

STRUCTURAL OPTIMIZATION INVESTIGATIONS OF THE OPEN-SOURCE GURIT98M WIND TURBINE BLADE MODEL

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Keywords: Structural optimization; Laminated composites; Laminate optimization; Wind turbine blades

Abstract

Wind turbine blades are large scale multi-material composite structures with typical lengths of 100-130 m. The materials used are different non-crimp fabrics made of glass and carbon fiber, pultruded carbon planks, balsa wood, PVC foam, recyclable PET foam and resin materials like epoxy or polyester. The large design space combined with many structural response criteria and many manufacturing constraints call for the use of structural optimization techniques to design competitive lightweight blades. A detailed open-source Gurit98m model of a 98 m offshore wind turbine blade has been made available to the scientific community to accelerate the research efforts in the area, and this work will demonstrate several use cases of the blade. The model is intended for use in the detailed structural design phase, where the outer aerodynamic shape has been fixed. A load envelope with twelve load cases, containing mixed flap- and edgewise load cases, is provided according to certification guidelines. The materials used for the default design are different non-crimp fabrics made of carbon and glass fiber, recyclable PET foam and epoxy resin. The model contains 563 distinct laminate patches, each with an independent laminate design and associated design variables. The finite element model is available in both Abaqus and ANSYS formats, making it accessible in standard generic input file formats.

Different investigations of gradient-based structural optimization of the blade will be demonstrated, taking into account structural constraints like tip displacement, linear buckling loads and local failure criteria for the twelve load cases, together with manufacturing constraints. The default parametrization is thickness variables associated to the non-crimp fabrics and core materials, such that other researchers can take offset in this model. Examples of using Discrete Material and Direct Thickness Optimization (DMDTO), a variant of DMTO, will be included to demonstrate the potential of advanced structural optimization techniques for cost effective designs of wind turbine blades.