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ANALYSIS OF STEEL CHIMNEY SUBJECTED TO DYNAMIC WIND LOAD BY VARYING ITS GEOMETRY, DIAMETER AND HEIGHT

Sumeet Jadhav[*1] & Nagesh Shelke[2]
[*1]PG Student, Department of civil engineering DYPSOET, India
[2]Associate professor, Department of civil engineering DYPSOET, India

ABSTRACT

A Chimney is a structure that is used for removing hazardous gases from furnace and from big industry plants to outdoor atmosphere. Chimneys are generally vertical structure as far as possible to make sure that the hazardous gases flow easily and quickly by taking air into the combustion. Industrial Chimneys are having greater heights and slender structures with circular cross-sections. The height of a chimney determines its capability to pass gases to the outside environment via stack effect. Also, the dispersion of hazardous gases at greater heights can minimize their effect on the immediate surroundings. The project is based on the design concepts of chimneys according to Indian codes provisions and analyse through finite element method. Different types of steel chimney models are made by varying its height, geometry and diameter. The main objective of this study is to perform vibration analysis of steel chimney for dynamic wind loads using different critical velocity. Natural frequency and time period has been found out using analysis in Ansys. All the models are modelled in the Ansys Software

Keywords: *Ansys, critical velocity, natural frequency, steel chimney, vibration*.

I. INTRODUCTION

Chimneys are tall and slender structures with uniform or tapering circular cross-sections that are installed for releasing hot flue gases or smokes produced in any industrial furnaces, boilers or fireplaces into the higher heights of the atmosphere. Chimneys are designed as tall vertical structures in such a way that they release unwanted harmful gases smoothly by drawing air into the combustion, which is referred as the “Stack Effect”. Height of the stack is an influential parameter in affecting its transferability of flue outputs. Different construction materials, such as concrete, steel or masonry, are used for their construction, each of them having different stability conditions and design criteria. Undertaken work deals with industrial Steel chimneys only. Fig.1.1 shows steel chimneys located in an industrial campus.

Steel chimneys are classified on the basis of their supports and shape. Based on support they are classified as cable stayed or guyed chimneys and self-supporting chimneys. Self-supporting chimneys are widely used in the industrial areas. Chimneys up to a height of 80 m or 90 m are considered as short chimneys. Short self-supporting steel chimneys are more commonly preferred and installed in industrial zones as compared to long chimneys.

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Figure 1 Industrial Steel Chimneys (Ref: www.vedomosti.ru)

Geometry of a self-supporting steel chimney plays an important role in its structural behavior under lateral dynamic loading. However, the basic geometrical parameters of the steel chimney (e.g., overall height, diameter at exit, etc.) are associated with the corresponding environmental conditions. Steel chimneys to ensure a desired failure mode.

Two important IS-4533: 1989 recommended geometry limitations for designing self-supporting steel chimneys are as follows:
i) Minimum outside diameter of the unlined chimney at the top should be one twentieth of the height of the cylindrical portion of the chimney.
ii) Minimum outside diameter of the unlined flared chimney at the base should be 1.4 time the outside diameter of the chimney at top

II. PROBLEM STATEMENT

Details of the chimney are as follows,

1. Height of the chimney – 30m
2. Outer diameter of chimney at bottom – 3.2m
3. Outer diameter of chimney at top – 3.2m
4. Thickness of shell at bottom –0.02
5. Thickness of shell at top – 0.02
6. Height to base diameter ratio – 1.6
7. Base diameter to top diameter ratio – 1.6
8. Basic wind speed – 39m/s
9. Terrain category -2
10. Class of structure – c
11. Risk coefficient k1 – 1
12. Topography factor k3– 1

Table 1. Nomenclature of Modeled Steel Chimney

MODEL NO.1	Uniform 30m
MODEL NO.2	Uniform 45m
MODEL NO.3	Uniform 60m
MODEL NO.4	Tapered 30m

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MODEL NO.5	Tapered 45m
MODEL NO.6	Tapered 60m
MODEL NO.7	Uniform + Tapered 30m
MODEL NO.8	Uniform + Tapered 45m
MODEL NO.9	Uniform + Tapered 60m

III. METHODOLOGY

Following methodology is adopted for this research:

IV. RESULT & DISCUSSION

The results and discussion may be combined into a common section or obtainable separately. They may also be broken into subsets with short, revealing captions.

