Effect of Windload on Tall Structures in Different Terrain Category

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Abstract— **Wind is a perceptible natural movement of air relative to earth surface mainly within the shape of air cutting-edge blowing in a specific route. The major dangerous factor which problem to civil engineering systems is that, it will load any and every item that comes in its way. Wind blows with much less speed in rough terrain and better speed in smooth terrain. This paper gives Storey Displacement, Storey Drift, Storey Shear occurring in special storey due to wind in special terrain category. Four models are analysed using of ETABS 2019 package. Present works gives an excellent source of facts about variation in Storey Displacement, Storey Drift, Storey Shear in different terrain categories.**

Keywords*: *Wind Load, ETABS, Terrain, Storey displacement, Storey Shear, Storey Drift.

I. INTRODUCTION

No obvious definition for tall building is there. From the features of the building, it is quite difficult to term it as "Tall Building". Number of floors or height are not the factors for a building to be said as tall. A structure which is bounded by floors, roof top, walls & commonly windows can be named as tall or short building depending on many factors. "A tall building" is a multi-storey arrangement in which maximum of the occupier's rest on elevators to fulfil their purposes.

Maximum noticeable structures are known as high rise buildings in many nations. On the basis of operational approach, it is quite easier to account a structure as high when their plan and structural examination are somewhat exaggerated by the crosswise loads. This can be explained by an example such as sway which it experiences due to wind load or earthquake load which all are horizontal loads. As elevation rises, the wind forces start to govern. Hence, basic outline for high rise buildings is established about ideas related totally to the resistance experienced by turbulent wind. High rise structures, which are commonly planned for workplace or marketable use, are one of the best well-known descriptions in the history of Indian urban development in 12th era.

There are four distinct wind classifications for tall constructions that can be built

- Terrain category 1
- Terrain category 2
- Terrain category 3
- Terrain category 4

Category 1: Exposed open area where there are few or no obstacles and when the average height of any nearby objects is less than 1.5 meters.

Terrain Category 01

Category 2: Open terrain with well scattered obstruction having heights generally between 1.5 to 10m.

Terrain Category 02

Category 3: Terrain with numerous, widely spread obstacles that are the size of buildings and can reach heights of 10 meters, with or without a few lone, tall obstructions.

Terrain Category 03

Category 4: Terrain with numerous large high closely spaced obstructions.

Terrain Category 04

II. OBJECTIVES

In the present work following objectives are considered:

- To analyse the multistorey building by considering the effect of wind load with different terrain categories.
- To compare the results of Storey displacement, Storey drift, Storey shear in different terrain category.

III. METHODOLOGY

This chapter describes the standard step-by-step method for modelling the four different regular structure

- Model Type 1- Structure in Terrain Category 1
- Model Type 2- Structure in Terrain Category 2
- Model Type 3- Structure in Terrain Category 3
- Model Type 4- Structure in Terrain Category 4

Flow Chart

Architectural Drawings
↓
Creating grid Lines
↓
Defining Material Properties
↓
Defining Section Properties
↓
Slab Details
↓
Assigning Properties
↓
Definition and assigning Loads
↓
Assigning Supports
↓
Defining Response Spectrum
↓
Analyzing the building

STEP-BY-STEP METHOD FOR MODELLING OF THE STRUCTURE

Step1: Collection of data related to structure considering software implementation

Number of Stories	G+15
Plan Dimension	16m*15m
FL to GL	1.5m
F to F height	3m
Materials	M30 grade concrete and Fe500 Steel
Size of Column	300mm X 800mm
Size of Beam	300mm X 600mm
Slab Thickness	150mm
Seismic Zone	Zone IV

