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A Review Paper on Comparative Analysis of Steel Chimney with and Without Soil Structure Interaction

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Abstract: ***Chimneys are commonly vertical, or as close as likely to vertical to guarantee that the gases stream easily, drawing air into the burning. The tallness of a smokestack impacts its capacity to exchange vent gases to the outside condition by means of stack impact. Also, the scattering of poisons at higher elevations can diminish their effect on the prompt environment. Industrial Fireplaces are tall and thin structures with roundabout cross-areas. The project based on the examination and structure ideas of stacks according to Indian codes arrangements association was likewise made through limited component investigation. The examination of steel stack with and without comparative principle target of this examination is to perform soil structure interaction and vibration analysis subjected to Dynamic wind loads. The effect of manhole opening is also an important parameter for the study.***

Keywords: Ansys, Dynamic Wind, Soil structure interaction, Steel Chimney, Vibration Analysis.

I. INTRODUCTION

Chimneys are very important industrial structures for discharged waste harmful gases at higher elevation in atmosphere. These structures are tall, slender and tapering with circular cross sections. For construction different materials are used such as concrete, steel or masonry. Geometry of a steel stacks plays an important role in behavior of structure under lateral loading. This is because geometry is primarily responsible for the stiffness parameters of the chimney. However, the basic geometrical parameters of the steel chimney (e.g., height of chimney, diameter at bottom, etc.) are associated with the corresponding actual site conditions.

The process in which the response of the soil influences the motion of the structure and the motion of the structure influences the response of the soil is termed as soil-structure interaction (SSI).so in this paper we studying that comparative analysis of self-supporting steel chimney with and without SSI and also to perform the vibration analysis of steel chimney.

Stack is a tall structure attached to a furnace, boiler, combustion chamber or ventilation system by which waste hot gases and solid particulates are discharged at an elevation such that it does not create nuisance to the surrounding environment. Steel chimneys are also known as steel stacks. Flue gases, with abrasive and corrosive characteristics, can damage the structural materials of chimney or liner. While a common impression is that industrial chimneys are simple vertical tubes of steel or concrete, to be forgotten once installed, in practice these are quite complex structures.



Figure -1: Industrial Steel Chimney (Ref: Anonymous)

