

Abstract

Alice La Fata, "Coupled thermal-electrical simulation of lightning interaction with large wind turbine blades", 2016.

In the scientific literature, none among the reports about the effect of lightning on wind turbine blades presents a validation of the simulations that use the Finite Element Method (FEM) for such evaluation. The simulations are necessary for the estimation of the critical stress conditions that wind turbine blades experience when are struck by lightning. Furthermore, these analyses are fundamental for the development of new protection systems against lightning and for the enhancement of materials of which wind turbine blades are made. The present analysis deals with the validation of the main steps necessary for the construction of the FEM simulations. The software used is Comsol Multiphysics – AC/DC module. The validation is divided in three main steps and is performed comparing results of the Finite Element Analysis (FEA) with analytical formulas found in the scientific literature.

The most relevant among the boundary conditions that have to be set for the FEA is the grounding that is the first step validated in this thesis. The correct evaluation of the so-called "skin effect" is the second step validated. The composite material on which the FEA is focused is CFRP-epoxy, one among the most promising solutions for the enhancement of the performances of wind turbine. CFRP-epoxy has anisotropic physical properties; therefore, calculations of the consequences of injecting a current in that kind of material is the third step validated in this thesis.

For all steps, outcomes of the comparison between FEA and analytical results reveal the good matching between the solutions. Hence, the grounding is properly evaluated, the computational accuracy is guaranteed for calculations related to the skin effect and the calculations related to the directional variation of the electrical conductivity in a material with anisotropic behavior are correctly calculated by the software.

The validation of the main steps necessary for the construction of the FEM simulation has been performed with very good results; therefore, it is now possible to proceed with the FEM modeling for the evaluation of the critical stress conditions that wind turbine blades experience when struck by lightning.