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Proposal of Extreme Wave Height Estimation Formula for IEC61400-3

Kenji Shimada[1] and Takeshi Ishihara[2]

[1]Shimizu Corporation, [2]The University of Tokyo

Abstract:

Extreme wave height for design of an offshore wind turbine situated in surf zone is calculated based on Goda's 1975 theoretical wave deformation model in accordance with requirement of exceedance probability specified in IEC61400-3 currently in revision. Based on the results, Goda's approximation formula for the maximum wave height is adjusted in conjunction with a propose of a treatment for implementation of the constrained wave. It is also proposed to employ Goda's incipient depth of wave breaking for tentative criterion of consideration of impact breaking wave force and its parameter is optimized. Furthermore, comparisons are made between Battjes & Groenendijk's model and Goda's model.

On the application of large-eddy simulation to the micro-siting of wind turbines on a complex geography

Keisuke Nakao and Yasuo Hattori

Central Research Institute of Electric Power Industry

Abstract:

In the early stage of construction, planners are often forced to make a decision about the micro-siting of wind turbines with limited information of the wind environment. In the country where there is a vast plain-field, the problem is not obvious because a flat terrain can be chosen as a location. On the other hand, in Japan, whose geography is precipitous and complicated, the decision of the micro-siting has direct relation to the power generation efficiency and running cost, mainly due to the effect of geography-induced wind and turbulence.

In recent years, Computational Fluid Dynamics (CFD) with Large-eddy simulation (LES) is becoming more and more applicable owing to the development of High Performance Computing (HPC) and open-source software. The primal advantage of CFD is to grasp the relative wind profile on the site to evaluate the cost benefit performance. What is more, the possibility of the gust-wind, which might result in a cut-out and, in some cases, a disastrous accident on turbine blades, can be estimated by the index of turbulence (Turbulence Intensity, TI).

We tackled a LES with open-source software, OpenFOAM version 2.1.1, on the real wind turbine site in Japan (Higashi-Izu district) to better understand the key issues for the optimal choice of the site. The domain contains 12.5 km in stream-wise direction and 7.5 km in span-wise direction with more than 1000 m difference in elevation in maximum.

For the first step, we tested the influence of tunable numerical configuration, i.e. grid resolutions (10m-50m in horizontal direction) and inflow condition (generic turbulent boundary inflow or laminar boundary inflow). The results show that the reasonable agreement with the observation is obtainable by an appropriate grid resolution and that the choice of inflow condition has the least effect because the enhancement of turbulence by the complex geography on the upwind is dominant. The latter might be a site-specific result of the complex terrain and is remained to be investigated in details.

As the next step, we discuss the tendency of mean-wind and turbulence properties of the ridge of the mountains, which is the possible place for wind turbine. We show each location has various tendencies of the wind acceleration and deceleration owing to the surrounding geography. The obvious acceleration is mainly due to the slope of the forward geography. On the other hand, the deceleration is caused by the flow separation of higher mountain on the upwind. Also, TI is mapped on the sites and the discussion is held with the characteristics of geography.

In order to make the micro-siting at the first-step easier, the effective geographical conditions which affect the enhancement of wind velocity and suppression of TI is discussed from the data sets.

A wind tunnel experimental study on wind turbine blade icing by using natural low temperature in cold region of China

Prof. Yan Li[1], Shaolong Wang[1], Fang Feng[1], Yingwei Zhang[1] and Kotaro Tagawa[2]

[1]Engineering College, Northeast Agricultural University, [2]Regional Faulty, Tottori University

Abstract:

In order to study the characteristics of wind turbine blade icing and to research anti-icing and de-icing methods, a simple and low cost wind tunnel experiment system for icing test was designed and made. The small scaled conventional open jet wind tunnel has been reformed by inducing the natural low temperature in the Northeast of China which belongs to cold region. A water spray system and the icing test section were installed to provide the icing conditions. Firstly, the verification experiments were carried out and the three main parameters: the temperature stability, the liquid water content and the medium volume droplet diameter were tested and calibrated. The results show that the main indexes can meet the requirements of the wind turbine blade icing test in a certain degree. Then, wind tunnel tests on blade airfoil under both the static condition and rotational condition were carried out. The characteristics of ice accretion during certain duration on blade were recorded by a high speed camera. The characteristics of ice accretions on blade surface at different rotational speeds were compared and analyzed.

Summarization of Anti-typhoon Technology of Mingyang Mega-Watt Wind Turbine

Zou Libing, Qiying Zhang and Dongming Huang

Guang Dong Ming Yang Wind Power Group

Abstract:

Super-typhoon speed can reach to more 51m/s, and have ultra-strong destructive power, which will cause great challenge to wind turbine design. The Rammasun typhoon of 2014 has reached to 66.7m/s, and swept the whole Philippines, China and Vietnam, and caused many peoples death and properties destruction. There are many wind turbines collapse, tower buckling and blades broken. However, the Mingyang's wind turbines, including MY1.5-77&82, MY2.0-104 and SCD3.0MW-110, have frontally fought with Rammasun typhoon and demonstrated excellent anti-typhoon performance and high reliability. This paper considering several anti-typhoon wind turbines completely overcoming Rammasun typhoon, elaborated the Mingyang wind turbine anti-typhoon technology, including loads and stress, electric and control system, tower and foundation anti-typhoon research, advanced anti-typhoon bladed design, wind parks advanced management modes, and SCD unique anti-typhoon technology, which would provide a window for customers to look at Mingyang's advanced anti-typhoon technology and also provide a basis for anti-typhoon technology development of wind turbine's industry.