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Effect of Wind Load on High Rise Structure

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***Abstract*— The global urban population is expected to grow approximately 1.84% per year between 2015 and 2020. So to accommodate this large number of world's population in the urban area there is not enough space available on the horizontal ground. So the Analysis and design of high-rise buildings for lateral load such as wind load and earthquake are the major issues which are playing significant role in recent decades in the designing of new high rise buildings. In this research we study about how wind load analysis plays an important role in designing and analysis of this high rise buildings. Analysis carried out on G+19 structure to study its behaviour in wind load. All dynamic parameter such as storey shear, storey drift, torsion in column, change in reinforcement of column, displacement of mass C.G., change in bending moment, shear force and axial force in column and change in stresses of beam are analyzed and summaries its governing condition**

***Index Terms*— Necessity of high rise structure, Wind effect on high rise, Governing parameter during wind Load.**

I. INTRODUCTION

According to report "In all human history we have reached 3.5 billion of urban settlers and in the next 30 years we are going to have 3 billion more". So, to accommodate this large number of world's population in the urban area there is not enough space available on the horizontal ground. To accommodate all this population only space available is in vertical space. Therefore it is mandatory to study analysis of high rise building. Two load case are governing on high rise structure other than static load case. Earthquake load case and wind load case.

Here we have concentrated on wind load case. It drastically changes the behaviour of high rise structure.

G+19 building is analyzed to study wind effect. Parameter such as Axial force, bending moment and shear force in column, Stresses in beam, Storey shear, Storey drift , Displacement of building, Displacement of diaphragm are considered to study exact behaviour and governing parameter in wind load case.

II. ANALYSIS OF G+19 STOREY BUILDING

A computational study was carried out using the Etab9.7.1 software. The model was used to study the global failure of the building structure.

Basic data of model

a) Type of structure : R.C.C. framed structure.(Residential building)
b) Storey of the building : G+19.
c) Grade of concrete used for column : M 40
d) Grade of concrete used for beam and slab : M 30
e) Grade of steel : Fe 500
f) Location of building : Nashik
g) Floor to floor height: 3.2 m at ground floor & 2.9 m at above all floors.
h) Earthquake zone : III
i) Earth quake zone factor : 0.16 (IS 1893)
j) Importance factor : 1
k) Basic wind speed : 39 m/sec (IS 875 part III)
l) Response reduction factor : 5
m) Thickness of external brick work : 150 mm

Thickness of internal brick work : 100 mm

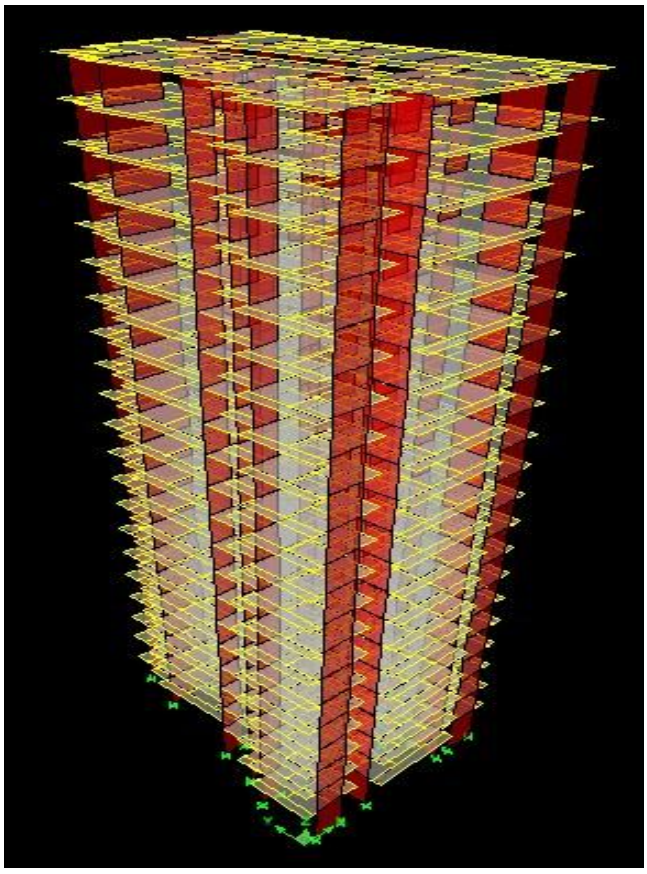

Fig 1. Model of building

Model was made by using M-30 grade concrete to beam and slab and M-40 to column. Floor load are taken by referring IS 875 (part I & II). Wind load combination are applied to building as per IS 456-2000 and IS 875-1987 (Part V)

It is a practical building located in chansi area of Nashik and it is developing by suyojit group, Nashik. Right now it is tallest buiding of the nasik which is under construction.

Wind load parameter are referred from IS 875-1987(Part III). Surrounding area of the building is open in present condition there for it designed for severe case of wind load.

