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Comparative Analysis of Tall Structure Subjected to Different Wind Categories

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Abstract:- This Study presents the comparative analysis of tall structure to Different Wind Categories. It is well known fact the wind loads may be estimated in particular zone with specified zone factor. Then the wind load of that zone can also be estimated based on the basic wind speed and other factors of that particular region. Modern tall structure designed to satisfy lateral drift requirements, still many oscillate excessively during wind storm. These oscillations can cause some threats to the tall structure as structure are more and more height becomes more vulnerable to oscillate at high-speed winds. In this paper, the response of tall structure different wind categories as per IS code practice is studied. Wind load analysis is used for analysis of a G+20 storey RCC building as per IS 875(part3):2015 codes respectively.

Keywords:- *Tall Structure, STAAD Pro, Wind load etc.*

I. INTRODUCTION

Buildings are defined as structures utilized by the people as for living, working or storage with rapid growth in population along with the development of industrial and commercial activities rapid urbanization has taken place which has resulted into continuous movement of rural people to metro cities. So, it is clear that the horizontal space constraint is an alarming situation for metros .To manages with the situation maximum utilization of space vertically calls for the construction of tall structures in large numbers.

Today, tall structures are a worldwide architectural phenomenon. Many tall structures are built worldwide, especially in Asian countries, such as china, Korea, japan, and Malaysia. From a structures engineer's point of view tall strictures in one that.by virtue of its height is affected by lateral force to an extent that they play an important role in the structural design.in general. Tall structures need to be designed for wind as well as earthquake loads .The contribution of higher mode effects are included in arriving at the distribution of lateral force along the height of the structure. When wind interact with a building both positive and negative pressures occurs simultaneously, the building must have sufficient strength to resist the applied loads from these pressures to prevent wind include building failure. Load exerted on the building envelope are transferred to the structural system, where in turn they must be transferred through the foundation into the ground, the magnitude of the pressure is a function of the following primary factors exposed basic wind speed, topography, building height, internal pressure and building shape.

II. OBJECTIVE OF THE STUDY

The main objective of this study is carry out the analysis of a G+20 multi stored building for wind load as per Indian Standard codes of practice IS 875(part 3):2015.

- To understand the code recommendations on tall structures for different terrains category.
- To understand the effects of wind on tall structures.
- To analysis the effect of wind load on tall structures by means of manual and software referring to S 875(part-3) 2015
- To validate the results of manual analysis with staad pro software.

III. METHODOLOGY

A. *Basic parameters*

- Grade of concrete :M40
- Grade of reinforcing steel: HYSD Fe500
- No. storey: G+20
- Total height (21*3+1m)=64m
- Parapet wall height :1.0m
- Height of each storey :3m
- Basic wind speed:33 m/s
- Location: Belgaum
- Risk coefficient (k_1) :1.07
- Terrain size coefficient (k_2):1.14
- Topography factor (k_3) :1.36
- Wind design code :IS 875(part-3) 2015
- Design life of the structure: 100 years.

B. *The steps involved*

Plan and elevation
⇩
Structural configuration
⇩
Analysis of structure by means of Manual methods
⇩
Analysis of structure by software
⇩
Result Discussion
⇩
Conclusion

