Shape Optimization of Tall Structure Subjected to Wind Excitation

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Abstract - *With the increasing application of light-weight and high-strength materials, modern tall buildings tend to more flexible and sensitive to wind excitation than those in past. In recent years, Tall structures are plays vital role in large cities because the growth of population and scarcity of lands. Therefore, tall structures are constructed widely in cities. But as a height of building goes on increasing the wind is more susceptible, and for different shape of building wind effect is varies. The main advantage of analyzing different shape of tall structure is to find out the wind effect changes with respect to height and shape of building. In the tall structures, shape of building in plan is affect the wind pressure coefficients. So, the effect caused by the wind load is different for variation in shape of building.*

This dissertation presents the finite element method based analysis of tall structure subjected to wind excitation. It has been widely accepted that the wind load and wind induced responses are the key factor in structural design of high rise structures, in particular in region of high wind speeds. Wind effects on tall buildings are composed of two lateral components (along wind and across wind). Wind load is applying as per IS:875 part 3, 1987. The various shape of buildings is taken under consideration. And by analyzing the wind effect on this different shaped structure, find out the best shape which gives less story responses.

Keywords: - Tall structures, wind analysis, finite element method (FEM)

1.INTRODUCTION

Now a day, the population is being increasing rapidly. Since the tall structures are the important part of urbanization. Tall buildings are critically affected by wind loads. Wind exerts forces and moments on the structure and its cladding and also it distributes the air in and around the building mainly termed as wind pressure. Sometimes because of unpredictable nature of wind it takes so devastating form that it can upset the internal ventilation system when it passes into the building. For these reasons, the study of air flow is becoming integral with the planning of a building and its environment. Tall buildings are flexible and are susceptible to vibrate at high wind speeds in all the three directions (x, y, and z) and even the building codes do not incorporate the expected maximum wind speed for the life of the building and does not consider the high local suctions which cause the first damage.

2. OBJECTIVES

This study will focus on effect of wind on the G+50 storey building, with the modelling by use of finite element method. and also, the comparison between different shapes of building which are having same height and wind force acting on it.

- To study and compare results of tall structures with different shape configuration in plan using appropriate software.
- To investigate behavior of various structural systems under wind load according to the IS:875 (Part 3).
- To carry out parametric study such as story drifts, lateral displacement etc. by modelling structures subjected to wind excitation.

3. DETAILS OF THE MODELS STUDIED

In order to evaluate the story displacement and base shear between different shapes of buildings using static analysis of finite element method, six sample building models are adopted. The finite element analysis software ETABS is used to create 3D model and analyzed. The wind load analysis as per IS:875 part 3 is done on all the shape of building in plan. The various shapes models are square, rectangular, triangular, hexagonal, octagonal, circular.

3.1. Modelling and Analysis

To study the effect of different shapes of tall structures subjected to wind excitation. Six different shaped building models has been considered. These models are of same height, same area in plan, and also considered in same locality.

Table-1: Building Design parameters

Size of Column (mm)	Column 1-10-1200*600 Column 11-20-1000*600 Column 21-30- 850*500 Column 31-40- 700*450 Column 41-50- 450*300
Size of Beam (mm)	300*500
Imposed Load	3 KN/m^2
Floor Finish	1 KN/m^2
Depth of slab	150 mm
Type of soil	Medium
Story Height	3 m
Area of plan (m)	50*50
Shape	Square, rectangular, triangular, hexagonal, octagonal, circular