All the results that were obtained in terms of static wind responses and dynamic responses for all 9 steel stack models ranging from Model-1 to Model-9 are presented here.

Comparison of 30m Steel Chimney with different parameters for different Shapes.

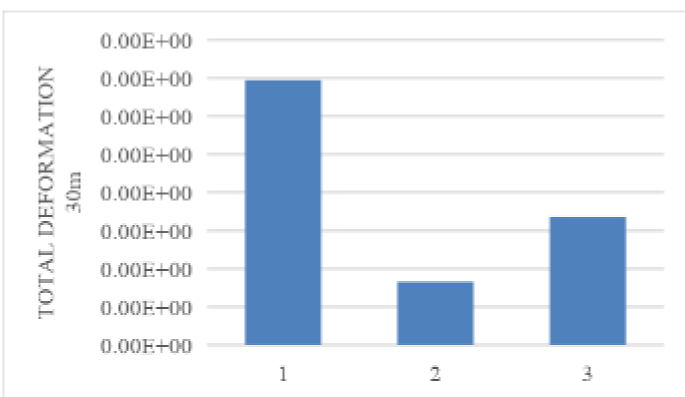

Figure 2 Total Deformation in 30m High Chimney for Different Shapes

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From the figure 2, it is observed that maximum deformation considerably reduces in tapered section for static and dynamic load. The deformation reduces by 50-60% due narrow shape at top which reduces its load intensity

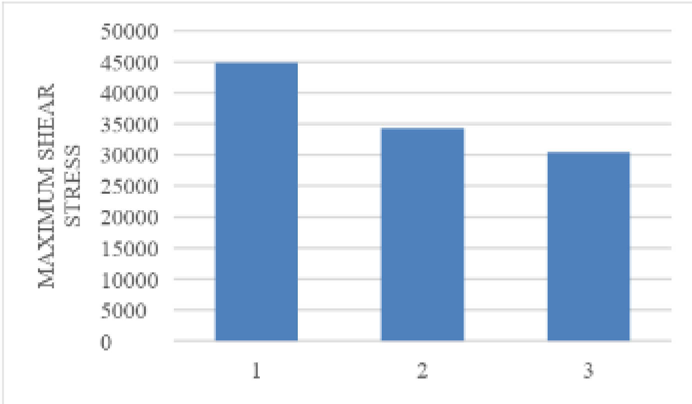

Figure 3 Maximum Shear Stress in 30m High Chimney for Different Shapes

From the figure 3, it is seen that maximum Shear stress reduces in tapered and uniform + tapered section for static and dynamic load.

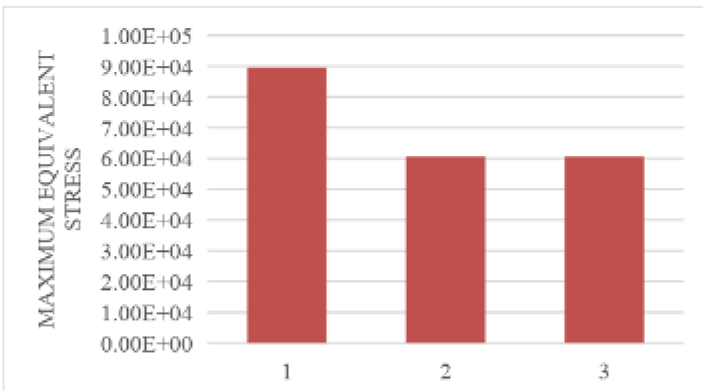

Figure 4 Maximum Equivalent Stress in 30m High Chimney for Different Shapes

From the Figure 4, it is observed that maximum equivalent stress reduces in tapered and uniform + tapered section for static and dynamic load and are almost equal.

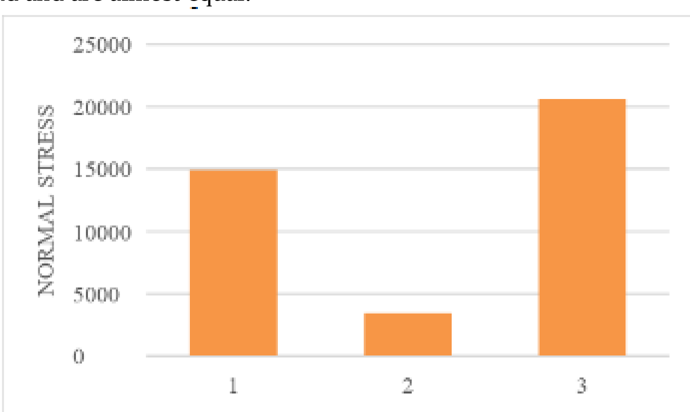

Figure 5 Normal Stress In 30m High Chimney for Different Shapes

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From the figure 5, it is observed that Normal Stress considerably reduce in tapered section for static and dynamic load

Comparison of 45m Steel Chimney with different parameters for different Shapes.

