ANALYSIS OF AERODYNAMIC MODIFICATIONS TO THE SHAPE OF THE TALL STRUCTURE

Himanshoo Verma[1], Dr.Rakesh patel[2]

1 Student , civil engineering department ,Sirts Bhopal M.P.,india

2 HOD, civil engineering department ,Sirts Bhopal M.P.,india

ABSTRACT

The structures that are man-made are bluff- bodies.During the structural analysis of a tall building, its stability under wind forces is of a major concern. Being a bluff body, the aerodynamic study plays a critical role in the determination of the principal response of a high-rise building to wind forces.The lateral loads on the buildings is plays an important role in the design of high structures. it is assume that tall buildings are symbol of power, technology, landmark of metro cities but bedside of this if care was not taken before construction of these buildings it can cause incontestable unsupportive effects on the attribute of urban life. To overcome this method several design and modification are possible.The structures response to wind depends on the wind's characteristics . In present study to minimize this impact, modification of aerodynamics action has been taken to reduced the impact of wind action on tall buildings. For this purpose fours cases has been studied, in which four different type of structural design which include cross sectional shape, stepped cross section rounded corner tapered faces for indore location .Among these approaches, an extremely important and effective design approach is aerodynamic structural modifications, including modifications of the cross-sectional form of the building and its corner designs, sculpted building tops, and horizontal and vertical openings by construction aerodynamic modification play important role for design of tall structure . wind force is a serious issue for high rise structure and it is also affect the strength and life and appearance of structure

Keyword : *Aerodynamic shape , wind load , Drag coefficient ,Model analysis, Drag Force, Tall structure*

1. INTRODUCTION :

The lateral loads on the buildings is plays an important role in the design of high structures. The structures response to wind depends on the wind's characteristics. Tall buildings, usually designed for office or commercial use, are among the most distinguished definitions of space in American urbanism's twentieth-century architectural history. According to National Building Code 2005 building having height more than 15m of India is called a high rise building. Vertical growth of buildings has become an ultimate option available due to the rapid growth of population, the high cost and, for improvement in aesthetic view of city and restriction in horizontal growth due to less space. The Wind can be defined as the large-scale horizontal movement of free air .

In metropolitan cities the creative reinterpretations of the building type by architects, the inadequacy and high cost of land in urban areas, the desire to prevent disorganized urban expansion, the need to maintain significant agricultural production, the idea of skyline, the impact of cultural significance and prestige have all contributed to the fact that buildings may produce excessive construction movement, the dynamics nature of wind is a critical issue, negatively affecting occupancy comfort and serviceability.

Now a days, it is assume that tall buildings are symbol of power, technology, landmark of metro cities but bedside of this if care was not taken before construction of these buildings it can cause undeniable negative effects on the quality of urban life. Today, it is virtually impossible to imagine a major city without tall buildings. Tall buildings are the most famous landmarks of cities, symbols of power, dominance of human ingenuity over natural world, confidence in technology and a mark of national pride

1.1 Minor Modifications

corner roundness, corner recession, chamfered corners, fitting of small fins and vented fins to the corners and slotted corners are the example of minor modification The researcher finds that small corner cut and recession are significantly effective to prevent aero-elastic instability by increasing the aerodynamic damping. For a deep depth rectangular prism, however, this effectiveness by the corner modifications is insignificant. The benefits of corner modification have still remained debated, for these modifications to buildings corners, in some cases, are ineffective and even have negative effects according to wind direction.mentions corner modifications in Taipei 101 building provide *25%* reduction in base moment when compared to the original square section. Holmes (2001) finds that chamfers of the order of 10% of the building width reduces both the along wind response by 40% and the across wind response by 30%, when compared to the rectangular cross sectional shape without any corner modification.

1.2 Major Modification

Modifications such as corner-recession, chamfered corner, helical shape, tapered shape, setback shape are the example of major modification This modification can be grouped into two types according to its effect on structural and architectural concept. Therefore, the major modification, which considerably affects the architectural and structural design of tall buildings, contains tapering, or setbacks along the height, sculptured building shape, openings, varying the shape of buildings, and twisting of building. Building codes admit a reduction of the wind pressure design loads for circular or elliptical buildings up to 40% of those of rectangular buildings.

2. ANALYSIS :

Since the analysis of basic cross section shapes shows that building with rectangular shape has the highest drag, further analysis is concentrated on the building with rectangular C.S. All the building models with aerodynamic modification considered for further analysis has a height of 180 m. The CFD analysis of modified shapes are conducted at 39 m/s (144.4 kmph). After the model formation CFD analysis is done by ansys software and out put is noted .In this reserch work major modification is consider for basically indore bhopal area of madhya pradesh where wind speed is 39 m\s so for analysis purpose four model is consider which detail are given below

2.1 Building With Single Step At Corner

C.S Dimension –
Length is = 150 m, width is =20 m with a single step of 2.5 m × 2.5 m on vertical