Table 1: G+15 Specification

Step2: Modeling of structure in ETABS

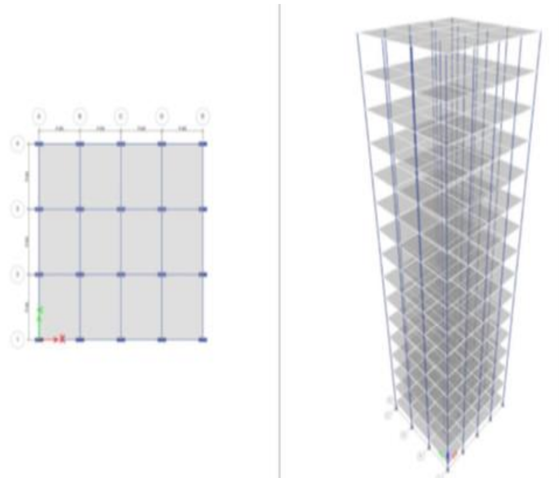


Fig-1: Plan of RCC Building

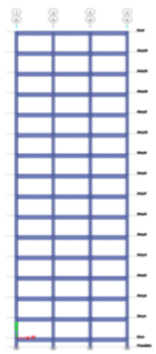


Fig-2: Elevation View

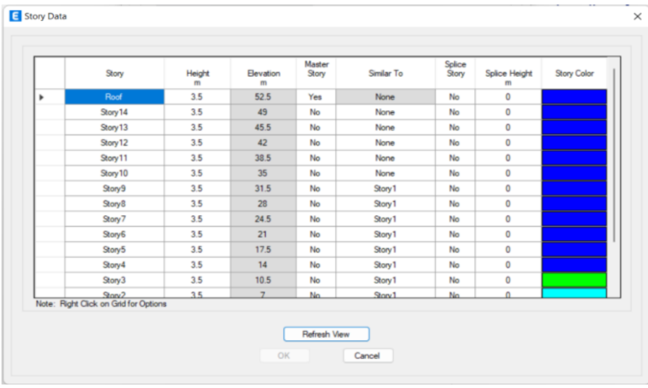


Fig-3: Storey Data

Step 3: Generating Material Properties (M40 & HYSD500)