- **Step-1: Plan and Elevation**

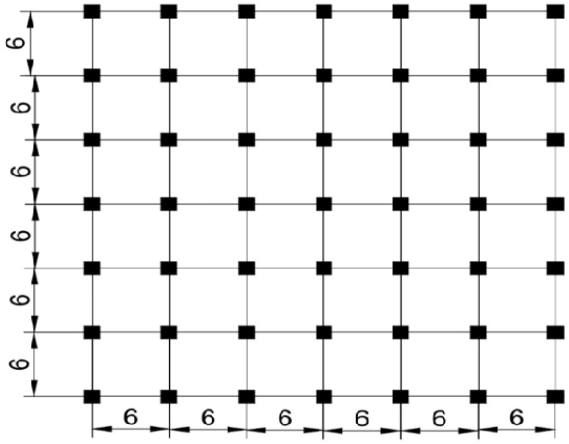

Fig. 1: PLAN

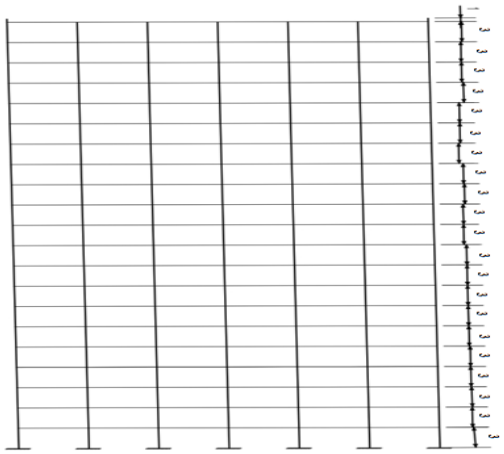

Fig. 2: ELEVATION

- **Step-2: Structural configuration**

The design wind speed, V_z at any height z,

$V_z=V_b\ k_1k_2k_3$

$V_z=35.31k_2$

Where,

V_b is basic wind speed in m/s,
k_1 is probability factor (risk coefficient),
k_2 is terrain roughness and height factor
k_3 is topography factor as per Claus 6.3.3 of IS 875(part-3)2015.

- The design wind pressure (P_d),

  $P_d=k_d\ k_a\ k_c\ p_z$

  $P_d=0.729p_z$

  Where,
  k_d =wind directionality factor for building as per clause 7.2.1 of IS 875(part-3) 2015

  k_a is area averaging factor(as per table 4 IS 875 (part-3)2015
  k_c is combination factor as per clause 7.3.3.13.
  $p_z=0.6(35.31k_2)^2=748.07\ k_2^2$
  $p_d=0.729(748.07k_2^2)=545.34\ k_2^2$

- *Design wind pressure p_d*

Height of structure (m)	Terrain Roughness (k_2)	Design wind pressure P_d in N/m^2
10	0.82	367
15	0.87	413
20	0.91	452
30	0.96	503
50	1.02	567
64	1.04	590

- The wind force acting on the building is given by

  $F_z = a_e\ p_d\ c_f$

  $F_z = 7.32p_d$

Height of structure in m	Design load $F_z=7.32p_d$ N/m	Wind force F(kN/m)
10	2686	2.68
15	3023	3.02
20	3308	3.30
30	3682	3.68
50	4150	4.15
64	4318	4.31

- **Step 3: Analysis of structure for wind load by means of manual method**

Wind load at floors for the same building considering the terrain category 3

Floor Level	Nodes point load
20	12.81
19	12.72
18	12.63
17	12.51
16	12.39
15	12.18
14	11.97
13	11.16
12	11.55
11	11.31

Floor Level	Nodes point load
10	11.1
9	10.83
8	10.47
7	10.14
6	9.75
5	9.27
4	8.9
3	0
2	0
1	0
G	0

Wind load at floors for the same building considering the terrain category 2

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Floor Level	Nodes point load
20	14.64
19	14.58
18	14.52
17	14.43
16	14.34
15	14.1
14	13.89
13	13.68
12	13.44
11	13.23

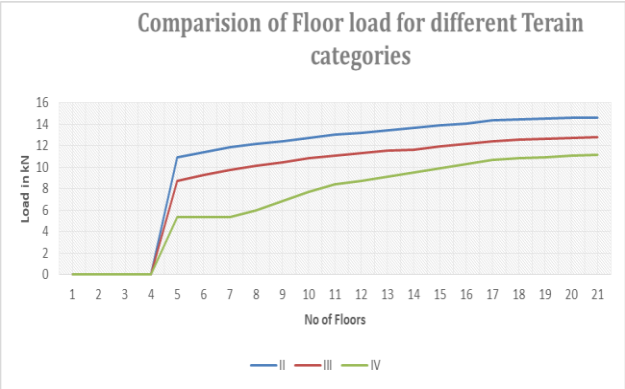
Floor Level	Nodes point load
10	8.82
9	8.28
8	8.28
7	8.13
6	7.38
5	7.11
4	6.84
3	0
2	0
1	0
G	0

Wind load at floors for the same building considering the terrain category 4

Floor Level	Nodes point load
20	11.16
19	11.04
18	10.95
17	10.82
16	10.68
15	10.29
14	9.9
13	9.54
12	9.15
11	8.76

Floor Level	Nodes point load
10	8.37
9	7.71
8	6.84
7	6.0
6	5.37
5	5.37
4	5.37
3	0
2	0
1	0
G	0

Comparision of Floor load for different terrain categories graph



- **Step 4: Analysis of structure by software method**Wind load at floors for the same building considering the terrain category 3

Floor Level	Nodes point load
20	9.72
19	9.72
18	9.72
17	9.66
16	9.36
15	9.36
14	9.36
13	9.36
12	9.36
11	9.36

Floor Level	Nodes point load
10	13.02
9	12.75
8	12.45
7	12.18
6	11.85
5	11.43
4	10.92
3	0
2	0
1	0
G	0

Wind load at floors for the same building considering the terrain category 2.