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II. LITERATURE REVIEW

1) *Kalpesh Dhopat et al (2018)[1] :* This paper summarizes the effect of height to base diameter ratio and top to base diameter ratio on behaviour of self-supported steel chimney. A total of 49 number of steel chimney configured with seven different heights and top diameter of chimney are selected and analysed for wind loadings and seismic loadings as per Indian standards (IS: 6533 part2) and IS 1893(part 4). The effect of geometric parameters on self-supported steel chimney is found out using STAAD pro.
2) *Kalagouda R Patil et al (2017)[2] :* This paper summarizes the analysis and design concepts of chimneys as per Indian codes provisions incorporation was also made through finite element analysis. Chimney models were designed on the basis of constant diameter with change in height taken into consideration. These models were analysed by finite element software STAAD Pro, ANSYS, emphasis also placed on effect of geometric limitations on the design aspects in designing chimney. The main objective of author was to study the design and constructional aspects of steel stack (with particular reference to steel plant) adhering to the guidelines given in internationally accepted standards/codes. Therefore, author had taken a practical case study and carried out design calculations by using the rules of codes viz., IS: 4533 part 1 and 2, IS: 875 part-3, IS: 1893 part1 and 4. Further to get full insight into the design of the steel stacks, a complete 3-D finite element analysis was carried out by using ANSYS software.
3) *M. Pavan Kumar et al (2017)[3] :* This paper presents a computer aided investigation on the seismic and wind effects on chimneys of different heights in the Indian scenario. Self-supporting steel stacks (provided as chimneys) of overall height 90m and 110m subjected to wind and seismic loads are considered in this study. The chimneys are analysed using STAAD.Pro software for seismic Zones II, III, IV and V and wind loads of basic wind speeds 39m/sec, 44msec, 49m/sec, and 50m/sec. Maximum shear force and bending moments developed in the steel stacks along with lateral displacements and mode shapes are determined and compared to study the structural response of steel stacks.
4) *Nimisha Ann Sunny et al (2017)[4]:* This paper includes the analysis of building structure in contact with soil involves an interactive process of stresses and strains developed within the structure and the soil field. The response of Piled-Raft Foundation system to the structure is very challenging because there is an important interplay between the component of building structure and the soil field. Herein, soil - structure interaction of buildings founded on Piled-Raft Foundation is evaluated through Finite Element Analyses using ANSYS v17.0. The building settlement and equivalent stress is computed. The study has been conducted by modeling building with soil and without soil. It is concluded that the interaction of building foundation-soil field and super-structure has remarkable effect on the structure.
5) *Rakshith B D et al (2015)[5]:* This paper summarizes the analysis and design concepts of chimneys as per Indian codal provisions incorporation was also made through finite element analysis. Effect of inspection manhole on the behaviour of Cantilever steel chimney, two chimney models one with the manhole and other without manhole were taken into consideration. These models are analysed by finite element software STAAD Pro, emphasis also placed on effect of geometric limitations on the design aspects in designing chimney.
6) *B. R. Jayalekshmi et al (2015)[6]:* This paper includes Three-dimensional (3D) soil-structure interaction (SSI) analysis of 300mhigh reinforced concrete chimneys having piled annular raft and annular raft foundations subjected to along-wind load is carried out in the present study. To understand the significance of SSI, four types of soils were considered based on their flexibility. The effect of stiffness of the raft was evaluated using three different ratios of external diameter to thickness of the annular raft. The along-wind load was computed according to IS:4998 (Part 1)-1992. The integrated chimney-foundation-soil system was analysed by commercial finite element (FE) software ANSYS, based on direct method of SSI assuming linear elastic behaviour. FE analyses were carried out for two cases of SSI (I) chimney with annular raft foundation and (II) chimney with piled raft foundation. The responses in chimney such as tip deflection, bending moments, and base moment and responses in raft such as bending moments and settlements were evaluated for both cases and compared to that obtained from the conventional method of analysis. It is found that the responses in chimney and raft depend on the flexibility of the underlying soil and thickness of the raft.
7) *K. Sachidanandam et al (2014) [7] :* The author found maximum deformation and maximum equivalent stress due to wind load in a self-supporting steel chimney with different combinations of foundation parameters. Three parameters considered in the paper. And also presented a step by step procedure for designing self-supporting Steel chimney 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 were studied. This analysis had given maximum mean result and minimum SN ratio result for best one and evaluate from the modal analysis due to seismic loading a self-supporting

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steel chimney. There was 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.

8) *Sahoo K et al (2013)[8] :* In this paper the Author carried out analysis of self-supported steel chimney with effect of manhole and geometric properties. Arbitrary models of steel stacks were selected and they were analyzed using ANSYS and Mathcad. Basis of selection of geometric parameters was top to bottom diameter ratio. Limitations of codal conditions were also highlighted. No mathematical equations or correlations were established by the authors for dynamic response variance and variance in geometry.

9) *B. Pallavi Ravishankar et al (2013)[9]:* This paper Tall asymmetric buildings experience more risk during the earthquakes (Ming, 2010). This happens mainly due to attenuation of earthquake waves and local site response which get transferred to the structure and vice versa. This can be well explained by the Dynamic Soil Structure Interaction (DSSI) analysis. In this research paper 150 m tall asymmetrical building with two different foundation systems like raft and pile is considered for analysis and assuming homogeneous sandy soil strata results are studied for input of Bhuj ground motion (2001, M= 7.7). The response of structure in terms of SSI parameters under dynamic loading for a given foundation systems has been studied and compared to understand the soil structure interaction for the tall structures. It has been clearly identified that the displacement at top is more than that at bottom of the building and stresses are more at immediate soil layer under foundation than the below layers.

10) *Gharad A.M. et al (2010)[10]:* In this paper A soil pile system and a soil pile system accompanied with stack like structure (chimney) is analysed. Linear analysis is carried out. For simulating radiation condition at infinity, Kelvin element was considered as boundary condition. Seismic excitations consisting of transient motion (El Centro earthquake time history) is used. Response (top nodes displacement) of a 2D soil pile model system is compared with the response of 3D soil pile model. The response (horizontal displacement) of top node of chimney without soil pile (fixed base) is compared with chimney with soil pile model.

