30, and G+35 building as compare to G+10 and G+15 building.
2. Here we noticed As the height of building increases Average Response Acceleration Coefficient gets decreases and Wind Effective Area gets increases. Because of this Wind load become more active as compared to Earthquake after 20th storey
3. Moments at base obtained from earthquake analysis For G+10 multi storey's building, was 1.632 times more than that obtained from wind analysis. Moment at base obtained from seismic analysis For G+15 multi storeys building, was 1.245 times more than that obtained from wind analysis.
4. However, the moments at base obtained from wind analysis was always greater than the corresponding moments obtained from seismic analysis

III. METHODOLOGY

There are different methods to study design wind force for buildings and other structures some of them are given below. We can use any of them to find out wind force on a high rise building:

1) Method 1– To find out wind load by Analytical procedure of Davenport 'Gust Factor Approach' for high-rise regular shaped buildings.
2) Method 2 – To find out Wind force study by International code, with references ASCE/SEI 7-05.
3) Method 3 – To find out wind force using generic formula.
4) Method 4 – To find out wind force using the electronic industries association formula.
5) Method 5 – To find out wind force using uniform building code (UBC) 97" formula.

IV. IMPORTANCE OF WIND LOADS ON THE TALL BUILDING

1. VARIOUS FACTORS

Buildings are defined as structures use by the people as shelter for living, working or storage. As now a days there is shortage of land for building more buildings at faster growth in both residential and industrial areas the vertical construction is given due importance because of which Tall structure are being built on a large scale. Wind in general has two main effects on the Tall structure:-

- It creates force and moments on the structure and its cladding

- It circulate the air all over sides of building mainly termed as Wind Pressure

Sometimes because of strong wind storms and without any warning nature of wind it takes so major problem form during some Wind Storms that it can upset the internal ventilation system when come into the building. For these reasons the study wind is becoming an important part with the planning and designing of a building and its environment.

Wind forces are examined in various forms of a building:-

i. Tall Buildings
ii. Low Buildings
iii. Equal-Sided Block Buildings
iv. Roofs and Cladding

Almost no research's are made in the first two forms as the structure failures are rare, even the roofing and the cladding designs are not carefully designed, and localized wind pressures and suctions are receiving more attention. But as Tall structure are flexible and are susceptible to vibrate at high wind speeds in all the three directions(x, y, and z) and even the Indian standards codes does not satisfying the expected maximum wind speed for the life of the building and does not take out the high local suctions which cause the first effect. From all these facts the Wind Load calculation for Tall structure are very important.

2. HIGH RISE STRUCTURES IN INDIA

Indian cities are setting an example for a demographic change due to people are moving to towns from villages which resulting urbanization, demand of houses, increase in price of land. The people from all over India migrate to the cities for better jobs and education, Industries, trade and commerce activities and number of educational sources. This is the reason of expansion of cities in all directions and all form of development. With an urban expansion of kilometers, But with this expansion some problems are also arise like of congestion, pollution, everyday commuting to work place, competition, deforestation etc.

The development is in different forms like High Rise with High Density also it can be like High Rise with Low Density also it may be Low Rise with High Density, or it can be Low Rise with Low Density.

In India, a building more than 74feet (21.5 m), generally 8 to 12 storey's, is considered as high-rise building. Also a structure is considered to be high-rise when it extends greater than the maximum reach available to fire fighters. According to the building code of India, a tall structure is one with four floors or more or a high-rise building is one 20 meters or more in height. Most of the tall structures in India are in the commercial capital Mumbai. More than 2000 high-rise structure are already constructed. With this more than thousand mid-rises exist already in the city. Mumbai is undergoing a massive construction boom, with thousands of tall structure and about fifteen high-rise building are under construction. Delhi and NCR regions are witnessing huge construction activities with 1600 already constructed high-rises structure.

V. CONCLUSIONS

The aim of this article was to understand wind load on a high rise structure and behavior of high rise building under wind load effect for different floor heights & having different floor systems like Flat slabs, Grid slabs & conventional solid slab-beam systems. In this article, number of elements observed such as change in reinforcement in column, change in behavior of beam, storey drift, storey shear, displacement of the structure, torsion due to wind load, Diaphragm displacement due to wind load etc. column reinforcement is increasing after applying wind load but axial load is remain unchanged or reducing in wind face area. Different load conditions are applied to the building structure by referring IS 875-1987(part III) and IS 875-1987 (Part V). Outside columns and beams are governing mostly in wind load case. Column reinforcement is greater due to high bending moment as compare to static case of structure. Stresses in framed beam are increases after applying the wind force. Wind force creates the coupling moment which increase the stresses in beam. It was found that isolated

topographic effects can increase wind design load on buildings constructed on hills and escarpments from 22% to more than 100%. To make structure stiffer in wind case, framed beam and column shall have enough stiffness. Shear force on longitudinal member i.e. column is increased due to lateral load of wind. It is increasing gradually toward base of the structure. The wind effects are more when the height of the building increases. To design a building for wind, this storey shear should consider. Lateral force is greater for more height of the building. This develops the torsion and displaced in the diaphragm of the structure. Displacement of the diaphragm creates the eccentricity between center of gravity of force and center of gravity of mass. A structure should be designed in such a way that it withstand for the critical conditions of wind forces. As the wind velocity increases moments also increase according to the condition. In high rise structure, displacement of the diaphragm is more due to high wind load. It creates the additional stresses in structural elements like beam and column. Displacement increases, as the wind velocity increases for various types of opening. Base shear and base moment is less in medium rise structures compare to high rise structures.

VI. FUTURE SCOPE

The present study tells about only wind analysis not about seismic for ordinary wind force. It can be extended to seismic analysis and for vortex shedding effect and other parameter of the wind as all are governing for high rise building. Study on shape of the structure can be found out by using result of this study to minimize the stresses which arise due to wind force.

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