Floor Level	Nodes point load
20	12.82
19	12.82
18	12.82
17	12.75
16	12.42
15	12.42
14	12.42
13	12.42
12	12.42
11	12.42

Floor Level	Nodes point load
10	11.9
9	11.38
8	11.38
7	11.21
6	10.29
5	10.19
4	8.99
3	0
2	0
1	0
G	0

Wind load at floors for the same building considering the terrain category 4

Floor Level	Nodes point load
20	8.67
19	8.67
18	8.67
17	8.67
16	8.34
15	8.30
14	8.30
13	8.30
12	8.30
11	8.30

Floor Level	Nodes point load
10	8.63
9	6.35
8	6.35
7	6.21
6	4.13
5	4.13
4	2.07
3	0
2	0
1	0
G	0

Comparision of floor load for different terrain categories of terrain category IV.

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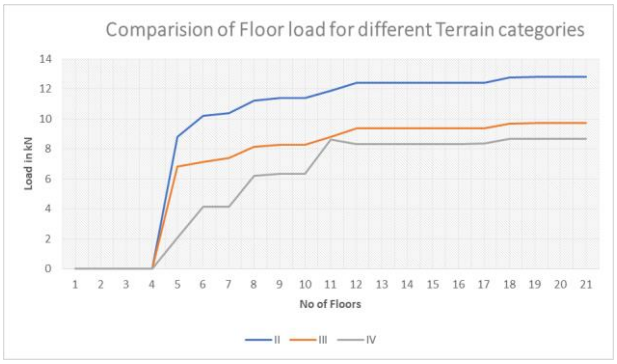

Fig. 3

IV. RESULT AND DISCUSSION

Comparision of manual and software load calculation of terrain category III

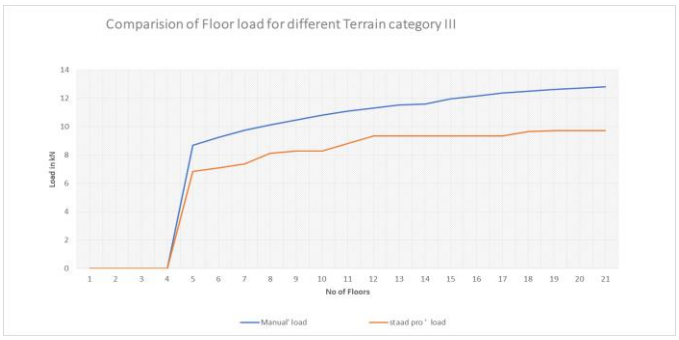

Fig. 4

Comparision of manual and software load calculation of terrain category II

Fig. 5

Comparision of manual and software load calculation of terrain category IV

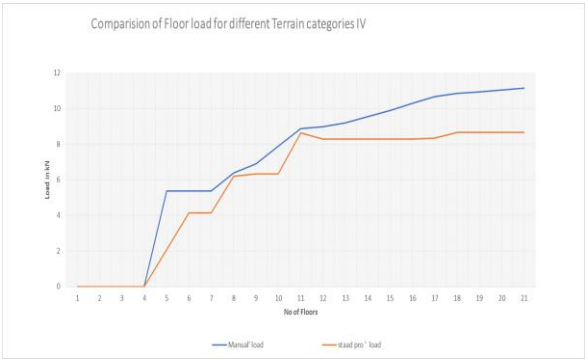

Fig. 6

V. CONCLUSION

- On the basis of manual analysis and software analysis for wind in the category 2 showing 30% heavier than category 4
- On the basis of manual analysis and software analysis for wind in the category 3 showing 15% heavier than category 4.
- It can be concluded by referring to above results that each category of wind is having impact rate of 15% from category 4 to 3and 3 to 4.

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