

Analytical Behaviour of Steel Chimney Subjected to Dynamic Loading

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ABSTRACT: Chimneys are tall structures and the major loads acting on these are self weight of the structure, wind load, earthquake load & temperature loads. In this paper the structural behaviour of the 40m above height bio medical waste disposal steel chimney in trichy sengipatti has been investigated. This report summarizes results collected from about 6month of continuous measurement and regular observations of the chimney. Steel chimneys are designed considering dead load, wind load and earthquake load. Geometry of a self supporting steel chimney plays an important role in its structural behavior under lateral dynamic loading. This is because geometry is primarily responsible for the stiffness parameters of the chimney. However, basic dimensions of industrial self supporting steel chimney, such as height, diameter at exit, etc., are generally derived from the associated environmental conditions. To ensure a desired failure mode design code (IS-6533: 1989 Part 1 and part 2) imposes several criteria on the geometry of steel chimneys. The objective of this report is to justify the code criteria with effect of wind and seismic load on industrial steel chimney. In future work the analysis will be carried out using ANSYS software. Analysis such as response to earthquake and wind oscillations has become more critical to influence on the response and design of chimney. The results will be obtained from the above cases are compared. Finally, the maximum values obtained in wind analysis and seismic analyses are then compared for deciding the design value. A comparison with some other chimney reported literature shows that bio medical waste disposal steel chimney is unique in height and slenderness. There is a need for revising the calculation model for vortex shedding of very slender chimney that is for chimney with slenderness ratio height through diameter above approximately 30.

I. INTRODUCTION

Most of the industrial steel chimneys are tall structures with circular cross-sections. Such slender, lightly damped structures are prone to wind-excited vibration. Geometry of a self supporting steel chimney plays an important role in its structural behavior under lateral dynamic loading. This is because geometry is primarily responsible for the stiffness parameters of the chimney. However, basic dimensions of industrial self supporting steel chimney, such as height, diameter at exit, etc., are generally derived from the associated environmental conditions.

Hence in this research work, the steel chimney of Thanjavur, The Bio medical waste incinerating yard set up by the Medicare Environ Systems at sengipatti, 21 kms from Thanjavur is chosen. The main objectives of the research are:

- To develop a finite element modal using ANSYS software
- To Analysis the self supported steel chimney with different foundation parameter (base diameter, height, stiffening ribs)
- To study the effect of wind load on steel chimney
- To create and Analysis the Taguchi technique using mini tab software
- To find out the best modal through that analysis and to Analysis the effect of seismic load on steel chimney

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II. METHODOLOGY

The initial design calculations were made by using suitable design considerations and the following steps were adopted.

- First create the modal using Pro-E software
- Save to IGES(Initial graphics exchange system) format
- Import to an IGES file into ANSYS software
- Specify the element type
- Specify the material type
- Provide the meshing
- Provide wind loading
- Analysis
- Create Taguchi technique using mini tab software
 - 3 parameters
 - 9 combinations
- Analysis the Taguchi technique
 - Equivalent stress and S/N ratio graph plot
- Evaluate results
- Find the suitable foundation parameter of modals
- Defining the Earthquake loads in Selected modals
- Determining time limits
- Evaluation of dynamic results

DIFFERENT FACTORS OF STEEL CHIMNEY

Table 1: Various Steel Chimney Parameters of Taguchi Method

	Factors/parameters name	Level 1	Level 2	Level 3
A	The base diameter of foundation(m)	12	13	14
B	Height(m)	2.5	3.5	4
C	Stiffening ribs(no's)	4	6	8

Table 2: Orthogonal Array For L9

Modal No	Stiffening ribs(no's)	The base diameter of foundation(m)	Height of foundation(m)
1.	4	12	2.5
2.	4	13	3.5
3.	4	14	4
4.	6	12	3.5
5.	6	13	4
6.	6	14	2.5
7.	8	12	4
8.	8	13	2.5
9.	8	14	3.5

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IV. RESULTS

FINITE ELEMENT MODALS

The finite element modal analysis was done. The total deformation of modals and their equivalent stresses were given in table 3.