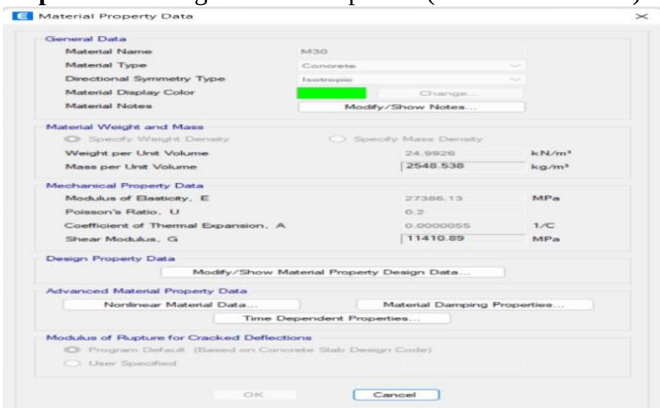


Fig-4: M-30 Concrete

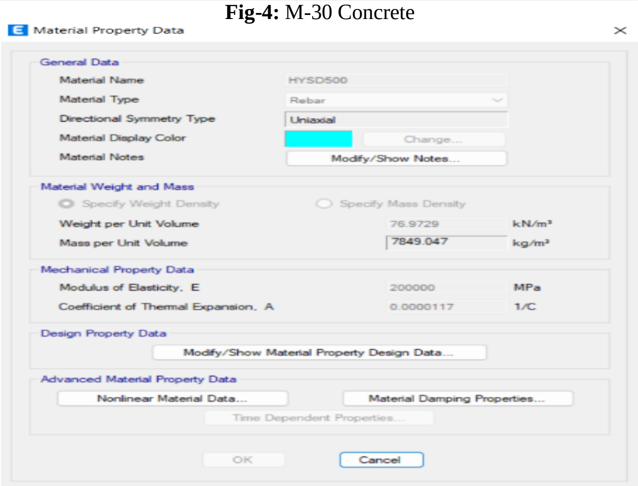


Fig-5: HYSD500

Step 4: Creating beam and column section of the structure

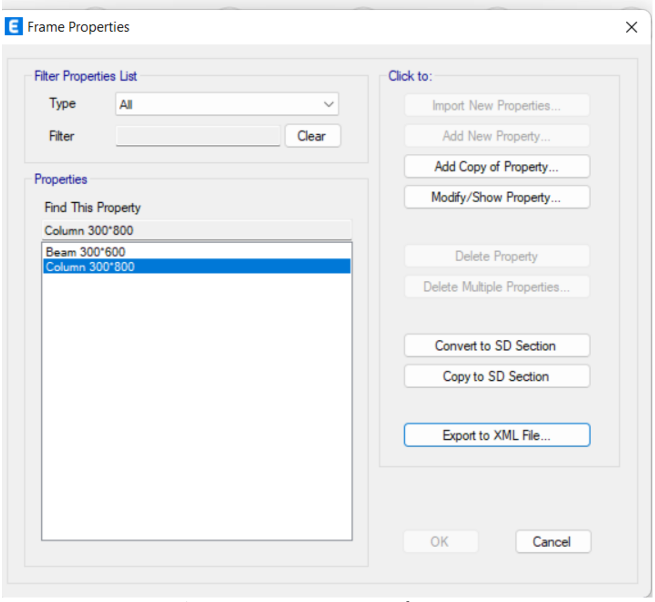


Fig-6: Section Properties of a Frame

Step 5: Design loads

The weight of materials shall be computed using the unit weights specified in IS: 875 (part-1)-1987. The imposed load or otherwise live loads are calculated using the occupancy classes defined in IS: 875(Part-2)-1987, which are as follows:

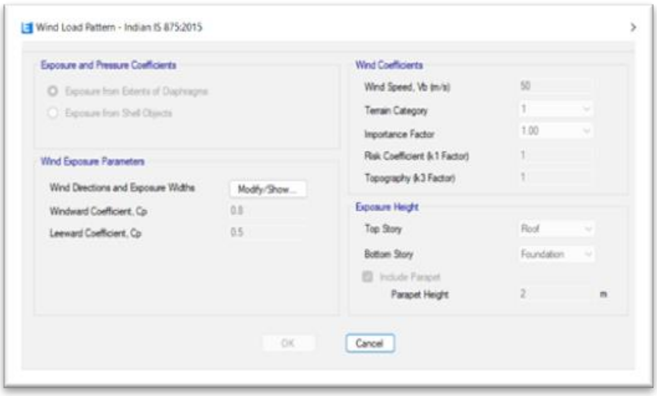
	Floor loading as per IS: 875(Part-2)-1987	**Live Load in KN/m².**	**FF+CP KN/m².**
I	Ground Floor to story 15		
A	All rooms & kitchens.	2.0	1.5
B	Stair	3.0	1.5
C	Lobby / Corridor	3.0	1.5
D	Toilets	2.0	1.5
II	Terrace		
A	Floor	1.5	1.0

Step 6: Defining Wind Load

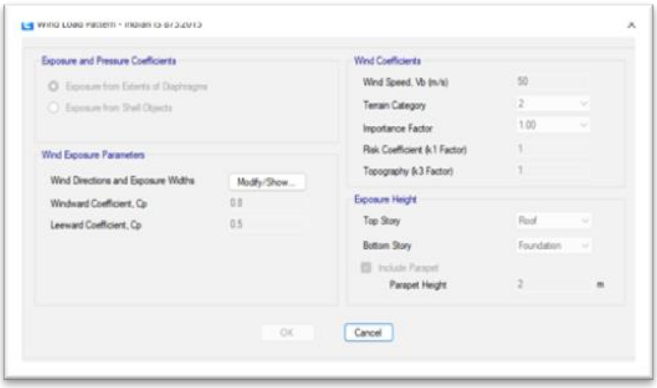
The loading due to wind is assessed based on the provisions of IS: 875 Part 3

Wind Speed	= 50 m/s
Importance Factor	= 1.00
Risk Co-efficient (K1 factor)	= 1
Topography (K3 factor)	=1