2.2 Building with Stepped Cross section (Case 2)

C.S Dimension **:** Length is = 60 m and width is = 20 m (at base and up to 50 m height)

Length is = 45 m and width is =15 m (from 50 m to 100 m height)

Length is = 30 m and width is= 10m (from 100 m to 150 m height)

2.3 Building With Rounded Corner (Case 3)

C.S Dimension : Length is= 60m, width is =20 m , Corner rounded at a radius of 5 m

2.4 Building with Tapered faces (Case 4)

C.S Dimension: Length is = 60 m (at base),width is =20m (at base), Tapering angle 2 degrees in front and rear faces and 6 degrees on other two faces

Table -1 Element and Node detail of different cases

S.No.	Model Mesh	Number of Elements	Number of Nodes
1	Building With Single Step At Corner (Case1)	8945474	9107692
2	Building With Stepped Cross Section (Case2)	8470921	8865089
3	Building With Rounded Corner (Case 3)	9098433	9163888
4	Building With Tapered Faces (Case4)	8870938	9088336

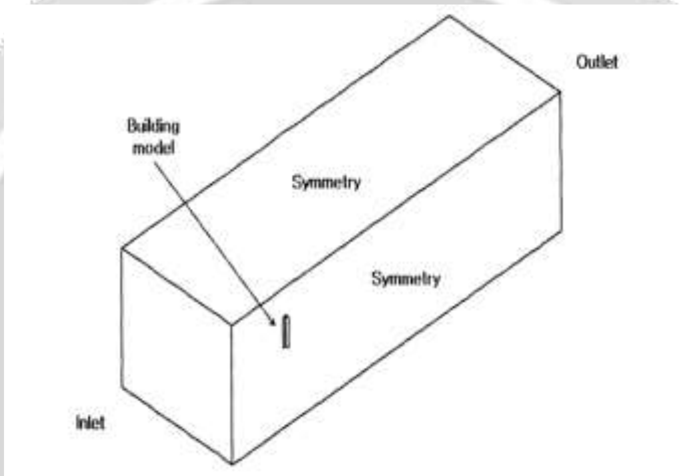

Fig -1 Mess view of structure model

Table -2 Summary of simulation model

S.No.	Description	Detail
1	Reynolds number	1.9 E+6 – 17.8E+6
2	Type of solver	Pressure based-Simple scheme
3	Turbulence model	Standard k-ε
4	Inlet flow velocity	140.4 kmph (39 m/s)
5	Mesh Unstructured	tetrahedral meshing
6	Material properties of fluid domain (air)	Density- 1.225 kg/m3
7	Viscosity-	1.7894e-05 kg/m-s

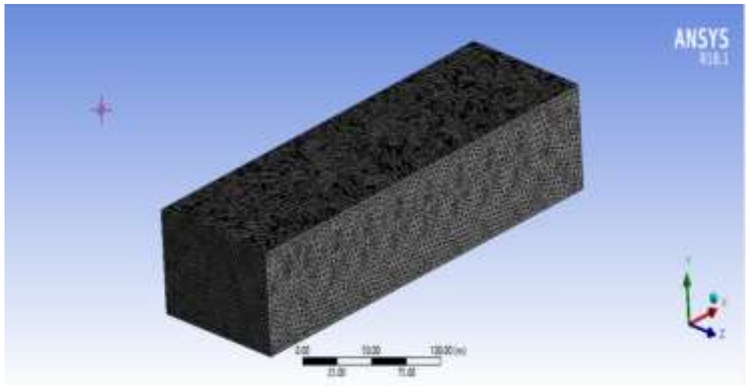

Fig -2 Mess Generation of structure model

3. RESULT

wind force coefficient and wind moment coefficient acting on the wall of each of various models. The reason that wind force coefficient of each model has the mean value of about 0.15 to 0.18 is that a certain force acts on the front face of a building model. As vortices are shed alternatively first from one side and then the other side after the flow develops, the feature that coefficient values fluctuate within certain ranges is shown. Wind force coefficient acting on left and right side of a building model has a mean value of about 0.0. For the force acting on these sides, vortices are shed alternatively to the left and the right side of a model, thereby inducing pressure difference. Like wind force coefficients in the direction of the wind and two sides of a building, wind moment coefficient shows similar patterns.

3.1 Results of change drag coefficient of different model of tall structure

From the analysis carried out in the aerodynamic modification of building with rectangular C.S with rounded corners edges have the least drag

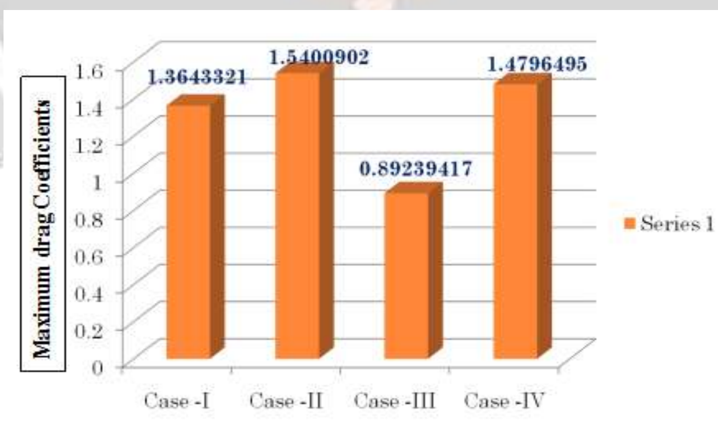

Chart -1 Variation of drag Coefficients at different height

3.2 Results of change maximum drag Force of different model of tall structure

From the analysis carried out in the aerodynamic modification of building with rectangular C.S with rounded corners edges have the drag force 10789.438 kN which is least.

