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Effect of Wind Load on High Building with Different Aspect Ratio Using Staad Pro

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Abstract – *Due to rapid increase of urban population in several countries such as India and other countries, has forced the re-evaluation of the importance of high-rise building. The impact of wind loads is to be considered for the design of high-rise building. In India there are many structures which are failed due to wind load. The wind loads on different type of structure are considered by IS 875(part 3): 2015. The present study focuses on the effect of wind load on building with different aspect ratio i.e. H/B ratio, where H is the total height of the building frame and B is the width of building frame using STAAD PRO. From the study we get the effect of wind load on height of building by varying the base of the width in the aspect ratio. The analysis of multistory building for class B zone for wind forces in terrain category TC-3 is carried out. 3-D model is prepared for G+13 multistory building in STAAD PRO.*

Key Words: High Rise Building, Story Drift, Story Displacement, Interstory Drift

1. INTRODUCTION

Wind is air in motion relative to the surface of the earth. The wind generally blows horizontal to the ground at high wind speeds. Winds are the large- scale movements of air currents in the atmosphere. It is of great complexity because of many flow situations arising from the intersection of wind with structures. The wind speed is null at ground level and maximum at critical height. The wind speeds are measured with the help of anemometers or anemographs which are installed at meteorological observatories at heights generally varying from 10 to 30 meters above ground.

Wind force depends upon exposed area of structure. The wind force depends upon terrain and topography of location as well as the nature of wind, size and shape of structure and dynamic properties of building. If the wind energy that is taken up by the structure is larger than the energy consumed by structural damping then the intensity of oscillation will continue to increase and will finally lead to destruction. The structure becomes aerodynamically unstable. Nowadays there is shortage of land for building and other structure, more buildings at a faster growth in both residential and industrial areas. By this vertical construction is given importance in present scenario and it will be important in future too because of which tall buildings are being built on a large scale. According to The National Building code 2005 of India "A Building having total height more than 15m is called as high-rise building".

STAAD PRO is "Structure Analysis & Design Program" software. It includes a state of the art user interface, visualization tools and international design codes. It is used for 3D model generation, analysis and multi material design. The commercial version of STAAD PRO supports several steels, concrete and timber design codes. It is one of the software applications created to help structural engineer to automate their task and to remove the irksome, slow and long procedure of the manual methods. It also gives optimum and exact analysis and design of the Structure.

1.1 Building Specification

To perform static linear analysis of G+13 story building against wind load with different aspect ratio i.e., H/B ratio. The total height of the building is 42m and only width parameter is varying. There are 4 bays along x-axis and 5 bays along z-axis. The basic wind speed is 50 m/s.

Table -1: Building Specification

Number of Stories	G+13
Utility of building	Residential Building
Type of construction	RCC Framed Structure
Story Height	3m
Wind Zone	V
Shape of building	Rectangular and Square Shape
Grade of Concrete	M30
Location	Vishakhapatnam
Thickness of Slab	0.15m
Beam Size	0.35x0.45m
Column Size	0.65x0.65m

1.2 Plan and Elevation of Building

The building consists of G+13 story having 42m of total height and each storey is of 3m.

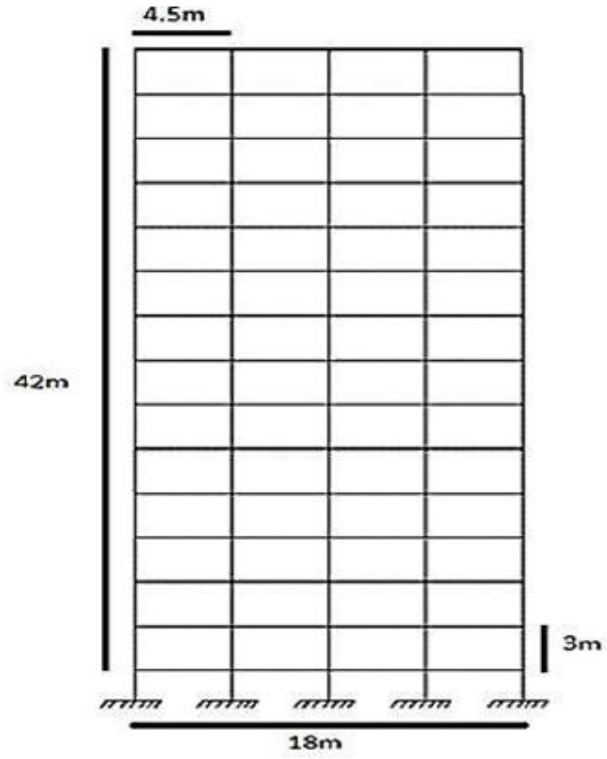

Fig 1: Plan of Building

Case 1 show the Aspect ratio (H/B) of 1.87 where the distance between 1 bay along z-axis is 4.5m and shows a Rectangular Plan.

