Special issue on Advances in Wind Turbine Supporting Structures

Preface

Wind energy has been highlighted as a green energy source. Recently, the wind turbine-related technology has a unique technical identity and demands in terms of the methods for design and maintenance. There have been remarkable advances for producing stronger, lighter and more efficient blades for the wind turbines; at the same time, a lot of corresponding problems should be dealt in order to prevent the occurrence of unfortunate accidents. To provide readers up-to-date technologies on design, analysis, and maintenance of wind turbine structures, this special issue was organized, and 9 papers were selected. Most of the papers were invited from those presented at the 2015 World Congress on Advances in Structural Engineering and Mechanics (ASEM15) held in Songdo, Korea on August 25-29, 2015. This special issue on Advances in Wind Turbine Supporting Structures covers the following topics.

Kim, S.B., Yoon, G.L., Yi, J.H., and Lee, J.H. presents *"Reliability analysis of laterally loaded piles for an offshore wind turbine support structure using response surface methodology"*. Mono-piles have been largely used for most of existing offshore wind turbine (OWT) foundations, because they are considered as an economical alternative with a relatively shallow-water. *Kim et al.* performed the reliability analysis using the response surface method and numerical simulation technique for an OWT mono-pile foundation to investigate the sensitivities of mono-pile design parameters, and to find practical implications of RSM reliability analysis.

Kim, D.H., Lee, G.N., Lee, Y., and Lee. I.K. presents "*Dynamic reliability analysis of offshore wind turbine support structure under earthquake"*. Seismic reliability analysis of a jacket-type support structure for an offshore wind turbine requires a number of dynamic calculations a first-order reliability method. In order to reduce those high-cost analysis, *Kim et al.* performed a new reliability analysis approach using a static response, in which the dynamic effect of the response was considered by introducing a new parameter called the Peak Response Factor. A numerical example was examined to compare the proposed approach with the conventional static response-based approach.

Yi, J.H., Kim, S.B., Yoon, G.L., and Andersen, L.V. presents *"Natural frequency of bottom-fixed offshore wind turbines considering pile-soil-interaction with material uncertainties and scouring depth"*. Pile-soil-interaction (PSI) effects is one of unsolved technical issues which still persist in the utilization of multi-member lattice-type supporting structures for OWTs. *Yi et al.* intensively investigated the effects of PSI on the dynamic properties of bottom-fixed OWTs. The tower and substructure were modeled using conventional beam elements with added mass, and pile foundations were modeled with beam and nonlinear spring elements.

Madsen, S., Pinna, R., Randolph, M., and Andersen, L.V. presented *"Buckling of Monopod Bucket Foundations—Influence of Boundary Conditions and Soil–structure Interaction"*. Large monopod bucket foundations offers the potential for large cost savings compared to typical piled foundations for offshore wind turbines. *Pinna et al.* performed numerical simulations to assess the risk of structural buckling during installation of large-diameter bucket foundations. Eigenmode-affine imperfections were introduced in a nonlinear finite-element analysis and the influence of modelling the real lid structure compared to classic boundary conditions was investigated.

Nguyen, T.C., Huynh, T.C., and Kim, J.T. presents *"Numerical evaluation for vibration-based damage detection in wind turbine tower structure"*. Potential damage in wind turbine tower (WTT) should be identified and assessed in timely manner to prevent local and global failures of the WTT. *Nguyen et al.* evaluated the feasibility of vibration-based damage detection methods for WTT structures. A frequency-based damage detection method and a mode-shape-based damage detection method were examined to locate damage in the WTT from changes in natural frequencies or mode shapes. Finite element models based on a real WTT structure in Jeju, Korea, were established and several damage scenarios were simulated by selecting damages close to bolt connections of WTT segments.

Loh, C.H., Huang, Y.T., and Hsiung, W.Y., Yang, Y.S., and Loh, K.J. presents *"Vibration-based identification of rotating blades using Rodrigues' rotation formula from a 3-D measurement"*. Accurate real-time monitoring techniques are needed to nondestructively detect damage occurrence in turbine blades in its early stage. *Loh, et al.* developed a vibration-based method to track the geometrical setup of a turbine blade by using a single 3-axes accelerometer mounted on the blade. The tilt and rolling angles of the rotating blade under operating conditions were determined from response measurement. A covariance-driven stochastic subspace identification method was applied to the vibration measurement.

Kraemer, P. and Friedmann H. presents *"Vibration-based structural health monitoring for offshore wind turbines – Experimental validation of stochastic subspace algorithms"*. There is a need for structural health monitoring (SHM) systems, to enable service and maintenance on demand and to increase the inspection intervals. *Kraemer and Friedmann* performed extensive experimental studies on the application of two vibration-based SHM algorithms for stability and structural change monitoring of offshore wind-turbines. The sensitivity of the methods for monitoring purposes were demonstrated through their application on long time measurements from a 1:10 large scale test rig of an offshore WT under various conditions.

Park, J.H., Huynh, T.C., Choi, S.H., and Kim, J.T. presents *"Vision-based technique for bolt-loosening detection in wind turbine tower"*. Vision image processing has been widely adopted for SHM in civil infrastructures, especially for geometrical identification of structural status. *Park et al.* developed a novel vision-based bolt-loosening monitoring technique for bolted joints connecting tubular steel segments of the wind turbine tower (WTT) structure. A bolt-loosening detection algorithm based on image acquisition, line detection and nut angle estimation, and bolt-loosening detection was evaluated on a lab-scale model simulating the real bolted joint connecting steel tower segments in the WTT.

Han, T.H., Park, Y.H., Won, D., and Lee, J.H. presents *"Design feasibility of double-skinned composite tubular wind turbine tower"*. Automatic section design is a great demand for optimized cross-sectional designs for wind power tower. *Han et al.* performed the design of 80 sections of double-skinned composite tubular (DSCT) wind power towers for 3.6MW and 5.0MW turbines by using their developed automatic section design software. In designing and analyzing, the material nonlinearity and the confining effect of concrete were considered. Also, the performances of the 80 designed sections were analyzed with and without considerations of large displacement effect.

Prof. Jeong-Tae Kim
Pukyong National University, Korea
idis@pknu.ac.kr

Dr. Jin-Hak Yi
Korea Institute of Ocean Science and Technology, Korea
yijh@kiost.ac.kr