

COUPLED FIELD ANALYSIS OF A CHIMNEY USED IN CEMENT INDUSTRY

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ABSTRACT Chimney, which form the last component of a system using a flue gas such as boiler, play a vital role in maintaining efficiency, draft, etc, of a system and also in minimizing the atmospheric pollution. Steel chimneys are also known as steel stacks. The steel chimneys are made of steel plates and supported on foundation. The steel chimneys are used to escape and disperse the flue gases to such a height that the gases do not contaminate surrounding. In this thesis, chimney will be designed considering dead load and wind load. The Bureau of Indian Standards (BIS) design codes procedures will be used for the design of the chimney. The chimney was considered as a cantilever beam with annular cross section. 3D model of the chimney is done in Pro/Engineer and coupled field analysis is done on the chimney in ANSYS. A simplified model of chimneys with various thicknesses like 10mm, 12mm, 14mm and 16mm were modeled atmosphere.

Keywords Chimney, Flue Gases, Coupled Field Analysis

I. INTRODUCTION Chimneys or stacks are very important industrial structures for emission of poisonous gases to a higher elevation such that the gases do not contaminate surrounding atmosphere. These structures are tall, slender and generally with circular cross-sections. Different construction materials, such as concrete, steel or masonry, are used to build chimneys. Steel chimneys are ideally suited for process work where a short heat-up period and low thermal capacity are required. also, steel chimneys are economical for height up to 45m. Fig. 1 shows a photograph of self-supporting steel chimneys located in an industrial plant.



Fig. 1: Shows a Photograph of Self-Supporting Steel Chimneys Located in an Industrial Plant

primarily responsible for the stiffness parameters of the chimney. However, the basic geometrical parameters of the steel chimney (e.g., overall height, diameter at exit, etc.) are associated with the corresponding environmental Conditions.

II. Literature Review

1. Menon and Rao(1997) reviews the code measures to estimate the across wind response of reinforced concrete chimney. In this paper, the difficulties in the codal evaluation of across wind moments and load factor provisions are examined through reliability approach. This paper mainly suggest that it is essential to design at certain conditions for the acrosswind loading [3].
2. K.R.C. Reddy, O.R.Jaiswal and P.N.Godbole (2011) discusses about wind and earthquake analysis of tall reinforced concrete chimney. In this paper two reinforced concrete chimneys are analysed for wind and earth quake loads. Earth quake analysis is done as per IS 1893 (part 4): 2005 and wind analysis is done as per IS 4998 (part 1): 1992. The combination of along & across wind loads of chimney is done as per ACI 307-98 code. Finally they computed the governing load for design of chimneys.
3. B. SivaKonda Reddy, C.Srikanth, V.RohiniPadmavathi (2012) discusses about wind load effects on tall reinforced concrete chimneys. In this paper they considered 275m reinforced concrete lined chimney. The study of this paper is along & across wind effects on this RCC Chimney for I and VI wind zones of India. Finally they concluded that, for Wind zone –I across wind loads are governing and for wind zone-VI along wind loads are governing rather than the across wind loads .

III. Problem Description & Methodology The objective of this project is to make a 3D model of the chimney and study the thermal and static behavior of the chimney by performing the finite

element analysis. 3D modeling software (PRO-Engineer) was used for designing different geometries (10mm, 12mm, 14mm and 16mm thickness) and analysis software (ANSYS) was used for thermal and static analysis. The methodology followed in the project is as follows:

- Create a 3D model of the steam chimney using parametric software pro-engineer.
- Perform thermal analysis and linear layer thermal analysis on the chimney for thermal loads, to find out the temperature distribution and heat flux
- Perform static analysis and linear layer static analysis on the chimney for thermal loads, to find out the deformation, stress and strain distribution.