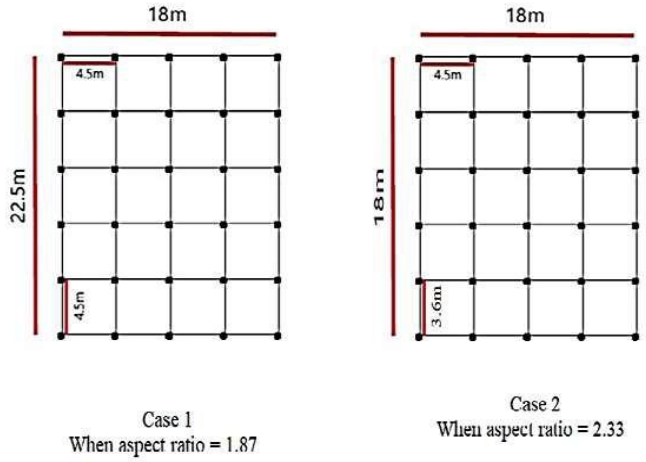

Fig -2: Plan of Building with different Aspect Ratio

Case 2 show the Aspect ratio (H/B) of 2.33 where the distance between 1 bay along z-axis is 4.5m and shows a Square Plan.

2. METHODOLOGY

Step 1- With the help of co-ordinate system, firstly we provide the nodes and connect them by using the command "ADD BEAM" to make the plan.

Step 2- By selecting all the nodes, use of translation repeat with step spacing= -3m, and global direction as Y, No. of steps = 1.
Step 3- By selecting all beams of plan, use of translation repeat with step spacing
= 3m, global direction = Y, No. steps = 13.
Step 4- Assigning supports to the structure.
Step 5-Assigning properties to the structure i.e. giving dimension to the beam and column.
Step 6- Wind Load Definitions: In Wind Load Definitions we input the intensity details i.e., Wind intensities with respect to height.
Step 7- Load case details-

- Dead Load (DL)
- Live Load (LL)
- Wind Load (WL-X and WL-Z)

Step 8- Assigning loads to the structure.
Step 9- Analysis
Step 10- Design
Designing is done as per IS 456:2000

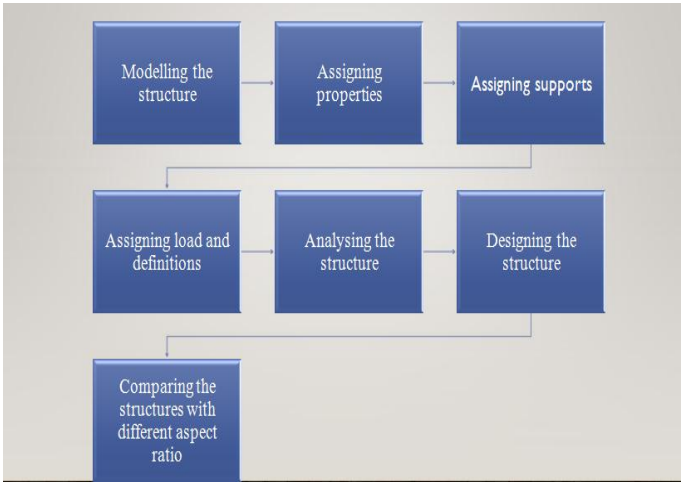

Fig -3: Flowchart of Methodology

3. RESULT

The obtained results from the analysis were tabulated and lateral displacements, storey drift, inter storey drift, shear force and bending moment were noted down. The analysis was carried out for G+13 storey structure. Graphs were plotted showing comparison for the two aspect ratio cases. Story displacement is the movement of each floor due to lateral forces of wind in either X or Y direction. The maximum impact of the displacement is found in the X direction

