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A REVIEW ON EFFECT OF WIND LOADING ON NATURAL DRAUGHT HYPERBOLIC COOLING TOWER

Parth.R.Chhaya[1], Nizam.M.Mistry[2], Anuj.K.Chandiwala[3]

[1]Civil Department, ChhotubhaiGopalbhai Patel Instituteof Technology, parthchhaya@gmail.com
[2]Civil Department,ChhotubhaiGopalbhai Patel Instituteof Technology, nizumistry@gmail.com
[3]Civil Department, Chhotubhai Gopalbhai Patel Institute of Technology, anuj.chandiwala@utu.ac.in

Abstract—This *paper deals with the study of two cooling towers of 200m high above ground level. Cooling tower is a device which converts hot water into cold water due to direct air contact. It works on the temperature difference between the air inside the tower and outside the tower.Natural draft cooling tower is one of most widely used cooling tower. Hyperbolic shape of cooling tower is usually preferred because of its strength and stability and large available area at the base due to shape. As it is very important structure in nuclear and chemical plants, it should be continuously assessed for its stability under self-weight, and lateral loads like wind load and earthquake load. Therefor cooling towers have been analyses for wind load by assuming fixity at the shell base. The wind loads on these cooling towers have been calculated in the form of pressures by using the circumferentially distributed design wind pressure coefficients as given in IS: 11504-1985 code along with the design wind pressures at different levels as per IS:875 (Part 3) - 1987 code. These towers with very small shell thickness are exceptional structures by their sheer size and sensitivity to horizontal loads.*

Keywords*- Cooling Tower, Wind Load analysis for cooling tower*

I. INTRODUCTION

A cooling tower is an enclosed device, designed for the evaporative cooling of water where hot water gets cooled by direct contact with air. Towers are divided into two main Types, the first being named natural draught cooling towers and the second mechanical draught cooling towers. In natural draught tower, the circulation of air is induced by enclosing the heated air in a chimney which then contains a column of air which is lighter than the surrounding atmosphere. This difference in weight produces a continuous flow of air through the cooling tower as long as water at a temperature above the wet bulb temperature is circulated through the cooling tower. NDCT makes use of the stack effect of a chimney above the packing to induce air flow up through the packing in counter-flow to the water.Reinforced concrete (RC) cooling towers are among the biggest civil engineering structures and a variety of problems corresponding to their design; construction and maintenance have been discussed in many papers and reported at numerous conferences.

WIND LOADING

Wind load is major external apply loading in the design of cooling tower. Till the recent
Publication of the is code of 875-1987 (part-3). Wind pressure is measured based on the
$P_z = 0.6 V_z^2$
Where
Pz = design wind velocity in N/m2 at Height.
$V_z = V_b\, k_1\, k_2\, k_3$
Vz = Vz = design wind velocity in m/s at height.
k1 = probability factor (risk coefficient)
k2 = terrain, height and structure size factor
k3 = topography factor

II. LITERATURE REVIEW:

A. G. MURALI, C. M. VIVEK VARDHAN AND B. V. PRASANTH KUMAR REDDY, "RESPONSE OF COOLING TOWERS TO WIND LOADS" JOURNAL OF ENGINEERING AND APPLIED SCIENCES, VOL. 7, NO. 1, JANUARY 2012

G. Murali, C. M. Vivek Vardhan and B. V. Prasanth Kumar Reddy This paper deals with the study of two cooling towers of 122m and 200m high above ground level. These cooling towers have been analysed for wind loads using ANSYS software by assuming fixity at the shell base. The wind loads on these cooling towers have been calculated in the form of pressures by using the circumferentially distributed design wind pressure coefficients as given in IS: 11504-1985 code along with the design wind pressures at different levels as per IS:875 (Part 3)- 1987 code. The analysis has been carried out using 8-noded shell element (SHELL 93) with 5 degrees of freedom per node. The results of the analysis include membrane forces, viz., meridional force (Nφ) and hoop force (Nθ), and bending moments, viz., meridional moment (Mφ) and hoop moment (Mθ). The vertical distribution of membrane forces and bending moments along 0o and 70o meridians and the circumferential distributions at base, throat and top levels have been studied for both the cooling towers. For circumferential distribution, non-dimensional values have been obtained by normalizing the membrane forces and bending moments using the reference values at 0o meridian. Similarly, the reference values at the base have been used for vertical distribution. These non-dimensional curves for both the cooling towers have been compared in the present study for the feasibility of any generalization. The finite element analysis of the cooling towers has been carried out using ANSYS software. The shell element is the most efficient element for the solution of shells having the arbitrary geometry and it accounts for both membrane and bending actions. The analysis has been carried out using 8-noded shell element (SHELL 93) with 5 degrees of freedom per node. In the present study, only shell portion of the cooling towers has been modeled and fixity has been assumed at the base.

