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RESPONSE ANALYSIS OF WIND TURBINE SUPPORT STRUCTURES USING FEM AND WIND GENERATION METHOD LINKED TO TIME SERIES OF MEASURED WIND SPEED

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ABSTRACT

A wind generation method linked to time series of measured wind speed is expanded and applied to FEM for the response analysis of wind turbine support structures. Results indicate that the mean, the standard deviation and the maximum of the tower bending moments with both conventional wind generation method and proposed method demonstrate a good agreement with the measurements, while correlation coefficients between observed and simulated moments increased from 0.067 to 0.488, when time series of measured wind speed was used.

KEYWORDS: WIND GENERATION METHOD USING TIME SERIES OF MEASURED WIND SPEED, RESPONSE ANALYSIS, FEM, WIND TURBINE SUPPORT STRUCTURE

1. Introduction

For offshore wind turbine, the costs for O&M (Operation and Maintenance) are estimated in the order of 30 to 35% of the costs of electricity and in between 10 and 15% for onshore wind turbine [Rademakers *et al.* (2003)]. The application of condition monitoring for early damage detection can be the feasible approach to reduce the cost for corrective maintenance. Detecting damage at an early stage enables to make the consequence damage reduce so that the costs of repair can be less expensive.

Among various condition monitoring techniques, measurements by additional equipments (e.g. strain gauge) can be the obvious way to get insight in the loading of wind turbine, however practically has insignificant drawbacks such as high cost of equipments and difficulty of sensor replacement. Instead, performance monitoring can be the promising technique for wind turbine, since wind turbines are essentially equipped with detecting devices for measurements of power, wind velocity, rotor speed and blade angle. A hybrid method, which is combined wind generation method based on the performance monitoring with FEM used for estimation of response, is expected to analyze loading of wind turbine tower with high reliability.

Conventional method for generation of wind turbulence based on given statistical parameters exists, e.g. the auto-regressive and moving average (ARMA) methods by Iwatani (1982). Iwatani method for generating wind fields uses statistical parameters such as mean wind speed, turbulence intensity, the spectrum of turbulence and spatial correlation. We subsequently applied generated wind fields to FEM to estimate response of the wind turbine