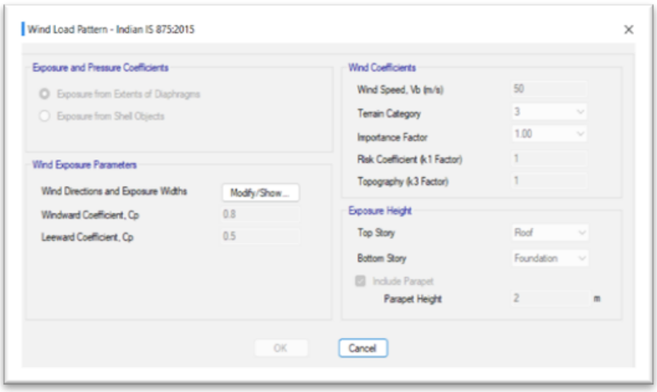
Step 8: Defining Terrain Category



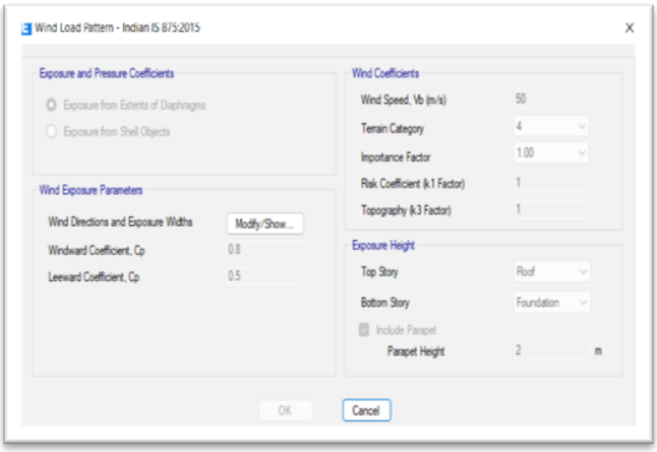
Terrain Category 1



Terrain Category 2

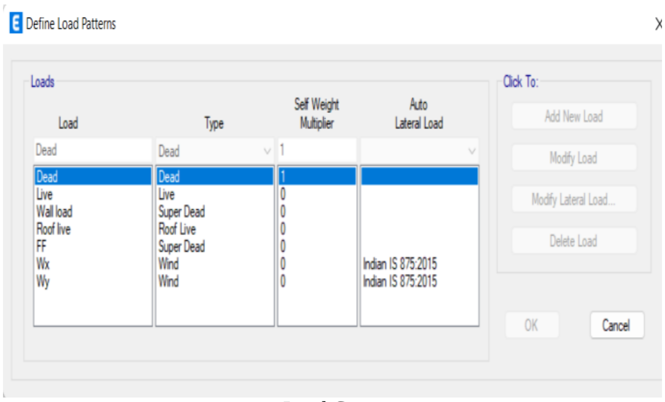


Terrain Category 3



Terrain Category 4

Step 9: Load Combinations



Load Cases

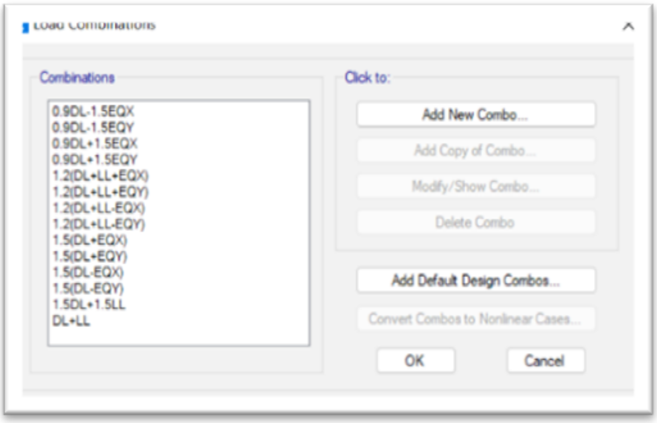


Fig-11: Load combinations for RCC structure

IV. RESULTS AND DISCUSSION

In the present study, high rise Reinforced Cement Concrete structural system is modelled and analyzed using ETABS 2019. Structures are analyzed and core results are extracted and presented in the present chapter 4 as below and conclusions are made in chapter 5 based on the brief discussion of results. Following Tables demonstrates the maximum Storey displacement, Storey Drift, Base Shear.