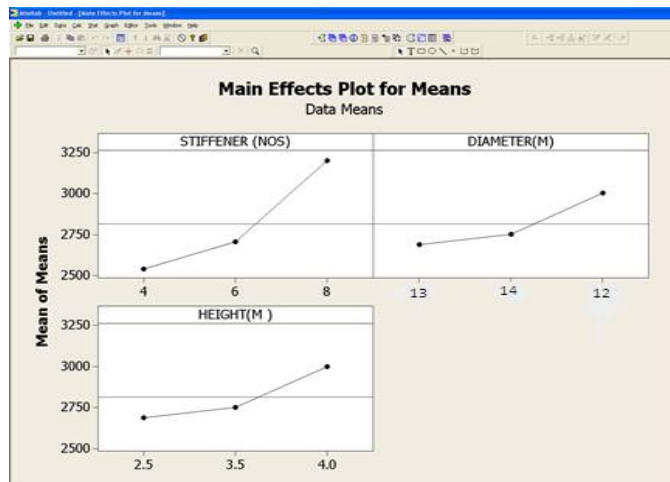
Table 3: Equivalent Stress and Total Deformation of Modals

Model no	Stiffening ribs (no's)	Base diameter of foundation(m)	Height of foundation(m)	Equivalent stress(Pa)	Total Deformation(m)
1	4	12	2.5	2505.5	4.7519X10-9
2	4	13	3.5	2504.5	5.4344X10-9
3	4	14	4	2605	4.822X10-9
4	6	12	3.5	2484.9	4.3476X10-9
5	6	13	4	2900.6	5.4467X10-9
6	6	14	2.5	2724.4	5.4568X10-9
7	8	12	4	3500.8	6.48X10-9
8	8	13	2.5	2835.8	5.2492X10-9
9	8	14	3.5	3266.1	6.0456X10-9

THE TAGUCHI DESIGN

The Taguchi design procedure was adopted step by step and the results were shown by the following figures.

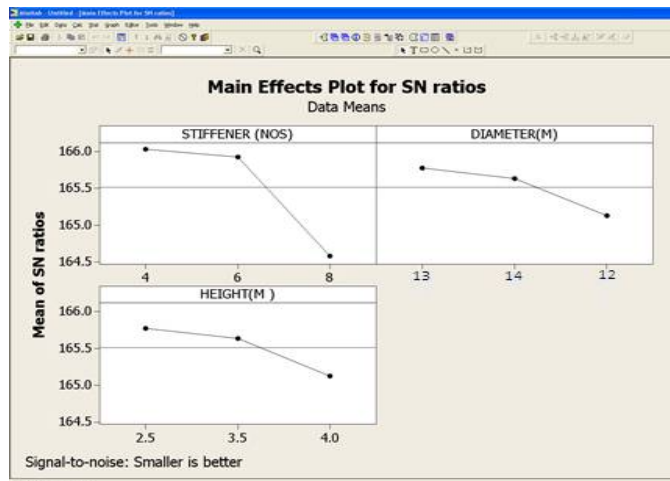
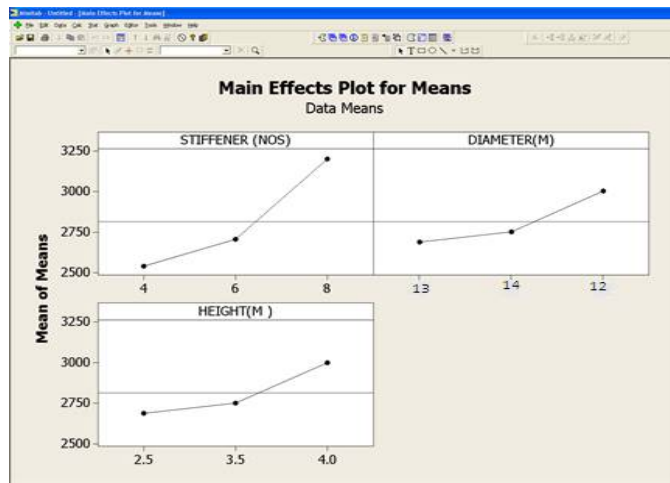
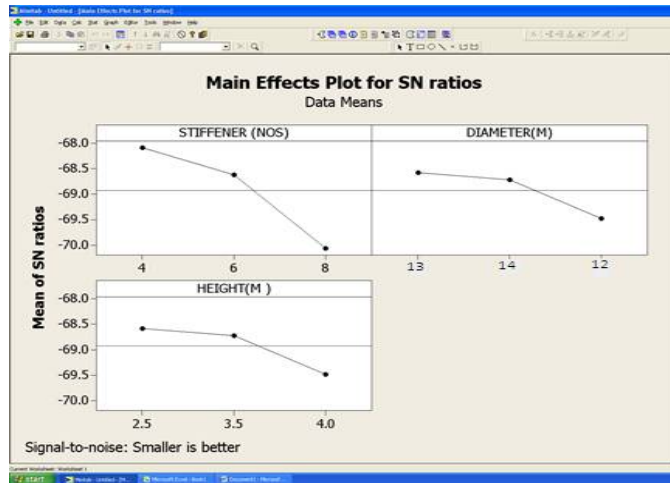
Stress graph and Deformation graph