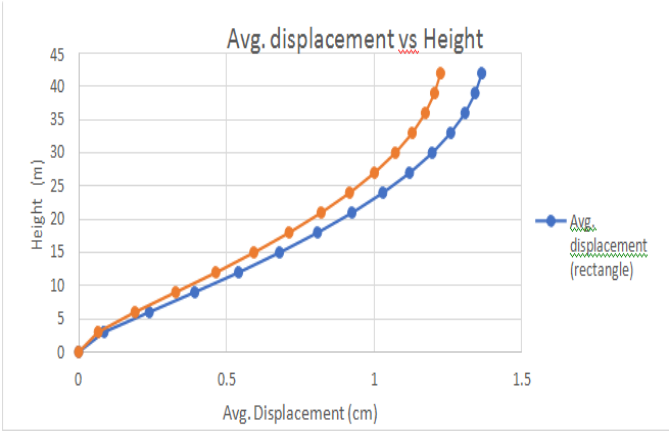

Fig -4: Graph between Height vs Avg. Displacement

In this Fig 4, Height (m) are taken on Y axis and Avg. Displacement taken on X axis. The graph is drawn for Square shape and Rectangular shape Structure. The value of avg. displacement starts decreasing by 12.22%, when the Aspect ratio changes from 1.87 (Rectangular shape) to 2.33 (Square shape).

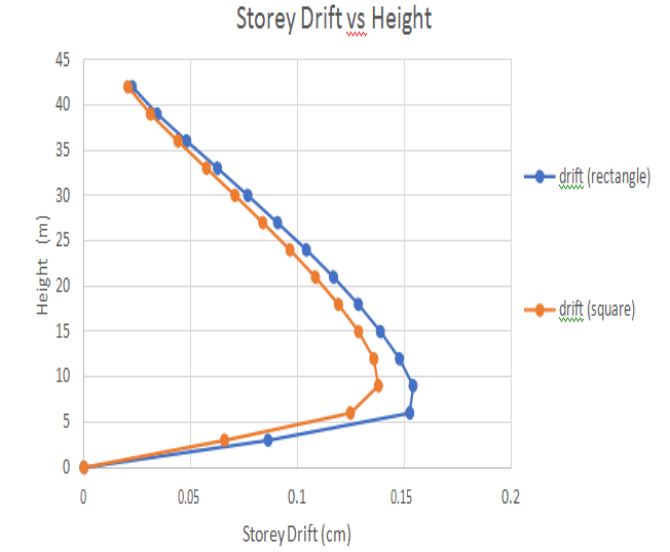

Fig -5: Graph between Height vs. Storey Drift

In this Fig 5, Height (m) are taken on Y axis and Storey Drift taken on X axis. The graph is drawn for Square shape and Rectangular shape Structure. The value of avg. displacement starts decreasing by 9.38%, when the Aspect ratio changes from 1.87 (Rectangular shape) to 2.33 (Square shape).

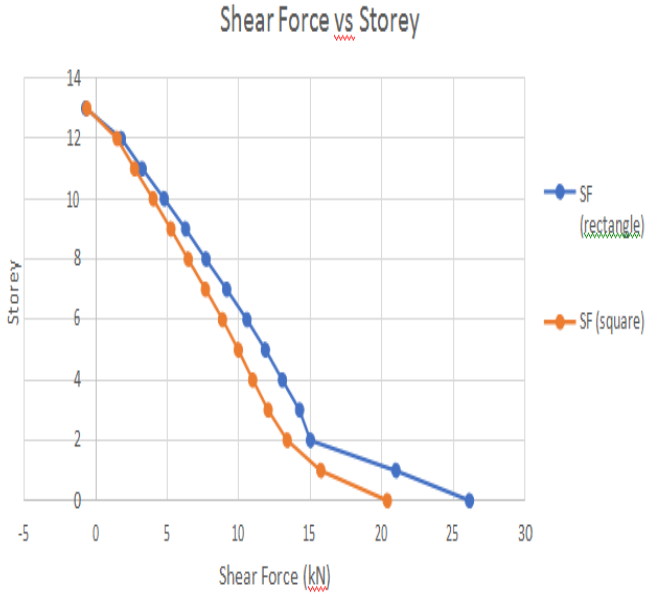

Fig -6: Graph between Storey vs. Shear Force

In this Fig 6, shows Height (m) are taken on Y axis and shear force taken on X axis. The wind load is applied on the outer edge columns from top to bottom it is observed that when the Aspect ratio changes from 1.87(Rectangular shape) to 2.33(Square shape), the value of Shear Force starts decreasing by 15.04% with respect to the storey height.

