Abstract

This work presents the development, implementation and analysis of a first order model of a variable camber wing. An aerodynamic model of a homogeneous wing employing variable camber actuation was developed based on the vortex lattice method and was applied to the approach and landing phases (low speed, steady state, high angle of attack) of a civil transport aircraft. The aerodynamic model was shown to predict the lift curve well up to the stall angle of attack of 18°. A novel way of varying the camber across the wing span was presented which uses a parameter defining the NACA 5 series camber line to provide a means of smoothly changing the camber at a specific span location combined with a linear variation of the parameter along the span. This provided a model of a homogeneous wing capable of smooth continuous changes in shape. The lift distribution along the span of the variable camber wing clearly demonstrated smoothness with none of the discontinuities caused by conventional ailerons. The camber control effectiveness was shown to be 44% less than that of conventional ailerons which is partly attributed to the linear variation in camber along the span. It was shown that the variable camber has even less coupling with the longitudinal aerodynamics than do conventional ailerons and that the coupling with both yaw and side force appears smaller. A strip theory model was developed based on the typical section in aeroelasticity with two degrees of freedom: heave and twist. It was assumed that the camber actuation mechanism holds the wing perfectly rigid once the desired camber is reached. The discrete model was verified against a continuous cantilever beam. The discrete model of the Citation V wing was found to have natural bending and torsion frequencies of approximately 8 Hz and 5 Hz respectively which lie in the expected range for light civil passenger jets. The stability of the system in response to aircraft angle of attack and variable camber inputs was evaluated both with and without the presence of aerodynamic damping in the model. The stability of the system was found to depend on the amount of aerodynamic damping present.