WIND ANALYSIS OF A MULTI STORIED STRUCTURE

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Abstract: Due to growing population and less availability of land, multistoried buildings are constructed which can serve many people in less area. Purpose of this project is to analysis and designs (G+13) multistory building using E-TABS. Aims are to give proper awareness regarding right design and details of the building. Planning is done using AutoCAD, Designs has involves Load calculations, manually and the Structure is analysis using E-TABS. Codes refer for these projects are NBC IS (456-2000). Concrete mix use is M30. The steel strength for all members is of grade Fe-415 & Fe500. For analyzing the structure, the loads are very important which are calculated using IS (875). The LIMIT STATE METHOD is the method which has been adopted. The manual design is a difficult process and consumes more time. The project purpose is to give the overall experience in the field of planning, design and to gain the knowledge in a practical way.

Keywords: - Multistoried, Planning, Analysis, Design, E-TABS, Residential buildings, Wind analysis, High rise Building, Design load.

1. INTRODUCTION:

For living purpose human civilization needs structure. The building should be built in an efficient manner so that it can serve people and save money. In simple words, a building means an empty space surrounded by the walls and roof, in order to give shelter for human being. In ancient period humans use caves to project themself from rain, wild animal, and thunderstorm. Thereafter, humans developed and built their homes using timbers i.e. wood material. Nowadays the recent houses are developed into individual and multistory building. Buildings are necessary indicator of social progress of the country. Economically to fulfill the needs of the people. The buildings are built too fast. A r.c.c composite frame is a 3D structure which consists of column, beams and slabs. The growth in population is directly affecting the high rise buildings demand. Buildings are a part of the definition of Human civilizations. A building should be constructed as per human requirement and not for earning money.

For plan of construction as protected it is imperative to know about different kinds of burdens and its impact on structure. In this manner it is fundamental to know about their most exceedingly worse blend to which it very well might be oppressed during its life expectancy. And furthermore to know about sidelong loads, for example, seismic tremor and wind load. The impact of sidelong burden is vital to consider for skyscraper composite design. Sometimes the impact of wind is found more noteworthy than tremor impact. It relies upon the zone factor characterized by codes. Loads due to wind acts on multi story structure can cause shaking the upper stories from 10m above height. Along these lines the multi-story assembling additionally
goes about as an entry outline the second amassing at base because of parallel breeze powers are more noteworthy. Accordingly it is critical to invalidate removal horizontal way by fitting plan. The importance of shape factor is playing a significant role in wind examination. Contemplating of wind impact the multi-story building like Bhurj khalifa have given significance of shape. Additionally plan abnormality of composite construction has talked about in the contextual investigation.

2. RCC FRAME STRUCTURES

A RCC circled structure is a social gathering of areas, bars, fragments, and foundations are interconnected to one another to form a unit. The pile moves in a particular manner to the construction, occurs from the lumps to the columns, from the beams and a while later to the lower sections (slabs), finally to the foundation (from it passes to earth core). The floor area of a R.C.C restricted construction building is 10 to 12 percent more than that of a pile bearing walled developing. Strong advancement is possible with R.C.C enclosed constructions and they can go against vibrations, wind loads, shudder and dazes more effectively than load-bearing walled structures. The speed of advancement for RCC surrounded constructions is progressively quick as compared to load bearing structure.

![Figure 1: Wind Response Directions](image-url)
3. METHODOLOGY

A Model of G+13 celebrated is created, investigation and configuration utilizing E-TABS programming. Building plan size is 38 m × 29 m. The structure is arranged in Nagpur. Following determinations are given to the construction Code based system for wind investigation: The fundamental breeze speed for any site will be acquired from Fig 3.1 and will be adjusted to incorporate the accompanying impacts to get configuration wind speed, Vz at any tallness, Z for the picked structure:

(a) Risk level
(b) Terrain unpleasantness and stature of design
(c) Local geography
(d) Importance factor for the cyclonic zone

It very well may be numerically communicated as follows:

\[ V_z = V_b K_1 \times K_2 \times K_3 \times K_4 \]

Whereas,

- \( V_z \) = Design wind speed at any height z in m/s
- \( K_1 \) = Probability factor (risk coefficient)
- \( K_2 \) = Terrain roughness and height factor,
- \( K_3 \) = Topography factor,
- \( K_4 \) = Importance factor for the cyclonic region.

**NOTE:** The wind speed may be taken as constant up to a height of 10 m (for all the structure). Wind pressure is acting on 10m above Structure.