IV. Introduction to CAD Throughout the history of our industrial society, many inventions have been patented and whole new technologies have evolved. Perhaps the single development that has impacted manufacturing more quickly and significantly than any previous technology is the digital computer

1. Introduction to PRO/Engineer Pro/ENGINEER, PTC's parametric, integrated 3D CAD/CAM/ CAE solution, is used by discrete manufacturers for mechanical engineering, design and manufacturing. Created by Dr. Samuel P. Geisberg in the mid-1980s, Pro/ENGINEER was the industry's first successful parametric, 3D CAD modeling system. The parametric modeling approach uses parameters, dimensions, features and relationships to capture intended product behavior and create a recipe which enables design automation and the optimization of design and product development processes.

B. Introduction to Finite Element Method Finite Element Method (FEM) is also called as Finite Element Analysis (FEA). Finite Element Method is a basic analysis technique for resolving and substituting complicated problems by simpler ones, obtaining approximate solutions Finite element method being a flexible tool is used in various industries to solve several practical engineering problems. In finite element method it is feasible to generate the relative results. ANSYS is an Engineering Simulation Software (computer aided Engineering). Its tools cover Thermal, Static, Dynamic, and Fatigue finite element analysis along with other tools all designed to help with the development of the product. The company was founded in 1970 by Dr. John A. Swanson as Swanson Analysis Systems, Inc. SASI. Its primary purpose was to develop and market

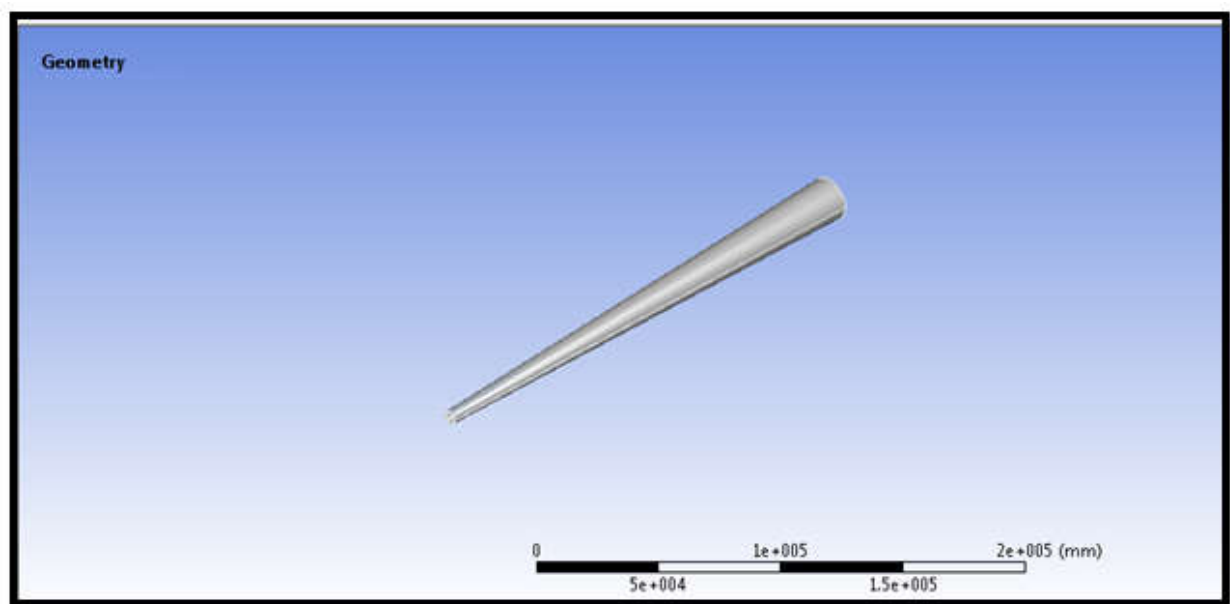
finite element analysis software for structural physics that could simulate static (stationary), dynamic (moving) and heat transfer (thermal) problems.

