

Literature Survey on Comparative analysis of RC & Steel Chimney

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Abstract - This study deals with the comparative analysis of Reinforced Concrete (RC) & Steel chimneys. Such chimneys (with heights up to 60m) will be analyze and designed in conformity with various codes of practice. The main masses to be thought-about throughout the analysis of tall structures like chimneys are wind masses, temperature loads and seismic loads in addition to the dead loads. The design is finished with limit state ideas (which are nonetheless to be incorporated into IS 4998). Present research work developed to analyze the investigation made by different researchers in the field of economic and safe chimney design. The research work presents the summary of different research work & concludes with identified gaps in the research as well as identified the object of required work.

Key Words: wind load, height/Base ratio, mode shape & Frequency.

1. INTRODUCTION

Chimneys or stacks are important industrial structures for the emission of toxic gases to a better elevation such the gases don't contaminate the close atmosphere. These structures are tall, slender and customarily with circular cross-sections. Different construction materials, like concrete, steel or masonry, are accustomed build chimneys. Steel chimneys are ideally fitted to method work wherever a brief heat-up amount and low thermal capability area unit needed. Also, steel chimneys considerable & economical for height up to 45m.

2. CONTRIBUTION OF RESEARCHERS IN FIELD OF RC & STEEL CHIMNEY

N.V. Dhandapani (2018) Chimneys are landmarks for power plants and industrial setups for modelling them using FEM approach. Chimneys are vertically and discharge, gaseous products of combustion, chemical wastes gases and exhaust air from and industry to the atmosphere. Rapid growth of industrialisation and increasing need for air pollution control as made RC chimneys as common structure in modern scenarios. With large scale industrialisation number of chimneys and stacks being constructed is increasing year by year. Here the chimney structure may be analysed by finite component analysis exploitation FEM approach. Based on ANSYS Software, the structure can be meshed (discretized into several parts are called elements). At last, we can apply the boundary conditions and calculate its design by applying numerous masses.

C.V.Siva Rama Prasad (2017) Industrial chimneys serve industries over the years to dissipate the hot flue gases in to atmosphere to reduce air pollution and to maintain air quality standards imposed on industries. Impact of pollutants on surrounding environment can be reduced by dispersing pollutants at higher altitudes. Usually, in case of chimneys draft, air quality standards, stiffness requirements etc governs the height. This paper considers different height to base diameters to study the load effects on industrial chimneys for wind and earthquake forces. Height of business chimneys chosen for analysis 40m, 50m, 60m and height to base diameter ratios of 11, 13, 15, 17, 19 & 21 corresponding to each height considered. Top diameter to Base diameter ratios most popular is zero.6, 0.8 and 1. Based on these parameters, a total of 54 chimneys were analysed for wind speeds of 39m/s, 47m/s and 55 m/s to evaluate wind response and stiffness criteria based on IS 6533:1989. All the chimneys considered were evaluated for seismic effects of zones III, IV and V based on IS 1893(Part 4):2005. Chimneys are modelled using linear element in STAAD PRO fixed at base for calculation of mode shapes and frequencies. Wind and Earthquake analysis was carried out to evaluate shear force, bending moment and stiffness criteria of industrial chimneys. Results are given for high diameter to base diameter magnitude relation, height to base diameter ratio, different wind speeds and earthquake zones considered. Conclusions are made based on the discussions of obtained results.

Michalcova (2017) In building practices, smokestacks are commonly sheathed with smooth metal plates. The wind load working on such sheathed smokestacks may be calculated per applicable standards. However, requirements for sheathing smokestacks with corrugated metal have been recently increasing due to dilatation of the metal plate. For these cases, the calculation standards do not define parameters for determining the sheathing roughness that affects the load size. The calculation standards consider only air flow around a cylinder with a course (rough) surface. In the case of a greater unevenness of sheathing of the flown around body, the standard considers only the roughness height, in this case, the metal corrugation height regardless of its type and shape. This fact may result in a large increase in frontal wind resistance. One of the options to determine the load acting on the flown around smokestack sheathed with metal other than conventional smooth metal is a numerical solution. Creation of a corrugated sheathing mesh is demanding on

the number of cells in the calculation area, and therefore, this approach is unrealistic for solution on desktop PCs at the present. The purpose of this numerical study is to see an applicable substitute, equivalent aerodynamic roughness, and thus the possibility of modelling in a simplified calculation area using the "wall function". A properly determined equivalent mechanics roughness contributes to the right definition of the coefficient of drag price that defines the dimensions of the wind load working on the flown around object (in Fluent drag coefficient). The given thesis simulates flowing around a sensible stack of a circular section for 2 differing kinds of protective covering - furrowed and tetragon plates. The task is dealt with using the finite volume method using CFD codes in Ansys Fluent software. The numerical solution results are evaluated and compared with standard regulations.

R.kalaimugil (2016) 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 a steel chimneys is designed considering wind load and earthquake load. Geometry of a self-supporting steel chimney plays an important role in its structural behaviour under lateral dynamic loading. This is because of geometry is primarily accountable for the stiffness parameters of the chimney. However, basic dimensions of commercial self-supporting steel chimney, like height, diameter at exit, etc., are usually derived from the associated environmental conditions.