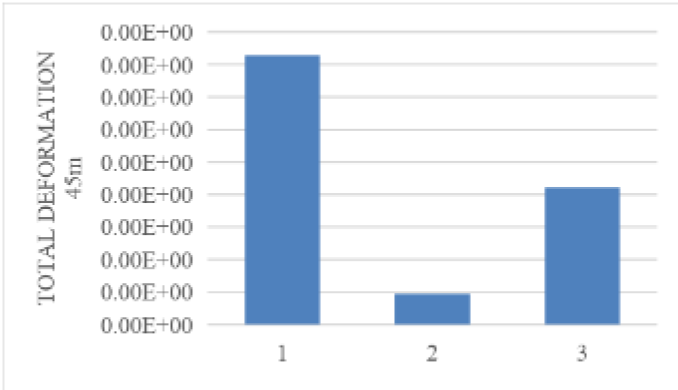

Figure 6 Total Deformation in 45m High Chimney for Different Shapes

In the above graph, it is observed that maximum deformation considerably reduce in tapered section for static and dynamic load.

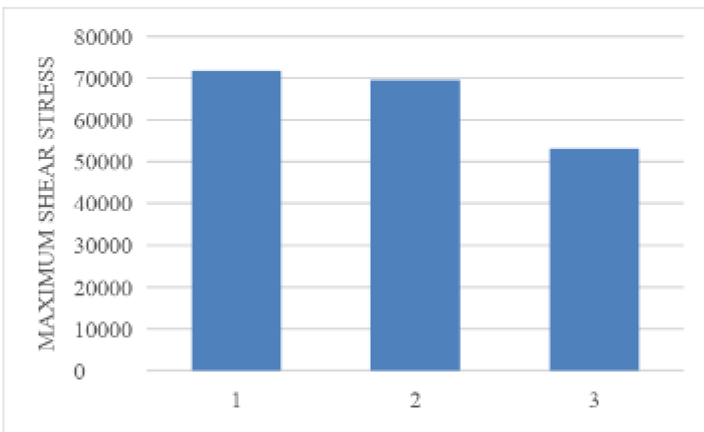

Figure 7 Maximum Shear Stress in 45m High Chimney for Different Shapes

In the above graph, it is observed that maximum Shear stress reduces in uniform + tapered section for static and dynamic load.

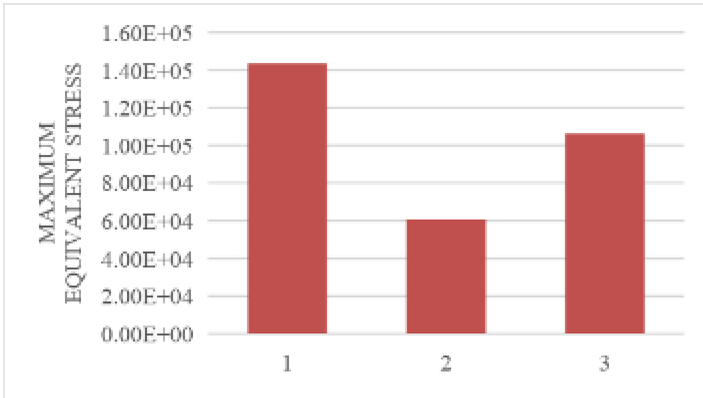

Figure 8 Maximum Equivalent Stress in 45m High Chimney for Different

From the above graph, it is observed that maximum equivalent stress considerably reduces in tapered for static and dynamic load. Shapes

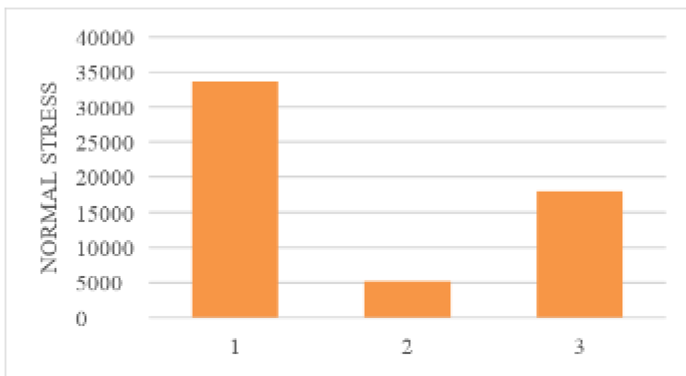

Figure 9 Normal Stress in 45m High Chimney for Different Shapes

In the above graph, it is observed that Normal Stress considerably reduce in tapered section for static and dynamic load.