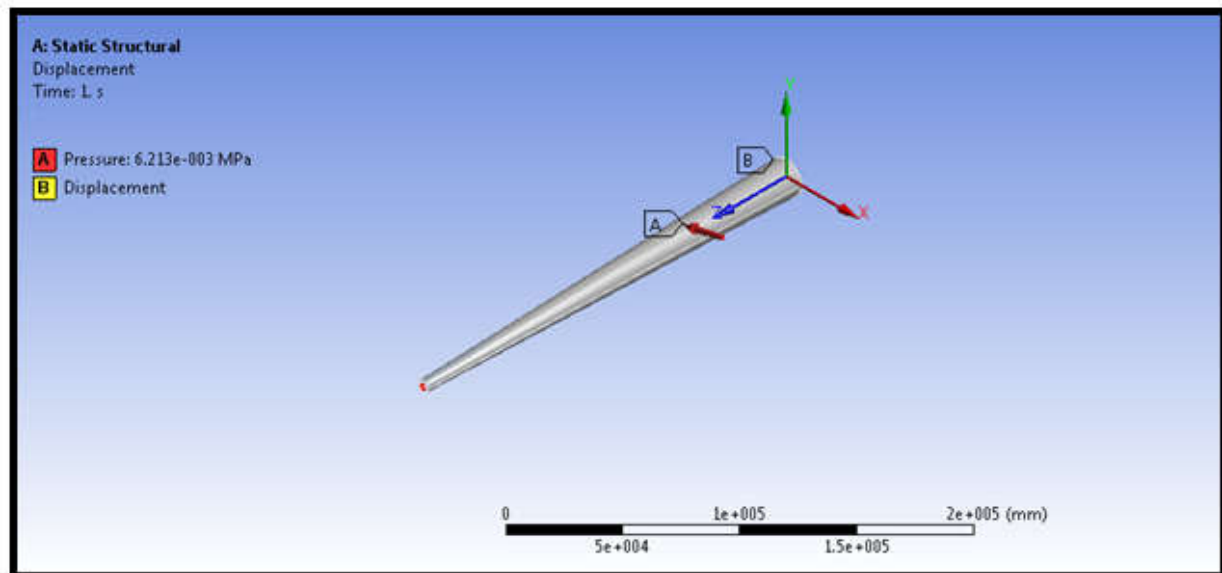
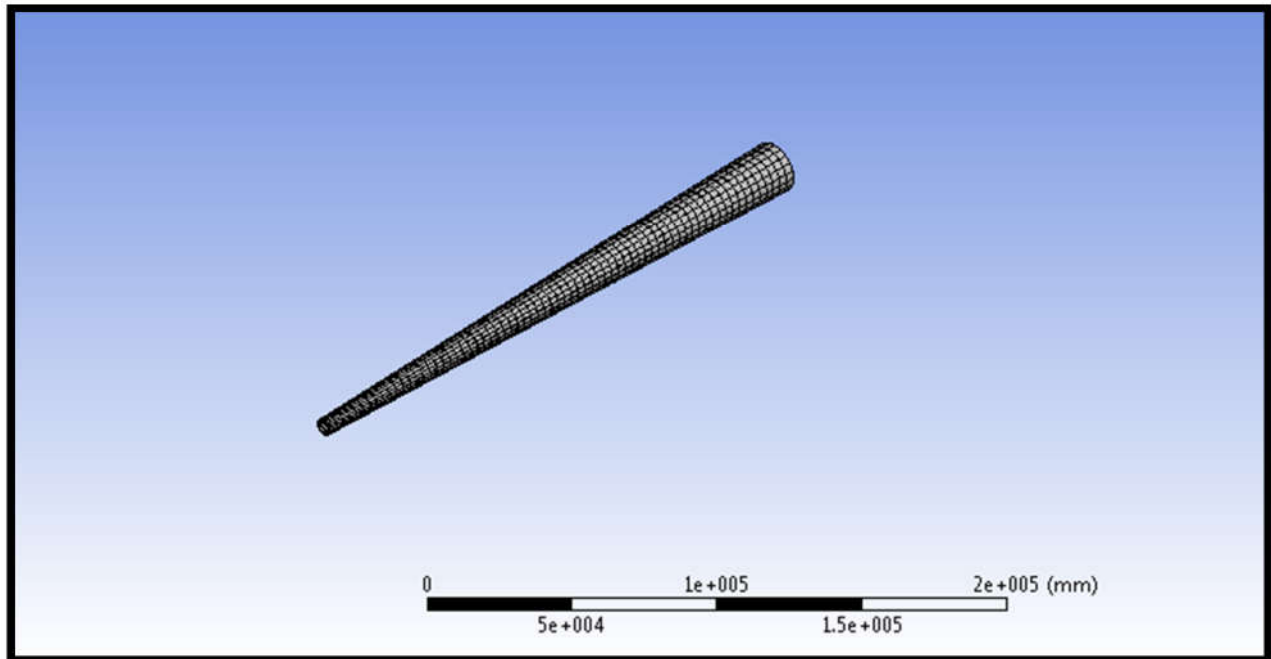
V. Modelling and Analysis