P. Kuras, I. Ortyl (2016) When compared to rigid reinforced concrete chimneys, steel industrial chimneys prove to be more susceptible to aerodynamic excitation. European standards and ISO standards impose high regime with regard to their protection against the impact of normal mode of vibration caused by wind excitation. In order to effectively prevent the occurrence of this phenomenon, vibration dampers are installed on structures. The same standards recommend the need, and establish the rules, for conducting direct measurements characterizing the dynamics of slender structures. The paper deals with the problem of determining the actual dynamic characteristics (vibration frequency and logarithmic decrement of damping) of steel chimneys equipped with vibration dampers. Measurement methods were reviewed, and their advantages and disadvantages were analysed about their use in the diagnosis of high dynamic structures. Examples of dynamic characteristics were presented based on the results of tests, which were performed when adjusting the dampers on two steel chimneys with different structure in terms of their design, and with different dynamic parameters. The results obtained using three instruments were assessed in terms of the degree of consistency of dynamic characteristics, which were determined experimentally. The data were acquired with the use of contact and non-contact methods, such as ground-based interferometric radar, robotic total station and MEMS accelerometer.

Mr.Praveen Kumar (2016) This report shows the certain design values for different configurations of chimney structures which may take consideration for foundation designing work. The effects of lateral force due to wind and earthquake loads are analysed by an equivalent static load method and dynamic analysis by response spectrum method. The present study is carried for the region Nashik, district of Maharashtra state in India. According to which wind load and earthquake load parameters were considered as per IS code such as IS 4998(part-1):1992, IS 1893 (part-4):2005 and IS 875(part-3). The present study is carried only to study the merits and demerits of these types of chimney configuration based on the analysis, for such terrain Conditions.

Rakshith B D (2015) Chimneys are tall and slender structures that are accustomed discharge waste/flue gases at higher elevation with enough exit rate such the gases and suspended solids(ash) are dispersed in to the atmosphere over a defined spread such that their concentration, on reaching the ground is within acceptable limits specified by pollution control regulatory authorities. This paper summarizes the analysis and design ideas of chimneys as per Indian coal provisions incorporation was conjointly created through finite part 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 part computer code STAAD professional, emphasis also placed on effect of geometric limitations on the design aspects in designing chimney

Harshal Deshpande (2015) Steel stacks are smoke releasing slender structures constructed in various industries. They are subjected to static and dynamic loadings. Dynamic analysis is administered by considering each unstable loading and dynamic wind loadings. Apparently dynamic wind effects are vital for steel stacks and that they govern the soundness conditions. Steel stacks being slender and long sections they are more prone to dynamic wind oscillations and corresponding stresses. Present study deals with relation of geometrical configuration and obtained dynamic response of short self-supported steel stacks below dynamic wind loadings and unstable loadings. 42 steel stack configurations for seven totally different heights of stacks are selected and analysed for dynamic wind loadings and unstable loadings as per Indian standards (IS:6533 part2) and IS 1893(part 4). a relation between dynamic response and governing pure mathematics of the stack is acknowledged. Use of excel sheets and STAAD-proV8i software is done for analysis.

John L. Wilson (2003) The results from associate experimental program are went to develop a non-linear dynamic analysis procedure for evaluating the inelastic response of tall concrete chimney structures. The procedure is employed to check the inelastic response of 10 chimneys, locomote tall from one hundred fifteen m to 301 m subject to earthquake excitation. Based on the study, a series of code

design recommendations are ready and incorporated into the 2001 CICIND code to encourage reliance on the event of plasticity in reinforced concrete chimneys and to forestall the formation of brittle failure modes. The basis for the selection of a structural response factor of $R=2$ which halves the seismic design forces is presented. The design recommendations lead to each improved performance and value savings of up to twenty compared with designs undertaken with the 1998 ACI307 and 1998 CICIND codes.

Devdas Menon (1997) This paper reviews the prevailing international code recommendations to determine the design along-wind moments in reinforced concrete (RC) chimneys and towers. A comparative study reveals significant disparities among the various code estimates of the design moments, given the same basic wind speed and terrain condition. These disparities are a matter of concern to practising chimney designers and approving authorities in many countries. The relative accuracy of these differing estimates, which are based on different gust factor methods have been quantitatively assessed with reference to rigorous stochastic dynamic analyses. This study covers several linearly tapered RC chimneys with heights in the range 100-400 m located in different terrain conditions and subject to the range of wind speeds encountered in practice. It is observed that the estimates of the design moments are generally conservative in varying degrees and are unconservative only in some cases. In very rough terrains, the lack of appropriate design provisions results in extremely conservative designs. With a view to improving the accuracy in the predictions, modifications to the gust factor method have been proposed in this paper.

