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A FLUID-STRUCTURE COUPLING ANALYSIS OF LARGE-SCALE HYPERBOLIC COOLING TOWER SUBBLECTED TO WIND LOADS

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ABSTRACT

The natural draught cooling tower is widely used in the thermal power stations and industrial power plants. In general, the large-scale cooling tower is a reinforced concrete thin-wall structure, supported with columns at bottom. The wind load is always the dominant load in design of the cooling tower due to its large size, complex geometry and thin wall. During the last several decades, some failure of the cooling towers occurred in England in 1965 and 1984, in Scotland in 1973, in France in 1979, which had caused more attention to the analyses of the serviceability and safety of the cooling towers subjected to wind loads. In order to improve cooling efficiency and save the land, the cooling tower was designed taller and larger. The highest cooling tower in the world at present is 200m. The problem which is regarded as not important in small cooling towers, become sharp to the large-scale towers.

Currently, there are two main methods to determine the wind loads when perform the wind-induced responses of the large-scale hyperbolic cooling tower under wind loads, one is to obtain the wind pressure distribution by experiments, and the other is to analyse the wind field based on Computational Fluid Dynamics(CFD). However, the work reported in the literature so far on the analysis of cooling towers subjected to wind loads did not consider the fluid-structure interaction between the wind and the cooling tower, which may be an important issue, especially for such kind of hyperbolical thin-wall structure that is sensitive to wind loads. Furthermore, the effect of internal airflow within the tower was also negelcted in the current research. Therefore, the coupling analysis of fluid-structure interaction (FSI) under wind loads, considering both the internal and external wind field of tower, is of importance for the safety of the cooling tower, which is also a chanllenge to the numerical simulation.

In this paper, a coupling analysis of the large-scale hyperbolic cooling tower subjected to wind load was performed, in which the interaction between the structure and the

internal and external wind field of tower was considered. The effect of terrain roughness on the distribution of wind speed is treated and the turbulence model of wind field is used. The 3D finite element model with shell and beam elements for the tower structure and 3D finite volume model for the wind field are employed. The stress, strain and displacement can be achieved by FSI analysis, and the distribution of both the flow field and the pressure field about airflow is also obtained. Furthermore, the soil-structure interaction of the large-scale cooling tower was also studied in this paper, in which the soil was modeled as 6-side 3D element. The results indicated that the proposed method of coupling analysis of fluid-structure and soil-structure interaction for large-scale hyperbolic cooling tower can produce more rational results.

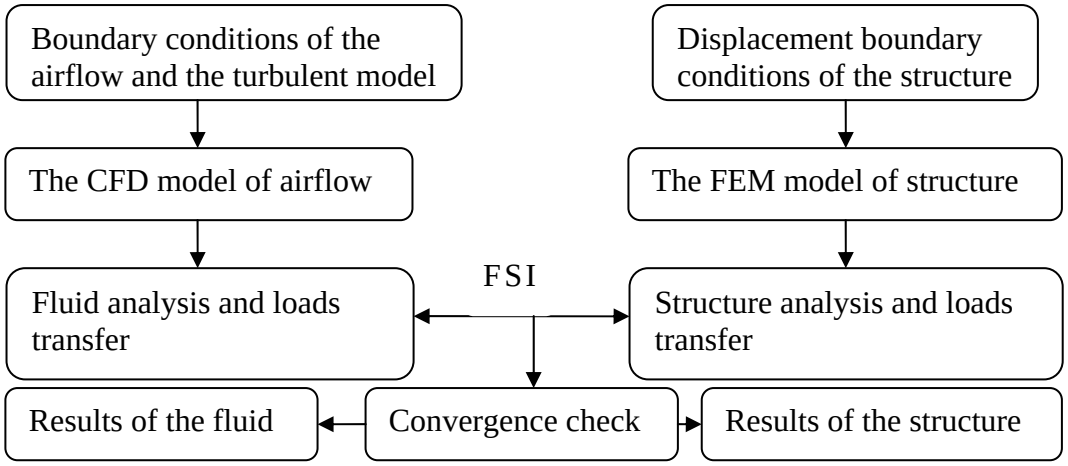

Fig.1 Flowchart of coupling analysis

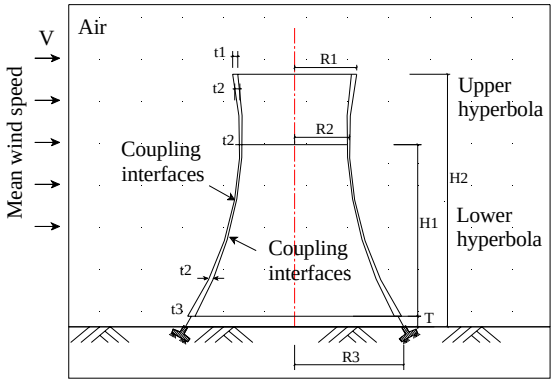

Fig.2 Model of coupling analysis

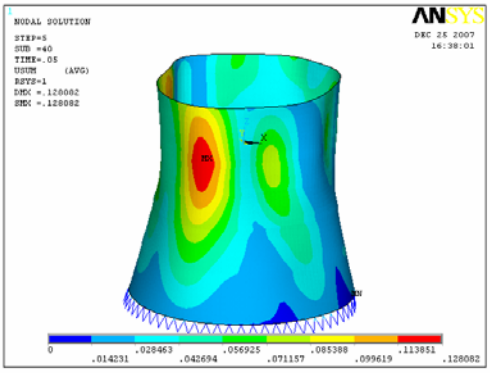

Fig.3 Displacement of the tower

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