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Programme

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The Book of Abstracts

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FLUID-STRUCTURAL ANALYSIS AND OPTIMIZATION OF COMPOSITE WIND TURBINE BLADE

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Abstract

Wind energy is one of the most promising sources of renewable energy. The wind energy is converted into mechanical power through blades which are a major part of wind turbines. Nowadays, composite materials have been used for the fabrication of wind turbine blades to reduce blade weight. Fluid flows over the blade's structure surface and creates pressure loads resulting in the deformation of the blade. Numerical modeling methods are applied to estimate flow-induced deformation and they are required for the optimization of composite wind turbine blades. The wind turbine blade is analysed by computational fluid dynamics (CFD), finite element analysis (FEA), and the one-way and two-way system coupling of fluid-structure interaction (FSI) simulations of the composite wind turbine blade. The CFD was used to find the initial pressure load of the structure. Five types of the composite material were analysed to compare the results and define the optimum composite material based on the values of stress and deformation. The finite element analysis was used to test the tensile stiffness of the chosen composite laminate and to study the effect of micro-scale structural porosity on strength of structural materials. FSI simulations were performed for several wind speeds and then the results were analysed through the comparison of normal and shear stresses, blade deformations, force and moment reactions. The results are presented in the terms of the normal and shear stress distribution, and blade deformation with defined positions of the maximum values on the blade structure.

Keywords

Numerical modeling, composite materials, finite element analysis, deformation of structure, optimization of structure