A. Models of Narrow Plate Using Pro-e Wildfire 5.0 The vertical narrow plate is modeled using the given specifications and design formula from data book. The isometric view of vertical narrow plate is shown in below figure. The vertical narrow plate profile is sketched in sketcher and then it is extruded vertical narrow plate using extrude option

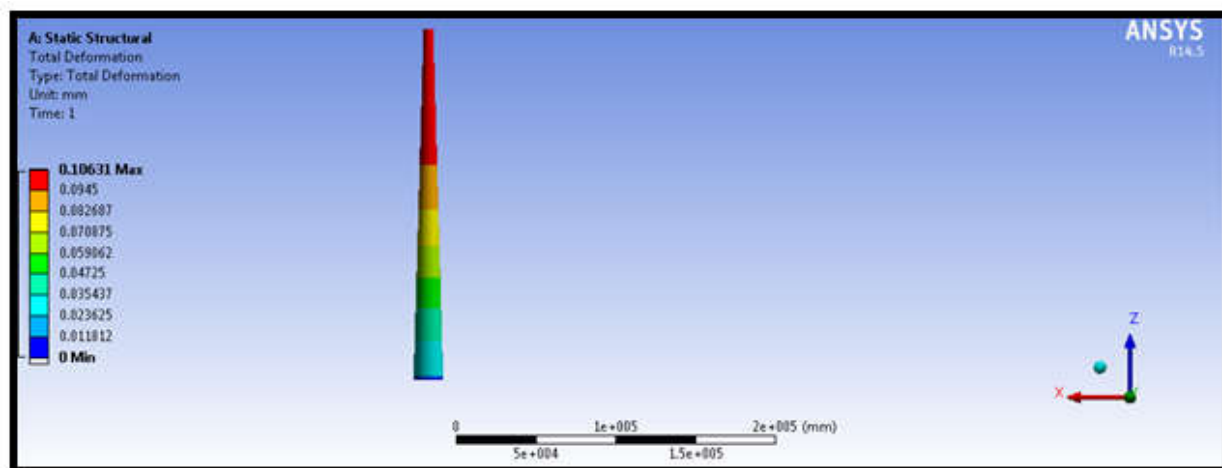
Without Insulation

5.1.1 Material -Concrete

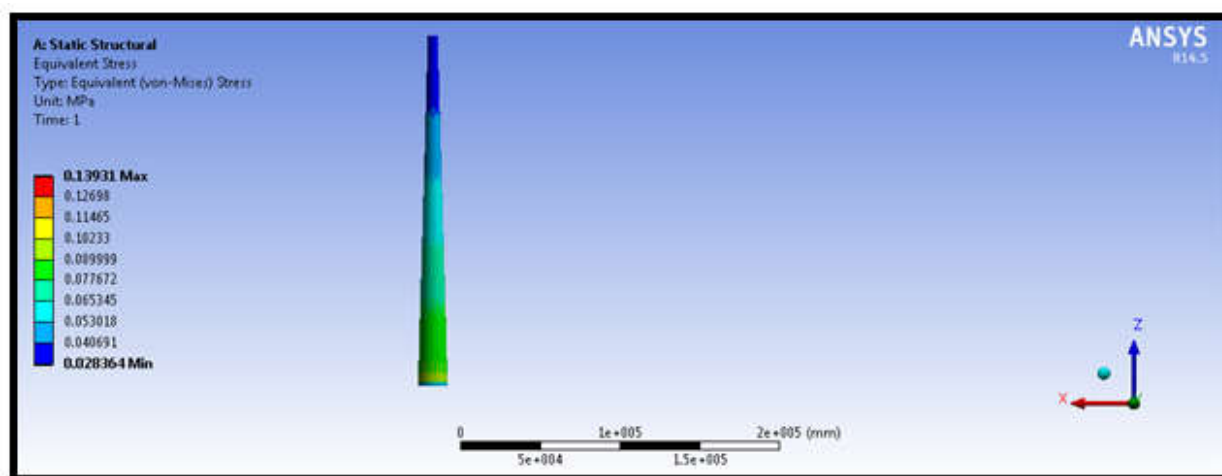




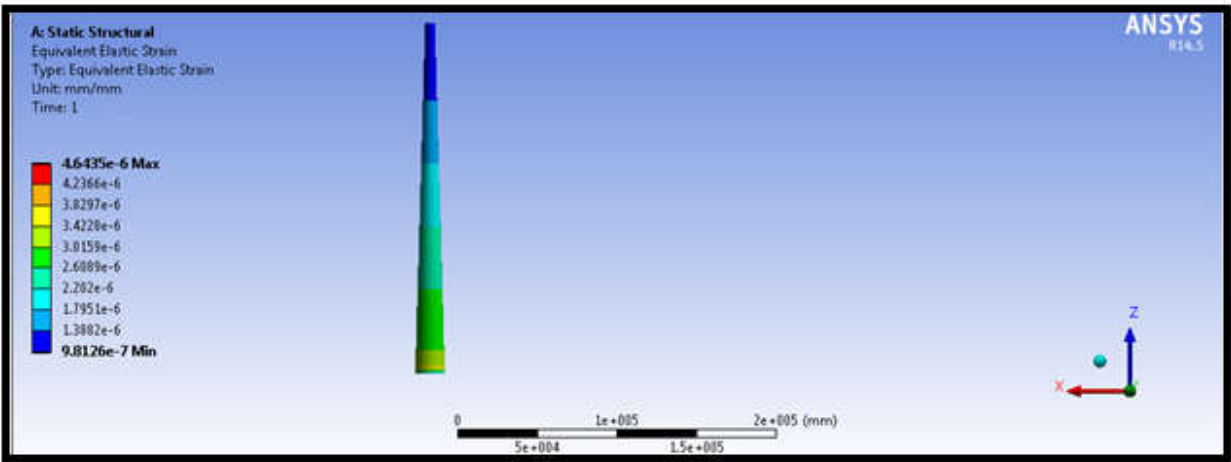
Deformation



Stress

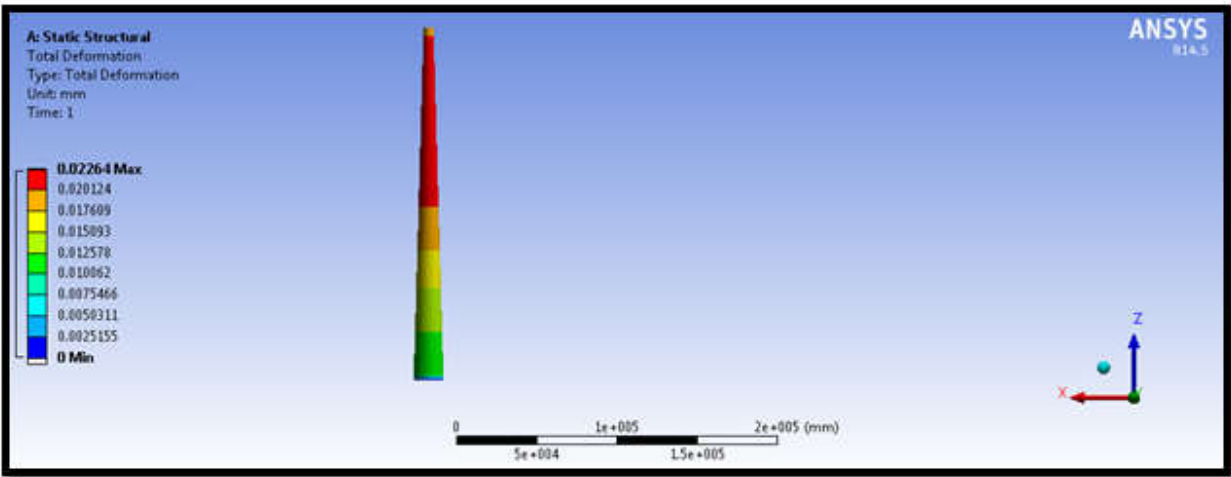


Strain

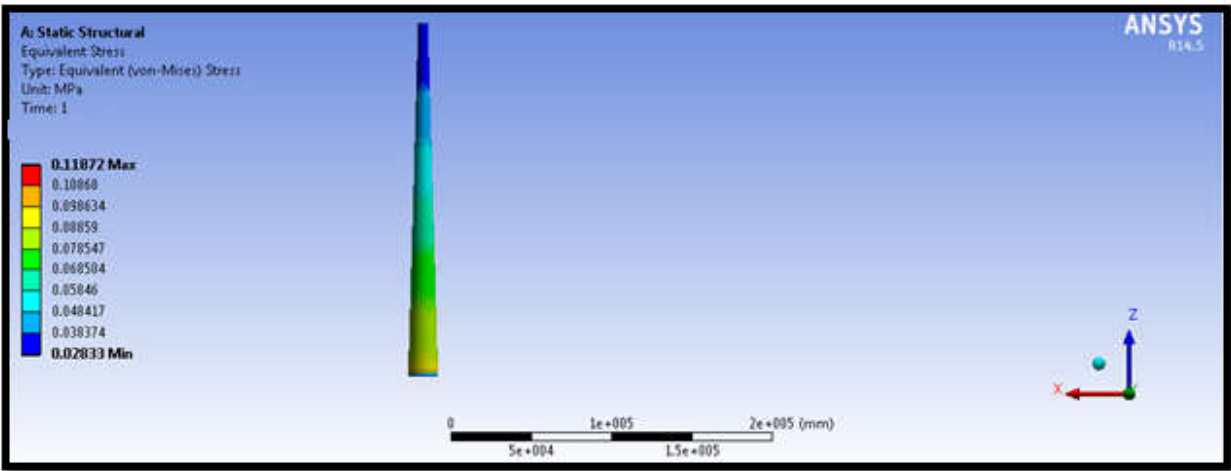


5.1.2 MATERIAL -CARBON EPOXY

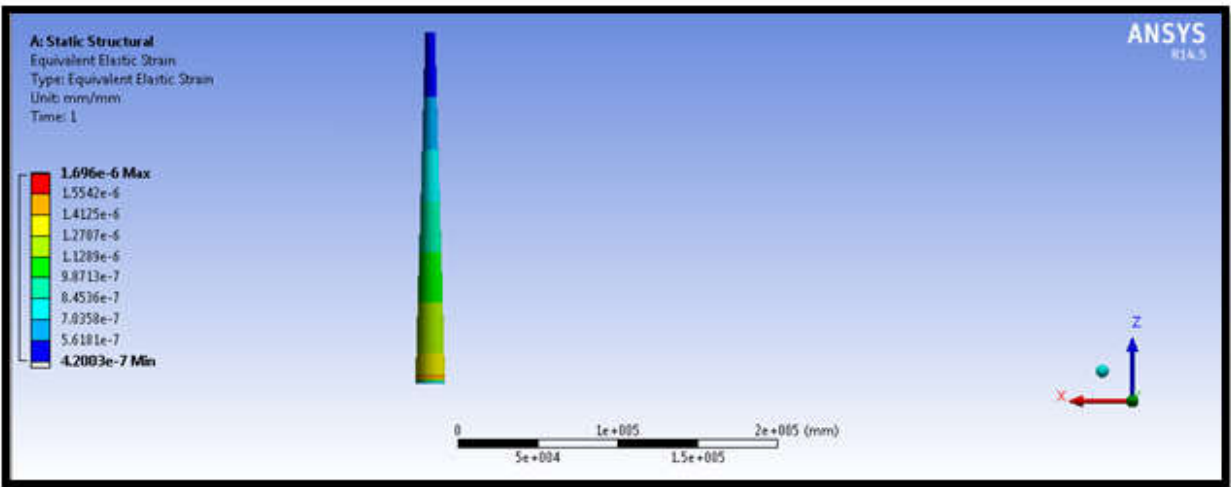
Deformation



Stress



Strain



