Performance analysis of composite ply orientation in aeronautical application of unmanned aerial vehicle (UAV) NACA4415 wing

ABSTRACT

The advancement in today's material science has driven composite materials to globally use in aircraft design with its superiority in high structural stiffness and significant weight reduction. Composite structures ordinarily comprise of laminates with various fibre orientation angles offers unique outcome, hence lead to optimized design for composite structure. The paper deals with the layer wise finite element model for static structural analysis ofa CFRP laminated composite of unmanned aerial vehicle (UAV) wing. The objective of this study is to compare the results for different orientation of ply combinations which contributed to the high-performance of composite materials that exhibit both orthotropic strength and stiffness properties. Both properties present unique challenges for analysis and design. The study is further up to determine the optimum design for selected ply combination on a wing with a tubercle design at the leading edge of the wing. Tubercles mimicking the protuberances on the leading edge of a Humpback whale pectoral flipper, offering great performance from an aerodynamic perspective. Hence, optimum design of composite is found from the tabulated stress and displacement for each ply combination, where the tubercles design at the leading edge of UAV wing showed better performance with a reduction in 38.75% of deformation and 46.83% of stress, compared to normal leading edge of NACA4415 airfoil.

Keyword: Laminated composite wing; Ply orientation; Finite element; Optimum design; Composite structure