International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 6 Issue 3, March-April 2022 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Study of the Stability and Deformation of a RCC Chimney and Masonry Chimney during Wind Turbulence using ANSYS Software - Review

Richa Chandrakar[1], Mahesh Ram Patel[2]

[1]Research Scholar, [2]Assistant Professor,
[1,2]Department of Civil Engineering, SSTC Bhilai, Chhattisgarh, India

ABSTRACT
The chimneys are tall structures which are subjected to heavy wind loads. The current research reviews various researches conducted in analysing design and analysis of high rise chimneys using experimental and numerical techniques. The effect of material type on structural strength of tall chimney is also evaluated by various scholars. The effect of soil type, seismic zone on stability of chimney is also presented in this review.

KEYWORDS: *Chimney, stability, soil type*

How to cite this paper: Richa Chandrakar | Mahesh Ram Patel "Study of the Stability and Deformation of a RCC Chimney and Masonry Chimney during Wind Turbulence using ANSYS Software - Review" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-6 | Issue-3, April 2022, pp.148-151, URL: www.ijtsrd.com/papers/ijtsrd49458.pdf

IJTSRD49458

1. INTRODUCTION
A Chimney is a tall slender structure by means of which the waste gases are discharged into the outside atmosphere at a high enough elevation via stack effect. Chimneys are typically vertical or as near as possible vertical, to ensure that the gases flow smoothly, under the influence of what is known as stack or chimney effect. The space inside the chimney is called a flue. The height of the chimney greatly influences its ability to transfer flue gases to the external environment via stack effect. The function of a chimney is to convey and discharge combustion or flue gases away from the operating area of the industry as well as the human occupancy. The cross-section of the chimney is generally hollow circular, from aerodynamic considerations, and tapered, from considerations of structural economy and aesthetics. The chimney is subject to gust buffeting in the along-wind direction due to drag forces, and also to possible vortex shedding in the across-wind direction. Tall reinforced concrete chimneys form an important component of major industries and power plants. Damage to chimney due to wind or earthquake load may lead to shut down of power plants and important industries.

2. LITERATURE REVIEW
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.

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.

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.

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.

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.

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.

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 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.

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.

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.

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.

Wiik and Hansen [11] studied the phenomena by experimental and numerical simulation. The experiments were carried out in the industrial aerodynamic wind tunnel of the University of Hertfordshire, UK. This wind tunnel has a working section of 4.7 m. The atmospheric boundary layer was simulated by creating a barrier at the entrance and boards with graded roughness elements on the floor of the wind tunnel. Two different configurations were used: one with an ordinary overhang (0.3 m) and another having a large overhang (3.4 m).

Savory et al. [12] studied the effect of eave geometry on wind pressure coefficients. The test program was conducted in the wind tunnels at University of Surrey in the U.K. and at University of Western Ontario (UWO) in Canada. Two geometric scales of 1:100 and 1:43 were used. Models had curved and sharp eaves. Two types of boundary layer had been used, one smooth and another rough. A free stream velocity of 10 m/s had been used for all experiments. Results of the study showed that lift force was higher on sharp roof overhangs as compared to curved eaves.

Paluch et al. [13] studied the effect of canopies attached to industrial arch-roof buildings. Six scale models were used, with five types of canopies attached. Three of these canopies were instrumented and the static wind pressures were measured. The tests were done at the Boundary Layer Wind Tunnel of the Universidade Federal do Rio Grande do Sul. The study showed that canopy plays no role on the pressure distribution on roof for 0◦ wind incidence; but if the wind direction has any other value, the canopy influences the pressure distribution on the roof. For the design of canopies, the study proposed pressure coefficient values for two wind direction (0 and 90˚).

Zisis et al. [14] used large scale models to examine the pressure coefficients on canopies attached to low-rise buildings. The study used 1:6 scaled models. The experiments were performed in the Wall of Wind (WOW) consisting of 12 fans at the research facility of Florida International University. Canopy at the top and canopy at the middle of the wall were considered for the building tested. The study only considered five wind directions i.e. 0, 15, 30, 45 and 90◦ and used suburban terrain exposure.