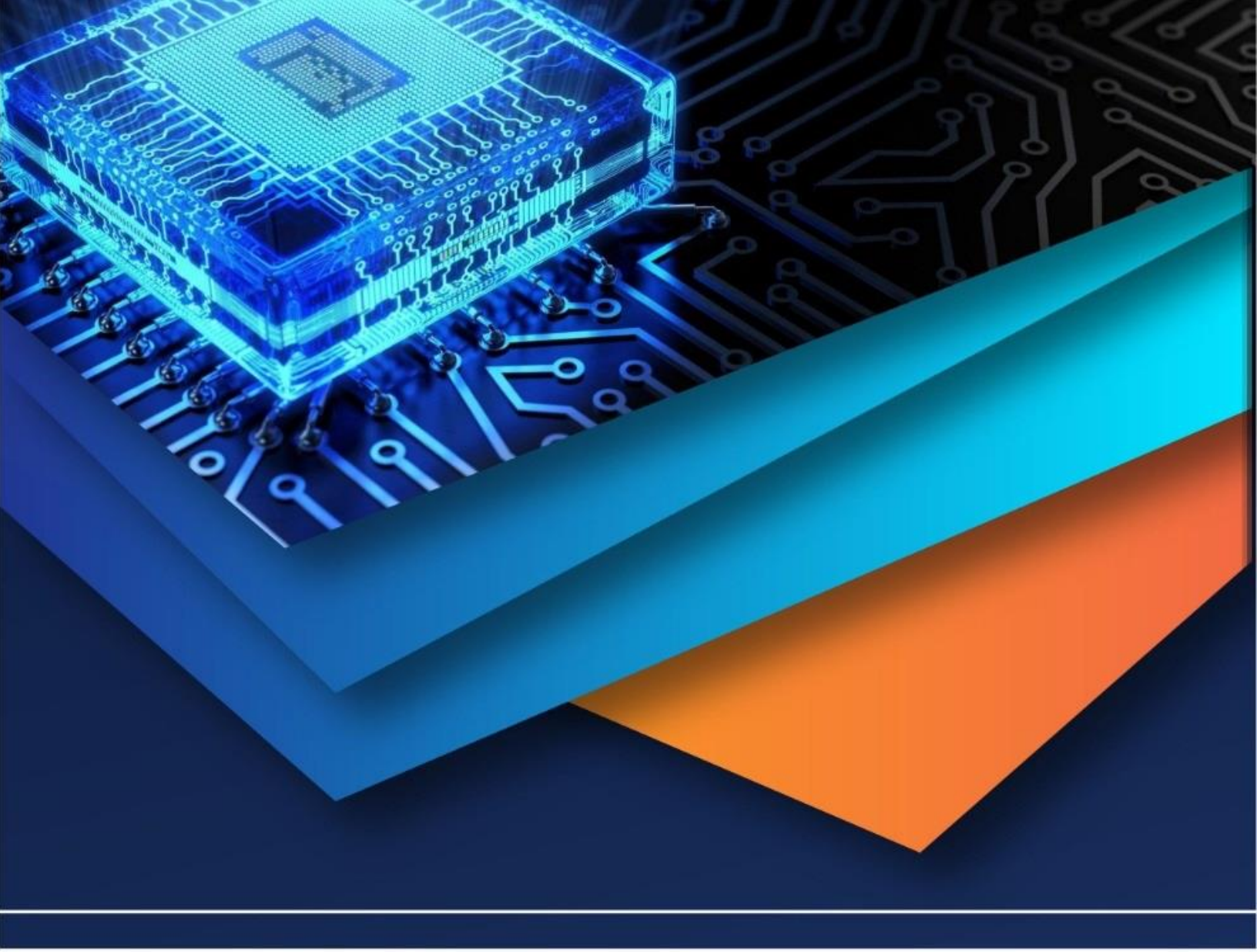
III.CONCLUSION

By studying all this literature studies we came to conclusion that there is a number of published works on steel and concrete chimneys. But in comparison to concrete, very less work is done on steel chimneys. Experimental and theoretical studies are presented on the behaviour of tall chimneys subjected to wind and seismic force in the above literatures. It is found that majority of the research papers on chimney are concentrated on its response to earthquakes. However, a very less research effort is found on the Comparative analysis of Self-supporting steel chimney with and without soil structure interaction and vibration analysis for the steel chimneys. In a self-supporting steel chimney inspection, manhole increases the von-mises stress resultant and top displacement. As evident from the modal analysis results, this is because manhole reduces the effective stiffness of a chimney therefore manhole opening in the analysis is important to select.

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