Comparison of 60m Steel Chimney with different parameters for different Shapes

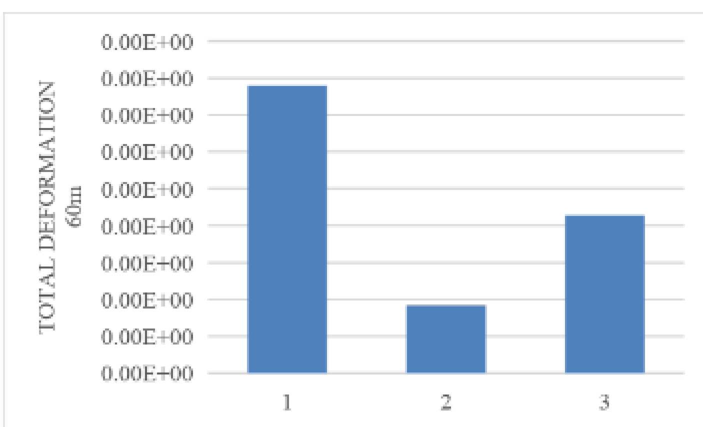

Figure 10 Total Deformation in 60m High Chimney for Different Shapes

From the figure 10, it is observed that maximum deformation considerably reduce in tapered section for static and dynamic load.

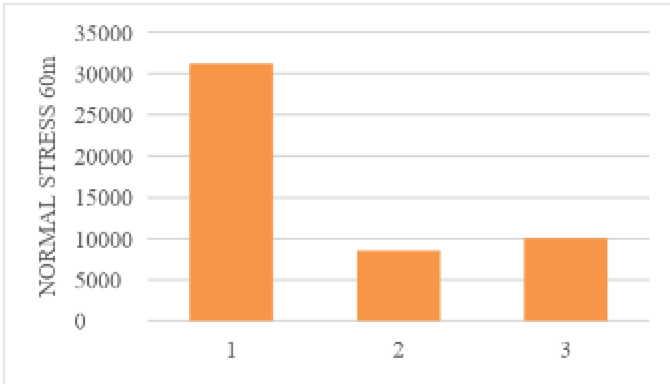

Figure 11 Normal Stress in 60m High Chimney for Different Shapes

From the figure 11, it is observed that Normal Stress considerably reduce in tapered section for static and dynamic load.

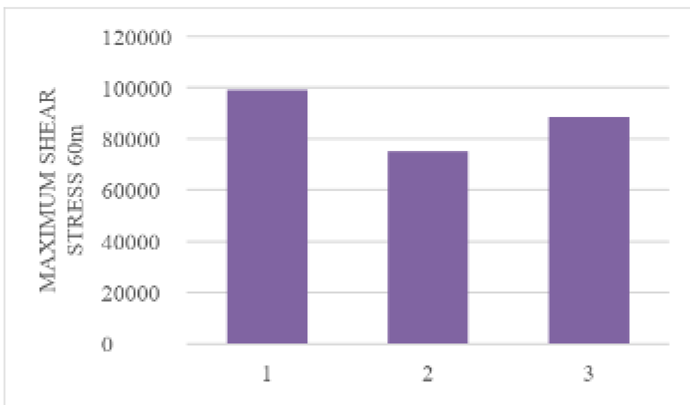

Figure 12 Maximum Shear Stress in 60m High Chimney for Different Shapes

From the figure 12, it is observed that maximum Shear stress reduces in tapered section for static and dynamic load

V. CONCLUSION

In this study, wind response of steel chimney is studied subjected to wind and following conclusions are made

1. The critical velocity is observed highest for mode shape 6 in all the cases.
2. The total deformation are observed to be 50-60% less in tapered section than others.
3. All stresses are varying linearly for all terrain categories.
4. Normal Stresses considerably reduces (70-80%) in tapered section for static and dynamic load

VI. ACKNOWLEDGEMENTS

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