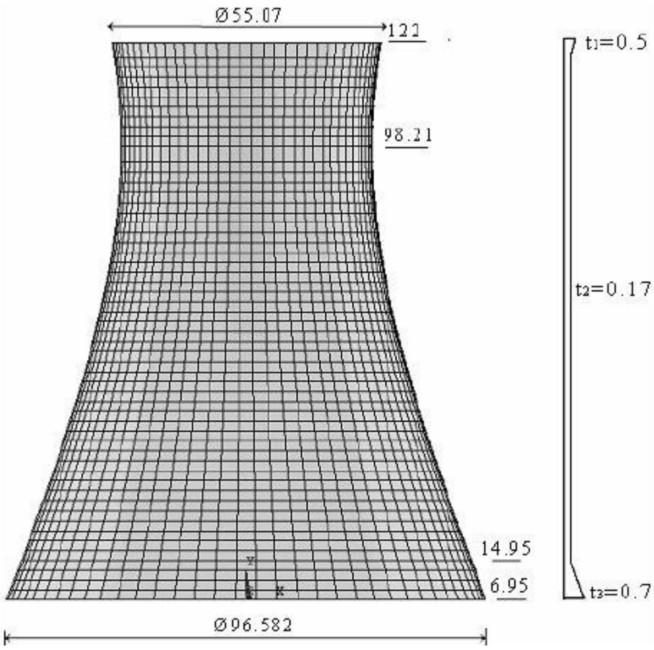

Figure 1: Geometry of Cooling Tower

B. TEJAS G. GAIKWAD, N. G. GORE, V. G. SAYAGAVI, KIRAN MADHAVI, SANDEEP PATTIWAR, "EFFECT OF WIND LOADING ON ANALYSIS OF NATURAL DRAUGHT HYPERBOLIC COOLING TOWER", IJEAT JOURNAL, OCTOBER 2014

Tejas G. Gaikwad, N. G. Gore, V. G. Sayagavi, Kiran Madhavi, Sandeep Pattiwar Natural draught cooling towers are very common in modern days thermal and nuclear power stations. These towers with very small shell thickness are exceptional structures by their sheer size and sensitivity to horizontal loads. These are the hyperbolic shells of revolution in form and are supported on closely spaced inclined columns. Wind loading on NDCT governs critical cases and requires research. This paper emphasize on effect of wind on Natural draught hyperbolic cooling tower. The slenderness of the columns and the large dimensions of the shell make these structures vulnerable to earthquake and wind disturbances. In this work efficient Analysis & design of cooling tower is presented with V- shapeConfiguration of Raker column. Finite element modeling of cooling tower shell is done which divide shell into number of plates to apply wind loading on each plate. Gust method and Peak wind Methods are adopted to apply wind load. For this purpose models are workout on Staad Pro V8i to give comparative results of analysis, design and constructability. Effective wind analysis can be done with the help of this methodology.Finite element model was prepared with the help of a coordinates mentioned in previous module. Configuration of Raker column is in V shape generated with the help of Staad Pro V8i Software.Finite element model was prepared with the help of a coordinates mentioned in previous module. Configuration of Raker column is in V shape generated with the help of Staad Pro V8i Software.

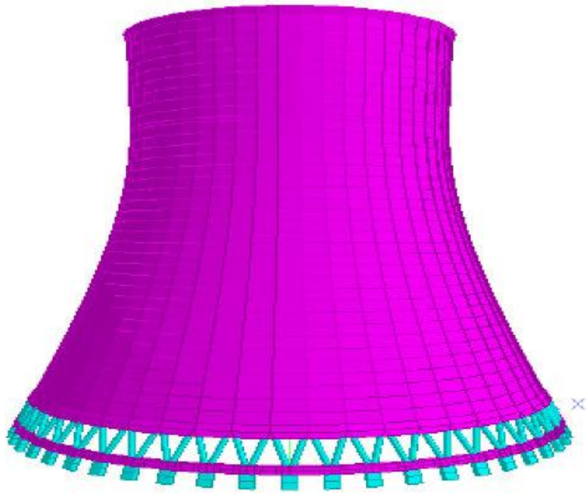

Figure 2: Finie Element Model of a Hyperbolic Cooling Tower

C. REINHARD HARTE B, WILFRIED B. KRA¨TZIG C, ULRICH MONTAG, "NEW NATURAL DRAFT COOLING TOWER OF 200 M OF HEIGHT", ENGINEERING STRUCTURES 24 (2002) 1509–1521, MAY 2002

