Effect of wing attachment bolts on the drooping phenomenon in CFRP composite aircraft wing

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ABSTRACT

This research paper investigated the effect of wing attachment bolts on drooping in carbon fiber-reinforced polymer (CFRP) composite aircraft wings. A comprehensive analysis of an aircraft wing model featuring a NACA 4412 airfoil design with internal ribs examined both stationary and flight conditions. At present, the wing spans are, in general, attached through simple bolt connections. In the presented study, the influence of varying tapering angles and the number of bolts on wing drooping are analysed. Initially, aluminium Alloy was chosen as the wing material, and frictional connections were made to represent structural interactions. Emphasising wing drooping during stationary and flight phases, a FEM-based computational model has been developed to investigate the total deformation due to drooping and variation with flight attack angles. The developed FEM model is tested against the mesh independency and further optimal mesh size was determined for numerical results. Comparative analyses between aluminium alloy and CFRP composite materials are conducted to determine performance differences.

The research aimed to identify the optimal configuration for the mechanical fasteners, minimizing transverse and total deformation and weight while enhancing fuel efficiency and aircraft performance. The advantages of employing CFRP for outer wing sections, such as superior strength-to-weight ratios, stiffness, fatigue resistance, and corrosion resistance, are highlighted. The findings provided valuable insights into the use of wing attachment bolts in CFRP composite aircraft wings and their impact on drooping. Integrating composite materials and optimal bolt configurations held significant potential for revolutionizing aviation design and achieving reliable, fuel-efficient, and eco-friendly flights.

Keywords: Wing drooping; FEM; Aircraft wing; CFRP composite.

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