STRUCTURAL ANALYSIS OF SMALL-SCALE COMPOSITE PROPELLER BLADE

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Abstract

Contemporary, light-weight, unmanned air vehicles almost exclusively imply propeller rotors that enable them to hover, as well as to move vertically and horizontally at acceptable amount of required power (that is usually supplied by electric motors). Rotor main parts are blades − curved, rotational lifting surfaces subject to conjugate aerodynamic, inertial and gravitational loads. Their skin is usually made of composite materials, i.e. glass or carbon fibres (or their combination) immersed in epoxy resin. Additional inner structural elements may include shear webs, spar caps, ribs or foam fillers. The goal of the presented research study is conducting and validating structural analysis of a propeller blade by finite element method. Different structural models (containing just skin, or skin with foam filler), materials (glass or carbon, uni-or biaxial plies), and ply-up sequences (differing in layer numbers and orientations) are considered. The complete blade geometry is modelled, including the root and tip sections. The blade is clamed at the root, while computed aerodynamic, inertial and gravitational forces are distributed along its surface (and volume). Since the blade operates in axisymmetric conditions, it was possible to perform static structural analyses. Obtained results include deflection (and deformation) fields, normal and shear stress distributions along the plies, etc. From the acquired numerical values, it is possible to define an adequate blade structure that will be able to withstand all working loads (multiplied by necessary safety factors) and ensure safe flight of the aircraft. Future research may include modal or fatigue analyses of propeller blades.

Keywords

Propeller blades, Structural analysis, FEM, Composite structure

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