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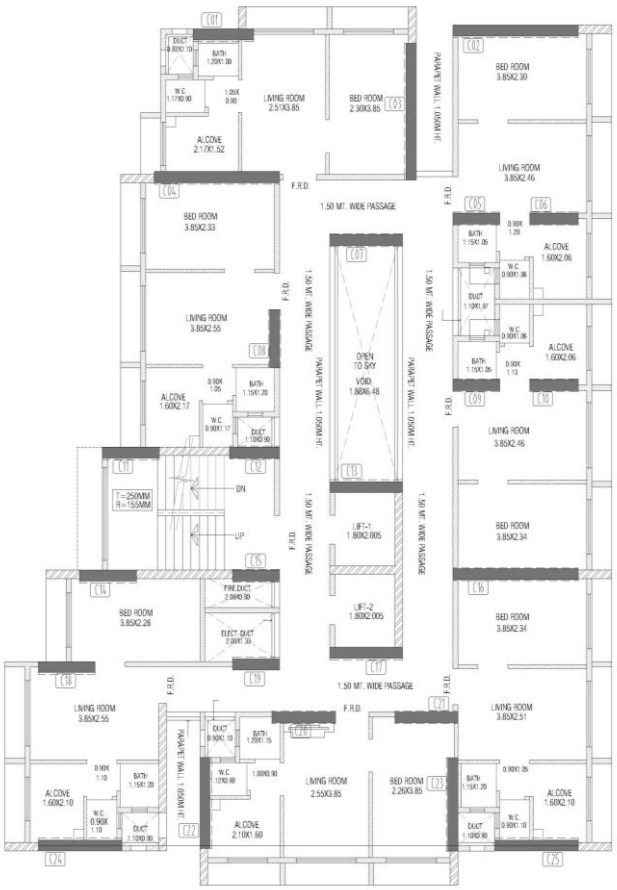

Fig 1. Plan of building

Fig.4 Governing beams in wind load case

Analysis carried out in both static and wind load condition.

III. STUDY THE RESULT OF ANALYSIS OF G+19 BUILDING LOCATED IN NASHIK

Reinforcement percentage is increased after applying wind load. Wind load develop the lateral stresses on the column which lead to bending of the column. Axial force, bending moment and shear force are observed after applying the wind load and it is conclude that axial force is less governing in wind load case. It is reducing as we go on upper storey. But bending moment is increased drastically. To resist this bending moment, percentage of steel in column has increased by 0.62 % averagely in each column.

There for column sizes should get increase for high rise structure to accommodate increased reinforcement. As per IS 456-2000, Maximum percentage of reinforcement is 4% but practically it creates the congestion and in result poor concreting come in face. There for maximum percentage of the steel shall be 3 % to accommodate reinforcement properly and to have rich and high strength concreting.

Wind load increase the stresses in column as well as in beam. Because cross wind load try to push the building which develops the stresses on framed member.

Cross wind load create the coupling moment in inner frame of the structure. It shall have more depth and more reinforcement to resist coupling moment of the frame. In figure highlighted beams are the framed beam which highly govern due to wind load.

Percentage of getting increase in framed beam as we go on upper floor of the structure. To make frame stiffer for wind load, framed beam and all column have sufficient stiffness to resist additional stress due to wind load.

As we have make frame stiff for lateral stresses, storey drift is minor and within permissible limit. Storey drift of this practical structure is 8.197mm in X direction and 6.781 mm in Y direction. Where permissible limit of storey drift is 0.004 times floor height i.e. 116 mm.

Wind in 90^o and 270^o creates the torsion effect on building. From the analysis it is found that columns which are in between internal and outer face of the building carrying more torsion than other columns.

Diaphragm of the structure is not important parameter of the building to check stability of the building. If Center of gravity of the mass of the structure and Center of gravity of the load of the structure have more distance than structure goes under high eccentricity which create the torsion during the lateral load and it may become primary reason of failure of the structural stability. In this structure maximum diaphragm displacement is 135.7 mm in 1.5 (DL + WL Y) load case.

From analysis it is observe that wind on X direction produce more diaphragm displacement than wind in Y direction. Because wind faces area on X direction is more than Y direction.

Maximum storey deflection in X direction is produce in load case (0.9DL+1.5WLY). It could happen because of less dead load.

Maximum storey deflection in Y direction is produce in load case (1.5 (DL+WLY)). It is very less than displacement produce in X direction.

It can conclude that structure should have more stiffness in X direction to minimize the mass displacement and make structure more stable.

IV. Conclusion

The primary objective of this study was to understand behaviour of the building structure in wind load case. All load cases applied to the building structure by referring IS 875-1987(part III) and IS 875-1987 (Part V). In this research, number of parameters observed such as change in reinforcement in column, change in behaviour of beam, storey drift, storey shear, displacement of the structure, torsion due to wind force, Diaphragm displacement due to wind force etc. column reinforcement is increasing after applying wind load but axial load is remain intact or reducing in wind face area. Outer side columns and beams are governing mostly in wind load case. Column reinforcement is exceeding due to high bending moment as compare to static case of building.

Stresses in framed beam is increases after applying the wind load. Wind pressure creates the coupling moment which increase the stresses in beam. To make structure more stiff in wind case, framed beam and column shall have enough stiffness.

Shear force on longitudinal member i.e. column is increased due to lateral force of wind. It is increasing gradually toward base of the structure. To design a building for wind, this storey shear should consider.

Lateral force of wind is high as higher storey of the building. This develops the torsion and displaced in the diaphragm of the building. Displacement of the diaphragm creates the eccentricity between center of gravity of load and center of gravity of mass. In high rise structure, displacement of the diaphragm is more due to high wind pressure. It creates the additional stresses in structural member.

V. Future scope

This research conducted only for ordinary wind load. It can be extend for vortex shedding effect and other parameter of the wind as all are governing for high rise structure.

Study on shape of the structure can be carry out by using result of this research to minimize the stresses which developed due to wind force.

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