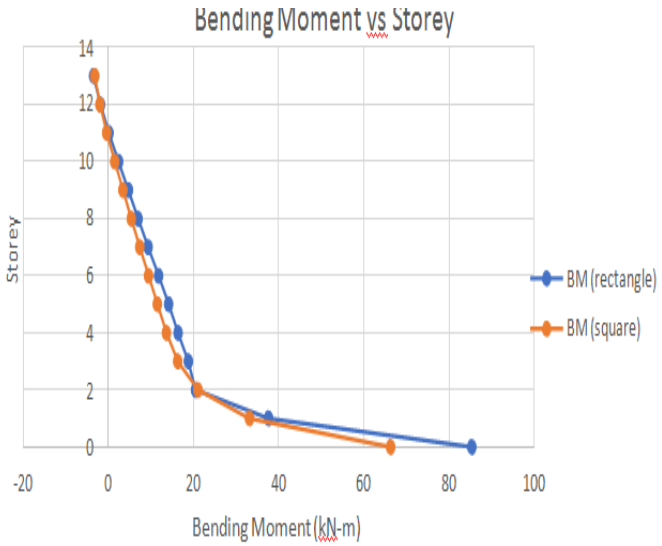

Fig -7: Graph between Storey vs. Bending Moment

In this Fig 7, shows Height (m) are taken on Y axis and Bending Moment taken on X axis. The wind load is applied on the outer edge columns from top to bottom and it is observed that when the Aspect ratio changes from 1.87(Rectangular shape) to 2.33(Square shape) the values of Bending Moment starts decreasing by 9.84% as it will act as cantilever.

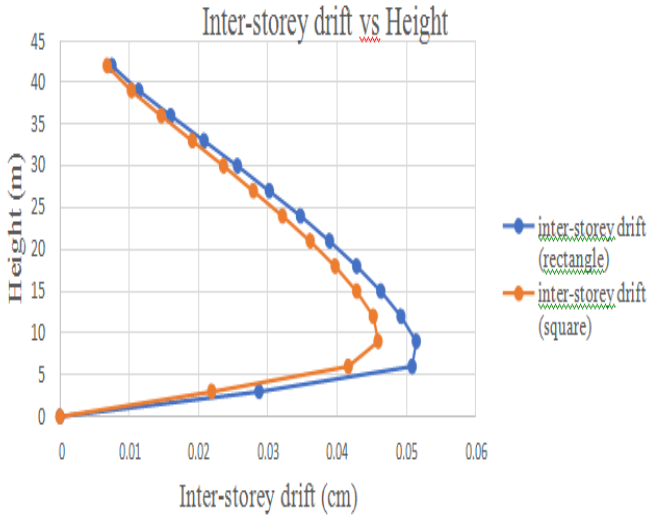

Fig -8: Graph between Height vs. Inter-storey Drift

In this Fig 8, shows Height (m) is taken on Y axis and Interstorey Drift taken on X axis. The graph is drawn for Square shape and Rectangular shape Structure. When the Aspect ratio changes from 1.87(Rectangular shape) to 2.33(Square shape), it is observed that the value of Inter storey Drift start decreasing by 9.42%.

4. CONCLUSIONS

After performing the analysis of the building frames using STAAD PRO software, the conclusions obtained are:

1. After analysis it shows that as the height increase, the Avg. Displacement increases but the RCC rectangle shape is shows more displacement as compare to square shape structure.

2. When the wind load applied along the length, it shows that RCC square structure has less storey drift as compared to RCC rectangular structure.

3. When wind load is applied along the length of the building frame, that RCC rectangular structure shows more inter storey drift as compared to RCC square structure.

4. After the analysis it shows that as the height increases both bending moment and shear force starts decreasing but RCC rectangular structure shows more bending moment and shear force as compared to RCC square structure.

5. It is also observed that in both cases bending moment and shear force is maximum at bottom and minimum at top.

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