## Abstract

Wind energy stands as one of the most important renewable energy sources. Wind turbine blades have grown considerably over the years, in order to gain more power. Large scale wind turbines blades are mainly based on fiber reinforced polymer composites; because an efficient way to further improves the performance of wind turbines is to reduce the weight of the onshore-offshore blades. The problem of the interior support structure of a -high power- horizontal axis onshore-offshore wind turbine blade is investigated in this study. A very detailed finite element model is developed, simulating the load-bearing box girder of the blade with a given airfoil shape, size and the type and position of the interior longitudinal beams and shear-webs. Material selection is the key issue in the design of these structures, since efficiency depends on the high strength-to-weight and stiffness-to-weight ratios. Previous work1 showed the challenging topics of material properties, design, topology details, computational analysis techniques and load response of a blade cross-section. In order to shed some light in a micro-scale level, a comparison of the most common composite blade materials (Glass fiber reinforced plastic and Carbon fiber reinforced plastic) is presented, regarding stress and strain distributions but also displacements, which are critical for optimal blade design.

Furthermore, wind turbine blades include many joints, where localized effects cause initiation of stress concentrations that may influence the static and fatigue strengths of the composite and sandwich parts2. They may also cause buckling phenomena with severe interlaminar and through-the-thickness normal stresses, which may determine the ultimate load-carrying capability of wind turbine blade structures. A failure criterion is applied based on the shell finite element analysis of the model, in order to dispose the stress levels throughout the box girder and locate the crack initiation point and the crack propagation. Results concerning both glass and carbon materials are presented.

The main objective of this study is to help further advance the use of computer-aided engineering methods and tools (e.g. geometrical modeling of the box girder, structural analysis and material selection methodologies) to the field of design and development of composite wind turbine blades, by assessing the stress state of the blade interior using the quasi-static finite element analysis and a post-processing methodology. The case of the tidal turbine blades will also be examined.