R. Ciesielski (1996) Two identical steel chimneys, 120 m high were erected about 5 years ago. During the exploitation of the chimneys, the occurrence of considerable cross vibrations of the whole supporting structure and of the chimney shaft was noticed. Similar observation results were obtained for each of these chimneys. Observation results constituted the basis for carrying out a computational analysis, which aimed at the determination of the causes of occurrence of this phenomenon and finding the possibility of reduction of chimney vibration. Results of these detailed analyses are presented and confronted with observation results. In order to eliminate extensive chimney vibrations caused by the represented mechanics development, specially designed turbulizers and, afterward, mechanical vibration dampers were applied. Effects of the treatments will be presented in the paper.

3. GAP IN RESEARCH REVIEW AND OBJECTIVE OF NEW RESEARCH

Based on the survey of available literature following gaps in the research are identifying.

1. There is very limited research which focuses on comparative analysis of varying height/Base diameter ratio of RC & Steel Stack.
2. There are a few works done on the structural deformation and stress distribution of Von Misses Stress and Maximum Principal Stress.

Based on above-mentioned gaps following the objectives of the research are being investigated

1. To comparative study of the performance of the RC & Steel stack with varying height/base diameter ratio.
2. To compare Principal & Max von Mis stresses on cylindrical in RC & Steel stack to optimize the performance of the chimney with safe and economic aspects.

4. CONCLUSION

From the research we understand about the contribution of different researches in the field of the Tall cylindrical structure system (Chimney), a gap in the research and objective of the research to be conducted. These contributions help to visualize the problem faced by RC & Steel Chimney from a new perspective. By evaluating the performance of both type of chimney with different height to base diameter its enhanced economic aspect may be achieved, which shall lead to the direction of the design of safe stronger and more economical chimney.

REFERENCES

- [1] N.V. Dhandapani, R. Manimaran, R. Velmurugan (2018) A Study on seismic load characteristics and modelling of chimney structure using fem approach" International Journal of Engineering & Technology" Vol.7 (2.8) (2018) 622-625
- [2] C.V.Siva Rama Prasad, Dr.S.K.Rao(2017) PARAMETRIC STUDY OF INDUSTRIAL STEEL CHIMNEYS" Journal of Emerging Technologies and Innovative Research (JETIR)" JETIR (ISSN-2349-5162) December 2017, Volume 4, Issue 12 pp 428-432
- [3] V. Michalcova, L. Lausova (2017) Numerical approach to determination of equivalent aerodynamic roughness of Industrial chimneys <http://dx.doi.org/10.1016/j.compstruc.2017.03.013>
- [4] R.kalaimugil, K.Shanthi(2016) ANALYSIS THE EFFECT OF WIND AND SEISMIC LOAD ON STEEL CHIMNEY" International Journal of Advanced Research in Biology Engineering Science and Technology" ISSN 2395-695X (Print) ISSN 2395-695X (Online) Vol. 2, Issue 4, April 2016 pp 78-85
- [5] P. Kuras, Ł. Ortyl, T. Owerko, R. Kocierz(2016) Analysis of effectiveness of steel chimneys vibration dampers using

surveying methods” In: Proc. of Joint International Symposium on Deformation Monitoring (JISDM), Vienna, Austria, 2016

[6]Mr.Praveen Kumar , Dr.Ajay Swarup(2016) ANALYSIS OF SELF SUPPORTING STEEL CHIMNEY “International Journal of Advance Research and Innovative Ideas in Education” ISSN(O)-2395-4396, Vol-2 Issue-1 2016 pp 151-157

[7]Rakshith B D, Ranjith A, Sanjith J, Chethan G 4(2015) Analysis of Cantilever Steel Chimney As Per Indian Standards” Int. Journal of Engineering Research and Applications” ISSN : 2248-9622, Vol. 5, Issue 5, (Part -5) May 2015, pp.151-162

[8]Harshal Deshpande , Roshni john Shweta motarkar (2015) Interrelation of Dynamic Response and Geometry of Short Steel Chimneys” International Journal of Scientific & Engineering Research” ISSN 2229-5518, Volume 6, Issue 12, December-2015

[9]John L. Wilson(2003) Earthquake response of tall reinforced concrete chimneys ” 002 Published by Elsevier Science Ltd.PII: S0141-0296(02)00098-6 ”

[10]Devdas Menon, P. Srinivasa Rao(1993) Uncertainties in codal recommendations for a cross-wind load analysis of R/C chimneys” Elsevier Journal of Wind Engineering and Industrial Aerodynamics 72 (1997) 455-468.

[11]Devdas Menon, P. Srinivasa Rao(1993) Estimation of along-wind moments in RC chimneys” Elsevier Engineering Structures, Vol. 19, No. 1, pp. 71 78, 1997

[12]R. Ciesielski, A. Flaga, J. Kawecki(1996) Aerodynamic effects on a non-typical steel chimney 120 m high” Journal of Wind Engineering and Industrial Aerodynamics” 65 (I 996) 77-86.

[13]R.D.Sharpe, R.I. Skinner(1993) The Seismic Design Of An Industrial Chimney With Rocking Base” Bulletin Of The New Zealand National Society For Earthquake Engineering, Vol. 16, No. 2, June 1983.