3.2 Plan of different shaped buildings

Figure- 1: Plan of Square shape building

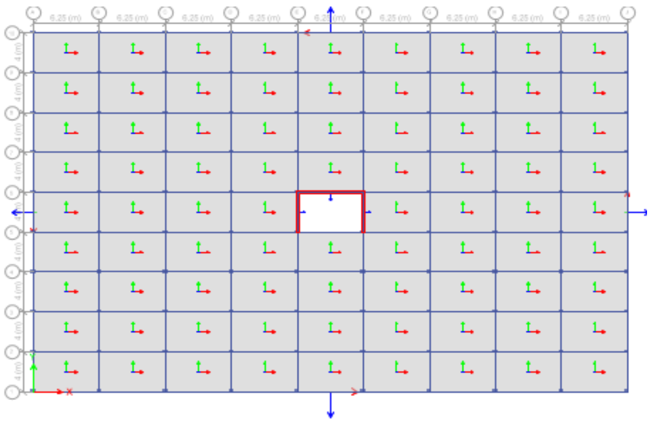

Figure- 2: Plan of Rectangular shape building

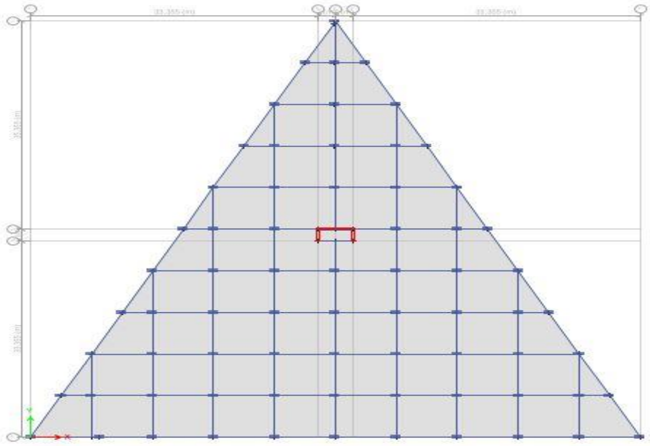

Figure -3: Plan of Triangular Shape building

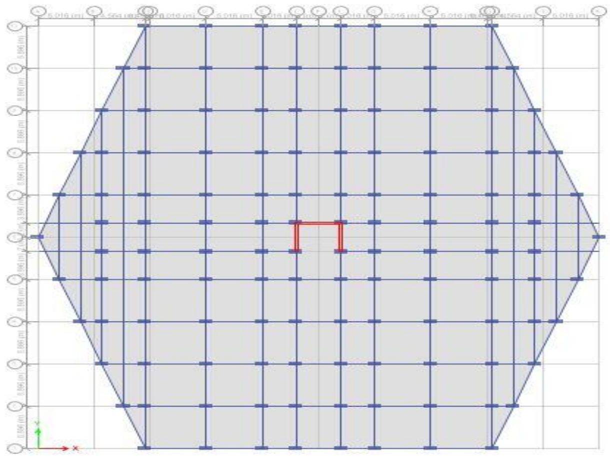

Figure -4: Plan of Hexagonal shape building

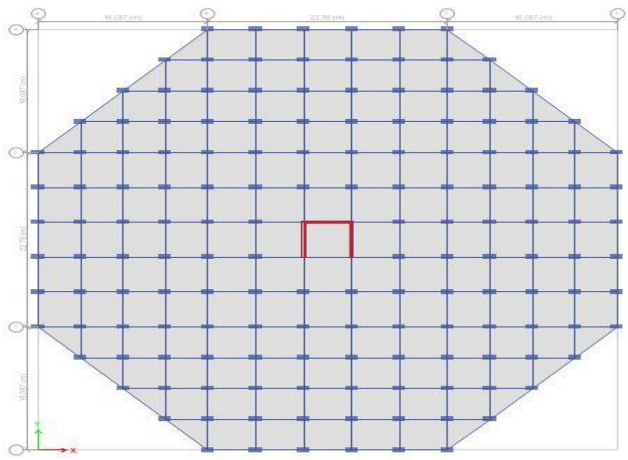

Figure- 5: Plan of Octagonal shape building

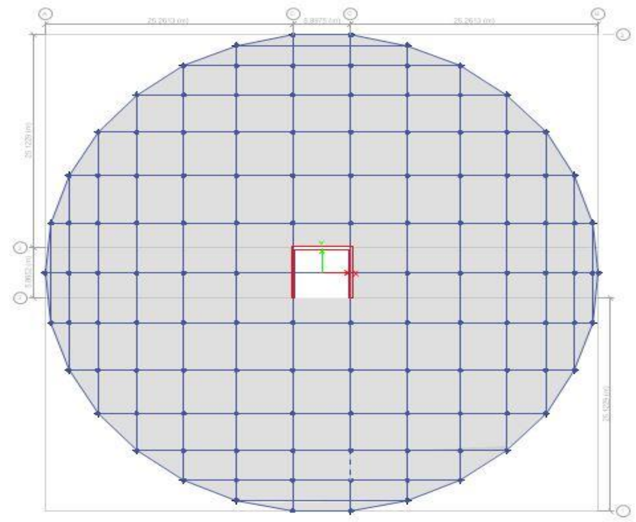

Figure -6: Plan of Circular shape building

3.3 Maximum Story Displacement

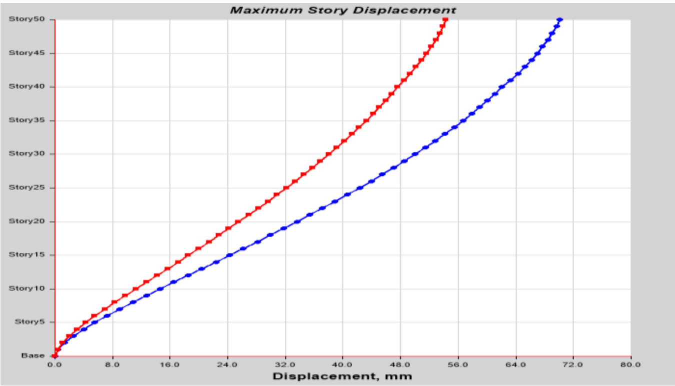

Chart-1: Maximum Story displacement for square shape

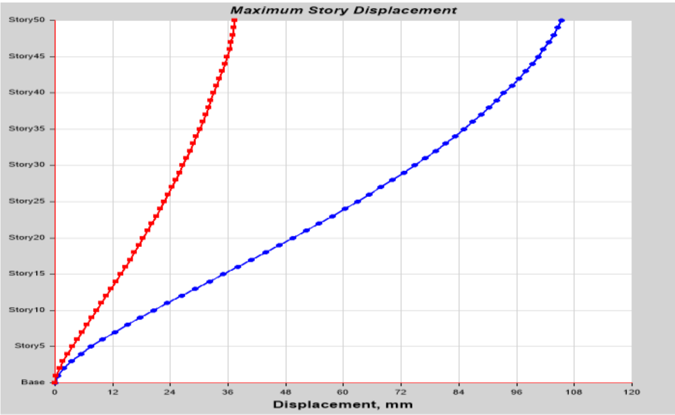

Chart-2: Maximum Story displacement for Rectangular shape

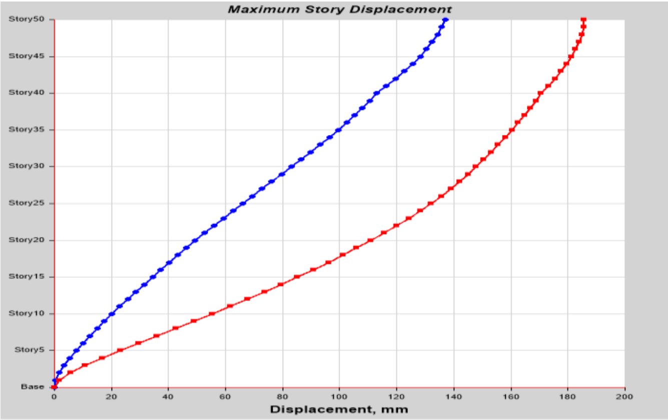

Chart-3: Maximum Story displacement for Triangular shape

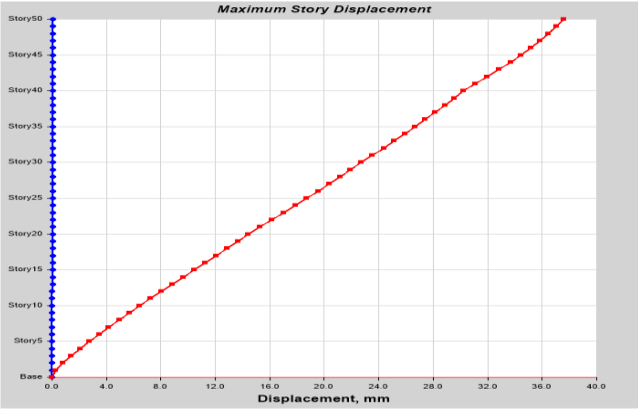

Chart-4: Maximum Story displacement for Hexagonal shape