4. MODELS

Figure 2: Plan From Base to 6 Story

Figure 3: Plan From 6 to 13 Storeys
5. MODELLING & ANALYSIS:

A RCC outlined construction is essentially a get together of chunks, pillars, segments and establishment connected to one another to form a unit. The heap move instrument in these constructions is from pieces to radiates, from bars to sections, and afterward eventually from segments to the establishment, which thusly passes the heap to the dirt. In this primary examination study, we have embraced the case by expecting to be the wind speed 44m/s as the design is built in Nagpur, as clarified underneath.
5.1 Design characteristic

The following design characteristic are considered for multi-story structure,

1] Basic wind speed (Vb) in (Nagpur) = 44 m/s

2] Design wind speed (Vz) = Vb.K1.K2.K3 (Formula)

   Whereas, this symbols indicates as follows:
   Vz = Design wind speed at any height of structure
   K1= Probability Factor
   K2= Structure,Height,Terrain
   K3= Topography of surface
   K4= Importance factor for the cyclone region

3] Design wind pressure pz = 0.6 x Vz^2
   Pz = Wind pressure in N/m^2
   Vz = Design wind pressure in m/s

4] Forces acting on the building.
   Wind loads on each member
   F = (cpe – cpi) A.Pd
   cpe = External pressure coefficient
   cpi = Internal pressure coefficient
   A = Surface area
   pd = Design wind pressure

5] Force acting on whole Structure
   F= cf . Ae . Pz
   cf = Force coefficient
   Ae= Frontal Area
   Pz= Design wind pressure
6. PLAN DETAILS

A Model of G+13 celebrated is created, examination and configuration utilizing E-TABS programming, plan size is 38 m × 29 m. The structure is situated in Nagpur. Following particulars are given to the design Code based methodology for wind investigation. The product utilized for examination of the casing models is ETABS 2018.

6.1 Parameters Considered for Analysis in Model

1) Type of building = Office or commercial
2) No. of storeys = G + 13
3) Area of 38 m x 29 m.
4) Storey height = 3 m.
5) Base storey height = 3.5 m.
6) Height of building = 42.5 m
7) No. Of storeys = 13
8) Thickness of slab = 150 mm
9) Grade of concrete = M 25 & M30
10) Grade of steel = Fe500
11) Size of beam = 300 X 500
12) Size of column= 450 X 500
13) Live load = 3.5 KN/m2
14) Dead load (wall load) = 13.25 KN/m
15) Floor finish (dead load) = 1 KN/m2

Supports: The buildings supports are assign as fixed.

Wind Load: - Taking Category 3 class B wind speed 44m/s (Nagpur)

7. RESULT AND DISCUSSION

7.1 Graphs

a) Storey Displacement( full Model)

A R.C.C structure are plan and modeled using finite element based software ETABS 2018. For analysis of building, IS CODES for design loads IS 875(Part 3):1987 is used for computing basic wind speed (Vb), Internal pressure coefficient (Cpi), External pressure coefficient (Cpe) and Terrain category, height of structure and structure size factor (k2) etc. The planning and analysis of the building are done without providing shear wall. the storey displacement for various load combinations considered above. Figure 6a & 6b shows the displacement of the structure according to the considered load combination. As seen in the given graphs the displacement of the structure for 1.2(DL+LL+WX+) and 1.2(DL+LL-WX+) are almost the same. Similarly, for wind in negative Y-
direction the displacement is almost same for both 1.2(DL+LL+WY-) and 1.2(DL+LL–WY-) [4].

I. Lateral Displacement
The lateral displacements for first and thirteen storey building obtained from equivalent static method. Graph of Lateral displacement Vs Storey No. for model with aspect ratio 1.0 along X-direction.

![Graph of Lateral displacement Vs Storey No. for model with aspect ratio 1.0 along X-direction.](image)

**Figure 6a:** Storey Displacement in X-Direction (full Model)

![Graph of Lateral displacement Vs Storey No. for model with aspect ratio 1.0 along Y-direction.](image)

**Figure 6b:** Storey Displacement in Y-Direction (full model)

The above graph of displacement shows the displacement of (G+13) for plan configuration. The above graph Figure says that the displacement is varies with increases in numbers of stories. (In Full Model)
The planning & analysis of the structure has been done initially without providing shear wall. Figure
6a & 6b shows the displacement of the structure according to the considered load combination. As seen in the given graphs the displacement of the structure for 1.2(DL+LL+WX+) and 1.2(DL+LL-WX+) are almost the same. Similarly, for wind in negative Y-direction the displacement is almost same for both 1.2(DL+LL+WY-) and 1.2(DL+LL-WY)

b) Storey displacement (wind x & windy)

![Figure 7a: Storey Displacement in X-Direction (wind x)](image)

![Figure 7b: Storey Displacement in Y-Direction (wind y)](image)

The above graph of displacement shows the displacement of (G+13) for plan configuration. The above Figures suggest that the displacement is varies with increases in numbers of stories. ( In Wind X &
Wind Y)

c) Maximum storey drift (wind x & wind y)

![Storey drift](image)

**Figure 8a:** Maximum Storey Drift in X-Direction (wind X)

![Storey drift](image)

**Figure 8b:** Maximum Storey Drift in Y-Direction (wind y)

d) Lateral loads to stories

Variation in various parameters such as maximum displacement, storey drift, axial force, shear force, bending moment is worked out after performing analysis, from the above graph its has been observed
that maximum displacement, axial force, bending moment and torsional moment increases per unit length increases with increase in number of storey whereas fluctuation is observer in case of shear force.

