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Aerodynamic behavior of wind turbines with polygonal cross-sectional tower

Yong Chul Kim

Tokyo Polytechnic University, Atsugi, Japan

Yukio Tamura

Chongqing University, Chongqing, China

Contact: kimyc@arch.t-kougei.ac.jp

Abstract

Wind turbines are commonly used power generation systems around the world and their application is becoming increasingly widespread. Traditionally, circular-cross-section wind towers have been used, but recent upsizing of wind turbines has exposed weaknesses of these structures, including problems related to manufacturing and inadequate strength. Thus, the concept of site-assembled modular towers with polygonal cross-sections such as octagonal and/or tetradecagonal has been proposed, but their wind-resistant performances have not been clearly investigated. In the present study, the wind-resistant performances of polygonal cross-sectional towers were investigated through wind tunnel tests. It was thus found that the maximum force coefficient of the upper structure is larger than that of the tower, which makes the effect of cross-sectional tower shape rather small. The mean and fluctuating lift force coefficients of a helical square cross-sectional tower were quite small for cases of tower only and wind turbine.

Keywords: wind turbine; polygonal cross-section; wind tunnel test; pressure measurement; force measurement; drag force; lift force.

1 Introduction

Wind turbines are commonly used power generation systems around the world and their application is becoming increasingly widespread because of their environmentally friendly characteristics. Traditionally, wind turbines with circular-cross-section towers have been used, but recent upsizing of wind turbines has exposed weaknesses of these structures, including problems related to manufacturing and inadequate strength.

Thus, the concept of site-assembled modular towers with polygonal cross-sections such as octagonal and/or tetradecagonal have been proposed. Actually, there is a wind turbine with a tetradecagonal tower in Europe. However, its wind-resistant performance has not been clearly investigated.

In the present study, the effect of tower cross-section was investigated by wind tunnel tests for a 5MW wind turbine with seven polygonal cross-sections: square, helical square, octagon, decagon, dodecagon, tetradecagon and circular. Pitch angle,

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