A. STOREY DISPLACEMENTS

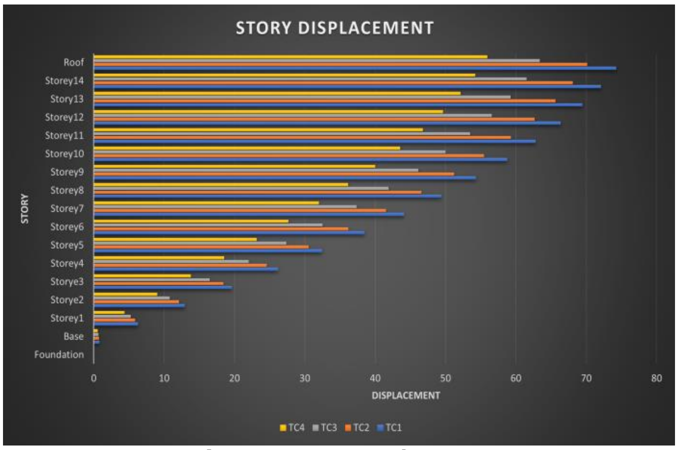


Chart-1: Storey vs Displacement

Storey displacement results are presented in the form of graphs in Chart 1. From the results, it can be seen that Height of Structure or Building is directly proportional to Displacement of that structure i.e., more the height more will be displacement

B. STOREY DRIFT

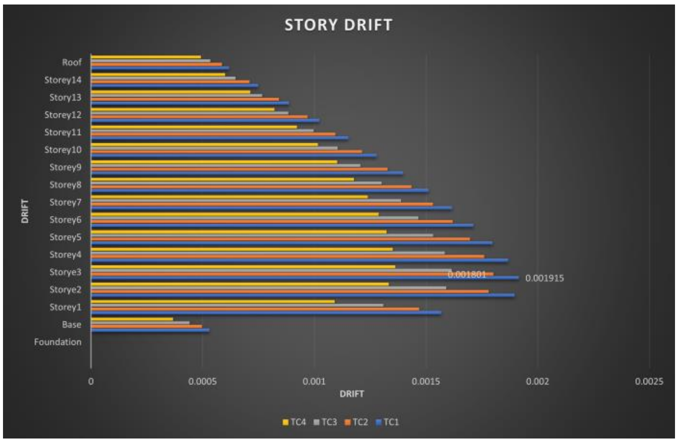


Chart -2: Storey vs Drift

Storey Drift results are tabulated in below Table 4 and presented in the form of graphs in Fig.4.2 From the results it can be seen that, Terrain Category 1 have the maximum Storey drift at Storey 3 i.e., 0.001915. After Storey 3 storey drift keeps on decreasing.

C. STOREY SHEAR

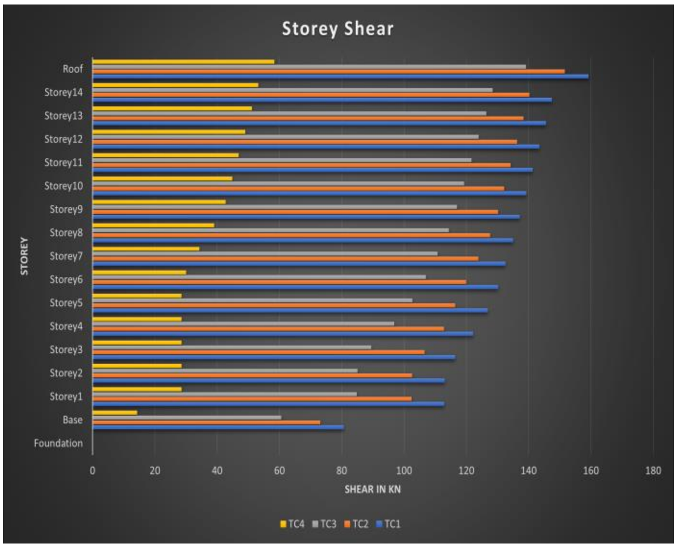


Chart-3: Storey shear

Storey Shear is shown in chart-3, from the results it can be seen that, Storey shear increases as the height of the structure increases

V. CONCLUSIONS

The following conclusions are drawn from the present study:

- Height of Structure or Building is directly proportional to Displacement of that structure i.e., more the height more will be displacement. Story displacement is greatest in Terrain Category 1 and lowest in Terrain Category 4. There is 24.62 percentage decrease in displacement from Terrain Category1 to Terrain Category 4.
- Terrain Category 1 have the maximum Storey drift at Storey 3. After Storey 3 Storey drift keeps on decreasing. At Storey 3 there is 28.82 percentage decrease in Storey drift from Terrain Category 1 to Terrain Category 4.
- Storey shear increases as the height of the structure increases. Story shear is greatest in Terrain Category 1 and lowest in Terrain Category 4. There is 63.36 percentage decrease in Storey shear from Terrain Category1 to Terrain Category 4.

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