Conceptual design and simulation validation based finite element optimisation for tubercle leading edge composite wing of an unmanned aerial vehicle

ABSTRACT

A finite element model is developed to determine deformation and stresses on a composite wing of unmanned aerial vehicle (UAV) with a tubercle design at the leading edge of the wing. Tubercles, commonly known as protuberances found on the leading edge of a whale pectoral flipper, offering great performance from an aerodynamic perspective. This paper deals with a first order shear deformation theory (FSDT) approach to discover the UAV laminates composite wing model of tubercle leading edge (TLE) with rib-reinforced so that the equivalent stiffness and material properties are obtained from the simulation of finite element analysis using ANSYS. Another structural configuration of design replicating the idea of monocoque concept, whereby foam is used at the leading and trailing edges of the wing. Styrene acrylonitrile (SAN) core foam is used representing high strength-to-weight ratio with its superiority in the mechanical properties of polymeric sandwich composites. The updated static structural analysis from rib-reinforced can be applied to update the wing stiffness distribution of monocoque-foam. The optimum design is concluded from the tabulated deformation and stresses of both wings, where monocoque-foam showed better performance with a reduction in 50.72% of deformation and 35.88% of stress, compared to rib-reinforced design.

Keyword: Laminates composite wing; Rib-reinforced; Monocoque-foam; Finite element analysis