IASS Annual Symposium 2019 – Structural Membranes 2019
Form and Force
7 – 10 October 2019, Barcelona, Spain

Stability analysis of super-large steel hyperbolic cooling towers

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Abstract

Cooling tower is a type of space thin shell structure whose stability is the weak point. After cooling towers at Ferry-Bridge Power Station suddenly collapsed in 1965, the wind load and the stability of hyperbolic cooling towers under the wind load have been done by many researchers.

Up to this time, the heights of cooling towers are increased to over 200m far higher than the prescriptive heights (<165m). Wind pressure and structural dead weight, which are the control loads in the design of cooling towers, increase with the height. Given the increasing height and loads, it's necessary to reconsider the stability of cooling towers, particularly the stability under dynamic wind load.

To understand the influence of wind load on cooling tower stability, static and dynamic nonlinear finite element analysis of steel hyperbolic cooling towers using ABAQUS is presented in this paper. The model's height, diameter at 0m height, height and diameter of throat were 220m, 185m, 170m, and 120.8m, respectively. The structure form is hyperbolic triangle space grid structure composed of ring beams and diagonal braces which both are steel pipes. Static wind load is based on Chinese Wind Load Code, meanwhile dynamic wind load time-history is from wind tunnel tests. Considering initial geometric imperfections, geometry and material nonlinearity, methods are full-range analysis for static analysis and central difference method for dynamic.

Comparing the results calculating by increasing wind loads, some conclusions for the design of cooling towers are given and this method may provide valuable insights for the future engineering application.