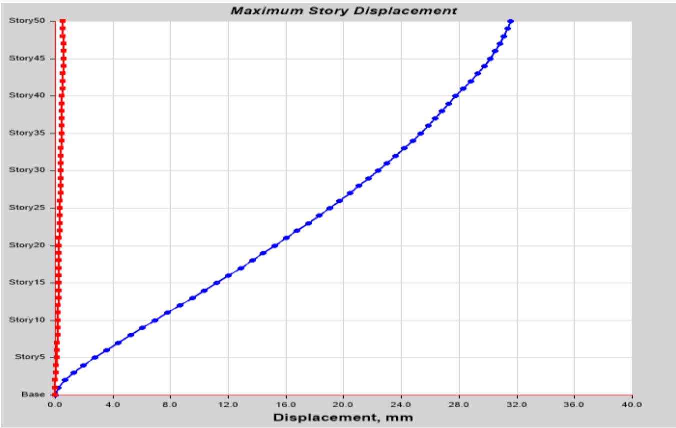

Chart-5: Maximum Story displacement for Octagonal shape

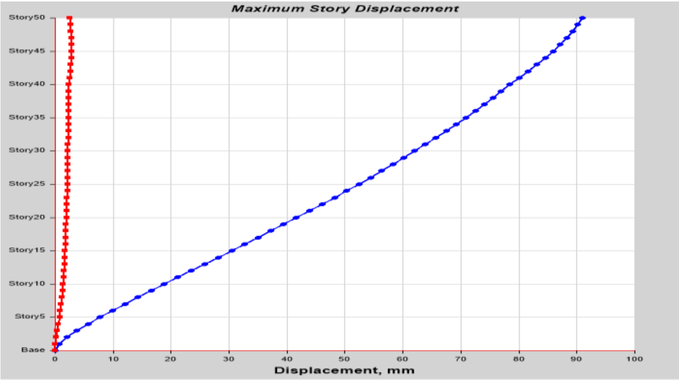

Chart-6: Maximum Storey displacement for Circular shape

4. RESULTS AND DISCUSSION

The wind load analysis on tall Structures for different shape of building is calculated. The shell load method and diaphragm method is used for calculations of story response values. For the different shape of the building the different story response values obtained at different height of building. Following are the values which obtained by finite element method

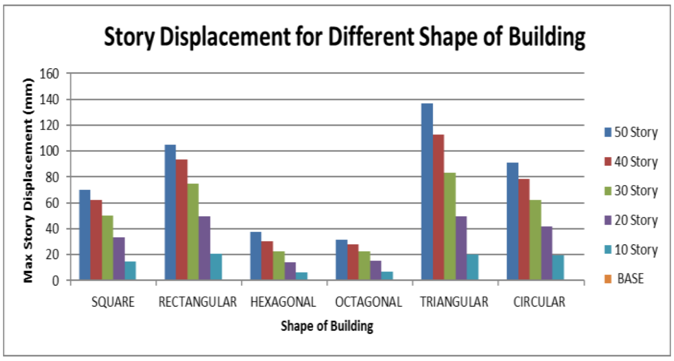

Chart-7: Story Displacement graph for different building Models

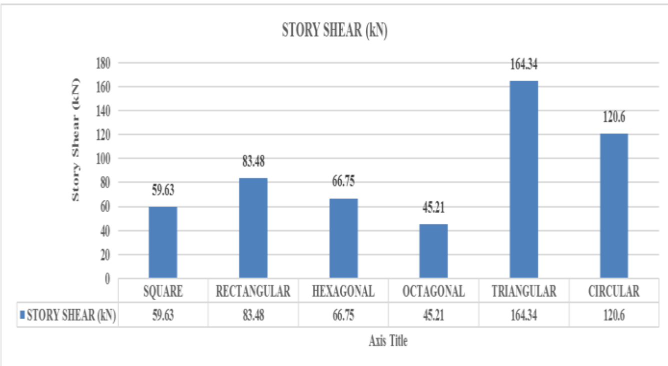

Chart-8: Story Shear Graph for different building Models

5. CONCLUSIONS

By analyzing the models that is square, rectangular, hexagonal, octagonal, triangular, circular shape in ETABS the results are as follows

The maximum story displacement in octagonal shape is 31.6 mm. which is less than all other shapes i.e. square, rectangular, triangular, circular, hexagonal. The maximum Story displacement in octagonal shape is 15% less than hexagonal shape. The maximum Story displacement in octagonal shape is 77% less than triangular shape. The maximum story shear in octagonal shape is 45.21 kN. which is less than all other shapes i.e. square, rectangular, triangular, circular, hexagonal. The maximum Story shear in octagonal shape is 32% less than hexagonal shape. The maximum Story shear in an octagonal shape is 72.5% less than triangular shape. The results show that the octagonal shape tall structure is more effective as compared to all other shapes in case of story displacement and story shear consideration.

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