Reinhard Harte b, Wilfried B. Kra¨tzig c, Ulrich Montag In the years 1999 to 2001 a new natural draft cooling tower has been built at the RWE powerstation at Niederaussem, with 200 m elevation the highest cooling tower world-wide. For manyreasons, such structures cannot be designed merely as enlargement of smaller ones; on thecontrary, it is full of innovative new design elements. The present paper starts with an overview over the tower and a description of its geometry, followed by an elucidation of theconceptual shape optimization. The structural consequences of the flue gas inlets through theshell at a height of 49 m are explained as well as the needs for an advanced high performanceconcrete for the wall and the fill construction. Further, the design and structural analysis of thetower is described with respect to the German codified safety concept for these structures.Finally, the necessity of extended durability of this tower is commented, the durability designconcept is explained in detail and illustrated by virtue of a series of figures.Geometry of the tower structure Due to the total height of the cooling tower is 200 m. Its basediameter measures 152.54 m, that one of the tower shell 136.00 m, and the top opening is88.41 m wide. Both the outer and inner shell surfaces possess areas of more than 60 000 m2equivalent to over 10 soccer fields each. Structural analysis and design of the cooling tower isbased on the German design regulations VGB-BTR [18].Main loading conditions for these structures are deadweight G, wind load W and thermal actions T. Becauseof the location of the plant-site, also seismic excitationsE had to be considered in the design. The highlyadvanced surveying and controlling in German coolingtower technology admitted a complete suppression ofinitial imperfections during the design.

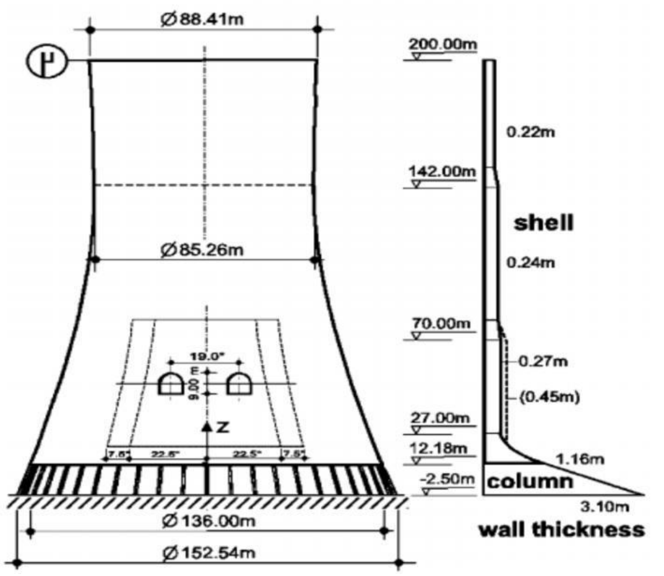

Fig. 3 Overview over the geometry of the cooling tower.

III. CONCLUSION

Cooling tower response is governed by both vertical and circumferential wind distribution. The ultimate load bearing capacity of the cooling tower shell under consideration is obtained as 1.925 times that of the design wind pressure that corresponds to the wind velocity of 40.2 m/s (90 mph). The nonlinear behavior is commenced by the formation of horizontal tension cracks in the windward meridian at the 43% height of the cooling tower shell. Free vibration analysis technique maybe used in a seismic analysis using the enforced seismic design needs of NDCT. The stress state in the cooling tower takes the full range from the tension to the compression domain. With the increase in height, wind vibration coefficients first increase, then decrease, and reach their maximum at the top section.

REFERENCES

[1] IS 875 (1987), "Indian standard code of practice for design loads (other than earthquake) for building and structures, Part 3, Wind loads", Indian Standard Institution.
[2] IS 11504 (1985), "Indian standard-Criteria for structural design of reinforcement concrete natural draught cooling towers", Indian Standard Institution.
[3] RESPONSE OF COOLING TOWERS TO WIND LOADS. G. Murali,C. M. Vivek Vardhan and B. V. Prasanth Kumar Reddy (2012)
[4] Effect of Wind Loading on Analysis of Natural Draught Hyperbolic Cooling Tower. Tejas G. Gaikwad, N. G. Gore, V. G. Sayagavi, Kiran Madhavi, Sandeep Pattiwar.(2014)
[5] Dieter Busch a, Reinhard Harte b, Wilfried B. Kra¨tzig c, Ulrich Montag (2002).