CONCLUSION 3D model of the chimney is done in Pro/Engineer and coupled field analysis is done on the chimney in ANSYS. A simplified model of chimneys with various thicknesses like 10mm, 14mm, 18mm, and 22mm were modeled. By Observing the thermal analysis the heat flux value is more for original model of chimney and linear layer thermal analysis the heat flux value is more for 10mm thickness of chimney model. When we compare the thermal analysis and linear layer thermal analysis the heat flux more for linear layer thermal analysis of chimney. By observing the static analysis the deformation and stress values are less for 22mm thickness of the chimney and linear layer static analysis the deformation and stress values are less for 22mm thickness of chimney model. When we compare the static analysis and linear layer static analysis the stress values are less for linear layer static analysis of chimney. So it can be conclude the 22 mm thickness of the chimney model is the best model when we do linear layer thermal and static analysis.

REFERENCES

- [1] S.N.Manohar,“Tall chimneys design and construction”, TATA McGraw-Hill Publishing Company Limited-1985.
- [2] Draft copy CED 38(7892): 2013 (third revision of IS 4998(part 1):1992), “Criteria for design of reinforced concrete chimneys”, Bureau of Indian standards, New Delhi, 2013.
- [3] Menon.D, Srinivasrao.P,“Estimation of along wind moments in RC chimneys”, Engineering Structures, Vol. 19, No. 1, pp. 71–78,1997
- [4] K.R.C. Reddy, O.R.Jaiswal, P.N.Godbole,“Wind and earthquake analysis of tall RC Chimney”, International journal of earth science and engineering, Vol. 4, pp. 508- 511, 2011.
- [5] B.Sivakondareddy, V.Rohini Padmavathi, Ch.Srikanth, “Study of wind load effects on tall RC Chimneys”, International Journal of Advanced Engineering Technology, Vol. 3, Issue 2, pp. 92-97, 2012.
- [6] K.R.C. Reddy, O.R. Jaiswal, P.N.Godbole,“Combined design moments of tall reinforced concrete chimneys”, National conference on wind engineering, pp. 135-146, 2012.

[7] M.G. Shaikh, H.A.M.I. Khan, “Governing loads for design of a tall RCC chimney”, Journal of mechanical and civil engineering (IOSRJMCE), pp. 12-19, 2009.

[8] IS 875(part 3): (1987), “Indian standard code of practice for criteria for design loads (other than earthquake) for buildings and structures”, Bureau of Indian standards, New Delhi, Reaffirmed 1997.

[9] IS 1893(part 4): (2005), “Criteria for earthquake resistant design of structures”, Bureau of Indian standards, New Delhi, 2005.

[10] K. Anil Pradeep, C.V. Sivaramaprasad, “Governing loads for design of a 100m RCC chimney”, National conference on new trends in civil engineering, pp. 81-87, 2014.