Roh and Kim [15] studied the net pressure coefficient on canopy attached to an L-shaped tall building. No wind tunnel test was conducted; instead, Computational Fluid Dynamics (CFD) was used for the study. Numerical analysis results were obtained using ANSYS CFX 11 codes. The study used various canopy sizes with different canopy height to building height ratios and it showed that building geometry plays a very vital role on wind loading on attached canopies.

3. CONCLUSION

From the existing researches conducted on chimney, the chimney design, orientation has significant effect on its stability. The wind direction and wind magnitude has significant effect on base shear and deformation generated on chimney. Due to wind loads, the deformation on topmost zone of chimney is higher than deformation on bottom of the chimney with maximum stresses at the immediate soil layer under foundation.

REFERENCES

[1] Kalpesh Dhopat, Shrirang Tande, Abhijeet Oundhakar, "Analysis of Self-Supported Steel Chimney with the Effects of Geometrical Parameters", International Journal of Engineering Research and Application ISSN: 2248-9622, Vol. 8, Issue5 (Part -II) May 2018.

[2] Kalagouda R Patil, Dr. B S Manjunath, "Mechanical Design And Analysis Of Steel Stack By Varying Its Height With Constant Diameter", International Research Journal of Engineering and Technology (IRJET) Volume 4- Issue 9 - September 2017.

[3] M. Pavan Kumar, P. Markandeya Raju, N. Victor Babu and K. Roopesh, "A parametric study on lateral load resistance of steel chimneys" International Journal of Civil Engineering and Technology (IJCIET) Volume 8, Issue 7, July 2017.

[4] Nimisha Ann Sunny Dr. Alice Mathai, "Soil Structure Interaction Analysis of Multi Storey Building", IJSTE - International Journal of Science Technology & Engineering | Volume 3 | Issue 11 | May 2017.

[5] Rakshith B D1, Ranjith A2, Sanjith J3, Chethan G 4, "Analysis of cantilever steel chimney as per Indian standards", International Journal of Engineering Research and Application ISSN: 2248-9622, Vol. 5, Issue5 (Part -v) May 2015.

[6] B. R. Jayalekshmi, S. V. Jisha, and R. Shivashankar, "Soil-Structure Interaction Analysis of 300m Tall Reinforced Concrete Chimney with Piled Raft and Annular Raft under Along-Wind Load", Hindawi Publishing Corporation Journal of Structures Volume 2013, Article ID 859246, 14 pages http://dx.doi.org/10.1155/2013/859246.

[7] K. Sachidanandam, R. Vijayasarathy," Analytical Behavior of Steel Chimney Subjected to Dynamic Loading", International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES) Impact Factor: 5.22 (SJIF-2014), e-ISSN: 2455-2585 Volume 4, Issue 7, July-2014

[8] Sahoo K. et al "Analysis of self-supported steel chimney as per Indian standard" Analysis of self-supported steel chimney as per indian standard.html (2013).

[9] Pallavi Ravishankar, Dr D Neelima Satyam, "finite element modelling to study soil structure interaction of asymmetrical tall building", Workshop of TC207 during the 18th International Conference on Soil-Mechanics and Geotechnical Engineering Paris Report No: IIIT/TR/2013/-1.

[10] Gharad A.M., Sonparote R.S., "Soil Structure Interaction of Chimney", International journal of civil and structural engineering volume 1, no 3, 2010.

[11] Wiik T, Hansen EWM. The assessment of wind loads on roof overhang of low-rise Buildings. J Wind Eng Ind Aerodyn 1997;67&68:687–96.

[12] Savory E, Dalley S, Toy N. The effects of eaves geometry, model scale and approach flow conditions on portal frame building wind loads. J Wind Eng Ind Aerodyn 1992;41–44:1665–76.

[13] Palucha MJ, Loredo-Souza AM, Blessmann J. Wind loads on attached canopies and their effect on the pressure distribution over arch-roof industrial buildings. J Wind Eng Ind Aerodyn 2003; 91:975–94.

[14] Zisis I, Raji F, Candelario J. Large scale wind tunnel tests for canopies attached to low-rise buildings. J Archit Eng 2017; 23(1):B4016005.

[15] Roh HW, Kim HR. Wind pressure distribution on canopies attached to tall buildings. J Mech Sci Technol 2011; 25(7):1767–74.