World Academy of Science, Engineering and Technology
International Journal of Mathematical and Computational Sciences
Vol:14, No:12, 2020

Flow Separation Control on an Aerofoil Using Grooves

Authors : Neel K. Shah

Abstract : Wind tunnel tests have been performed at The University of Manchester to investigate the impact of surface grooves of a trapezoidal planform on flow separation on a symmetrical aerofoil. A spanwise array of the grooves has been applied around the maximum thickness location of the upper surface of an NACA-0015 aerofoil. The aerofoil has been tested in a two-dimensional set-up in a low-speed wind tunnel at an angle of attack (AoA) of 3° and a chord-based Reynolds number (Re) of ~2.7 x 105. A laminar separation bubble developed on the aerofoil at low AoA. It has been found that the grooves shorten the streamwise extent of the separation bubble by shedding a pair of counter-rotating vortices. However, the increase in leading-edge suction due to the shorter bubble is not significant since the creation of the grooves results in a decrease of surface curvature and an increase in blockage (increase in surface pressure). Additionally, the increased flow mixing by the grooves thickens the boundary layer near the trailing edge of the aerofoil also contributes to this limitation. As a result of these competing effects, the improvement in the pressure-lift and pressure-drag coefficients are small, i.e., by ~1.30% and ~0.30%, respectively, at 3° AoA. Crosswire anemometry shows that the grooves increase turbulence intensity and Reynolds stresses in the wake, thus indicating an increase in viscous drag.

Keywords : aerofoil flow control, flow separation, grooves, vortices
Conference Title : ICSRD 2020 : International Conference on Scientific Research and Development
Conference Location : Chicago, United States
Conference Dates : December 12-13, 2020