**Fig 9a:** Auto Lateral lodes to the stories in X direction (wind x)

**Fig 9b:** Auto Lateral lodes to the stories in Y direction (windy)
## Table 1: The values are tabulated as follows

| Height in meters | K2  | Vz= Vb K1 K2 K3 | Pd=0.6 Vz 2 N/m | Pi = Cf x Pd KN/m2 |
|------------------|-----|-----------------|-----------------|-------------------|
| 10               | 0.98| 52.92           | 1680.32         | X Direction       |
| 15               | 1.02| 55.08           | 1820.32         | 2.08              |
| 20               | 1.05| 56.07           | 1928.98         | 2.26              |
| 25               | 1.10| 59.4            | 2117.02         | 2.39              |
| 30               | 1.20| 62.8            | 2298.01         | 2.63              |
| 35               | 1.35| 65.2            | 2350.05         | 2.81              |
| 40               | 1.40| 69.1            | 2498.01         | 3.01              |

## Table 2: The values are tabulated as follows

| Design wind pressure | Height (m) |
|----------------------|------------|
| 0.6 KN/m²            | 10         |
| 0.7 KN/m²            | 15         |
| 0.8 KN/m²            | 20         |
| 0.91 KN/m²           | 30         |
| 1.21 KN/m²           | 40         |
| 1.47 KN/m²           | 50         |

## 8. CONCLUSION

1. RC shear divider goes about as better horizontal burden opposing component when contrasted with the RC twofold corner to corner propping.
2. The presence of RC shear divider impacts the general conduct of constructions when exposed to sidelong powers. Subsequently RC shear divider can be considered as removal and float control primary component.
3. The idea of utilizing RC shear divider is one of the invaluable ideas which can be utilized to fortify structure.
4. Since the parallel removal is much less for five and thirteen story structures. Consequently the plan of structures of low to medium stature the breeze impacts must disregarded which is generally drilled.
5. The sidelong relocations are found inside the breaking point as indicated by code (IS 456-2000) in both static what’s more, powerful examination.
6. Maximum story floats found inside the cutoff as determined by code (IS 1893-2002 section 1) in both static also, dynamic examination.
7. RCC structure is liked for firmness and solidness in tall building structure.
8. In High ascent structure the breeze pressure is primarily relies upon uncovered space of working against the breeze power So that the uncovered space of building should be modified or needs to veer off to some point to lessen wind pressure.
9. Overall examination proposes rectangular design for along wind or across wind course is ideal due to huge solidness and less relocation against wind.
10. RCC structure is preferred for stiffness and durability in high rise structure.

9. REFERENCES
1. A E. Hassaballa, Fathelrahman M. Adam., M. A. Ismaeil, "Seismic Analysis of a Reinforced Concrete Building by Response Spectrum Method", IOSR Journal of Engineering (IOSRJEN),Vol. 3, Issue 9 (September. 2013),PP 01-09.
2. Ashok kumar N, Navaneethan M, Naviya B, Gopalakrishnan D, "Planning, Analysis & Design of Hospital Building Using Staad Provi", International Journal of Scientific & Engineering Research, Volume 8, Issue 4, April-2017.
3. B. Gireesh Babu, "Seismic Analysis and Design of G+7 Residential Building Using STAADPR International Journal Of Advance Research, Ideas And Innovations In Technology, Volume3,
4. Gaurav Kumar, Megha Kalra, "Review Paper On Seismic Analysis Of RCC Frame Structures With Floating Columns", International journal of advanced technology in engineering and science, Vol. No.4, Special Issue No. 01, February 2016.
5. Gauri G. Kakpure, Ashok R. Mundhada, "Comparative Study of Static and Dynamic Seismic Analysis of Multistoried RCC Building by ETAB: A Review", International Journal of Emerging Research in Management &Technology, Volume-5, Issue-12, December 2016.
6. Gourav Sachdeva, Phrangkupar Thahab, Eritcon Nonkyngynrih, "Analysis & behavior of RC Building Frame with Different Locations of Floating Columns", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Issue 6, June 2016.
7. Harman, Hemant sood, "Analyzing the Effect of Cross-Sectional Change of Column on Symmetrical R.C.C. Frame Structure" International Journal of Engineering Research & Technology (IJERT), Vol. 6 Issue 06, June - 2017.
8. K Venu Manikanta, Dr. Dumpa Venkateswarlu, "Comparative Study On Design Results Of A Multi-Storied Building Using STAAD Pro And ETABS For Regular And Irregular Plan Configuration", International Journal of Research Sciences and Advanced Engineering, Volume 2, Issue 15, PP: 204 - 215, September’ 2016.
9. Kavita K. Ghogare, "Seismic Analysis & Design of RCC Building", International Journal of Research in Advent Technology, Vol.3, No.2, February 2015.
10. Mahesh Ram Patel, R.C. Singh, “Analysis of a tall structure using STAAD pro providing different wind intensities as per 875 Part-III”, International Journal of Engineering Sciences & Research Technology, May, 2017.
11. Mohit Sharma, Dr. Savita Maru, "Dynamic Analysis of Multistoried Regular Building", IOSR Journal of Mechanical and Civil Engineering, Volume 11, Issue 1 Ver. II (Jan. 2014), PP 37-42.