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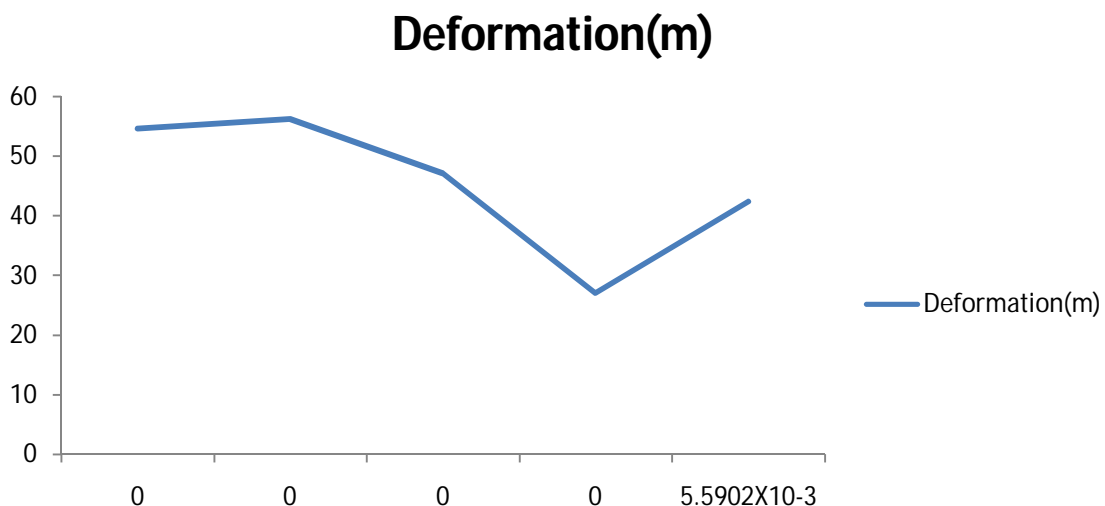
- Better result is found from these analysis that gives maximum result in mean and minimum result in SN ratio of self supported steel chimney with different foundation parameters. Therefore the suitable parameter of foundation is
 - Stiffening ribs = 8 no's
 - Base diameter of foundation = 12m
 - Height of foundation = 4m
- Take the selected modal for analysis under the seismic loads

MODAL ANALYSIS UNDER SEISMIC LOADS

The modals were analysed under different seismic loads and their deformations were tabulated in table 4.

Table 4: Frequency Vs Deformation

Mode no	Frequency(hz)	Deformation(m)
1	0	54.645
2	0	56.266
3	0	47.102
4	0	27.096
5	5.5902X10 ⁻³	42.385



Frequency Vs Deformation

V. CONCLUSION

It is found from this analysis that gives maximum deformation and maximum equivalent stress due to wind load in a self-supporting steel chimney with different combinations of foundation parameters. Three parameters consider for my project. And also in my project report present a step by step procedure for designing self supporting Steel chimney

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using IS: 875(Part 3):1987, IS 1893 part 4:2005 and IS 1893 part 1:2002 standards. The relation between the different foundation parameter and corresponding deformation and stress compared by mini tab software. This analysis gives maximum mean result and minimum SN ratio result for best one and evaluate from the modal analysis due to seismic loading a self-supporting steel chimney. There is a need for revising the calculation model for vortex shedding of very slender chimney that is for chimneys with slenderness ratio (height through diameter) above approximately 30.

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