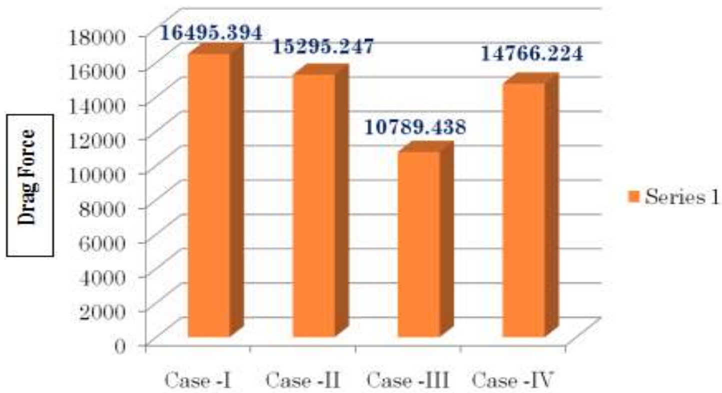

Chart -1 Variation of drag force at different height (kN)

3.3 Results of change in Bending moment of different model of tall structure

From the analysis carried out in the aerodynamic modification of building with rectangular C.S with rounded corners edges have the least moment equall to 1618.41 kN m.

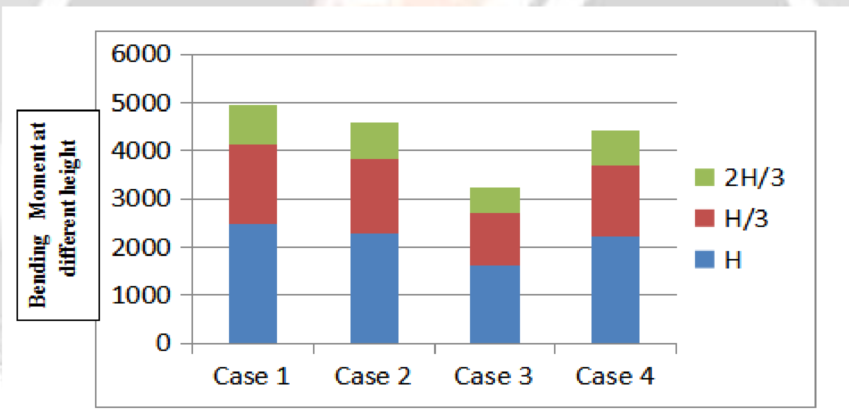

Chart -1 Variation of bending moment at different height (kN-m)

4. CONCLUSIONS

After calculating the factors, it was found that, Case-III (building with tapered faces) all three values are coming minimum such as for case-I Drag coefficient is 0.89239417, drag force is 10789.438 kN and bending moment is 1618.41kN m From the analysis carried out in the aerodynamic modification of building with rectangular C.S with rounded corners edges have the least drag

5. REFERENCES

[1]. Amin and Ahujab ASIAN Asian journal of civil engineering(building and house) Vol.11, No.4, (2010) pages 433-450

[2]. Shyam Baby ,Jithin P N, Anna M Thomas 2015 IJEDR | Volume 3, Issue 4 | ISSN: 2321- 9939Y.

[3]. Ahmed Elshaer , Girma Bitsuamlak , Ashraf El Damatty Aerodynamic shape optimization of tall buildings using twisting and corner Modifiifications, 8th International Colloquium on Bluff Body Aerodynamics and Applications Northeastern University, Boston, Massachusetts, USA June 7 - 11, 2016
[4]. Neethi B. International Journal of Engineering Research & Technology(IJERT)IJERTV7IS050095 Vol. 7 Issue 05, May-2018
[5]. Amin J.A. and Ahuja A.K., 2010, Aerodynamic Modifications to the Shape of the Buildings: A Review of the State-of-the-Art, Asian Journal of Civil Engineering (Building and Housing) Vol. 11, No. 4 (2010)
[6]. Bashor R. and Kareem A. 2007, Probabilistic Performance Evaluation of Buildings: An Occupant Comfort Perspective, ICWE12 Cairns 2007.
[7]. Xie Z.N., Gu M. 2007, Simplified Formulas for Evaluation of Wind-Induced Interference Effects among Three Tall Buildings, Journal of Wind Engineering and Industrial Aerodynamics, 95 (2007) 3