The effect of localized roughness on laminar separation bubbles

Nianhua Liu[1] & Serhiy Yarusevych[1]
1 Mechanical and Mechatronics Engineering, University of Waterloo, Waterloo, Ontario, CANADA

The effect of localized roughness on the aerodynamic performance and flow development on a NACA 0018 airfoil is experimentally investigated at a geometric angle of attack of 6°and a chord Reynolds number of $\mathrm{Re}_c = 100\,000$. Under the selected operating condition, a liminar separation bubble (LSB) forms on the model suction surface for the baseline case. Direct force measurement and planar Particle Image Velocimetry (PIV) measurement are conducted to characterize the effect of a spanwise finite roughness strip centered at the midspan and that of a roughness strip extending the whole model span. The results reveal a descending trend of the aerodynamic performance as the spanwise strip length increases. The mean velocity fields presented in Figure 1 show that roughness strips eliminate the LSB downstream (Figures 1*b* and 1*c*). Furthermore, the localized roughness strip affects a flow region whose spanwise extent exceeds significantly that of the strip, producing a three-dimensional LSB (Figure 1*b*). The finite roughness strip induces significant spanwise flow within a limited region (Figure 1*b*), leading to variation of mean LSB topology and vortex shedding characteristics along the spanwise direction.

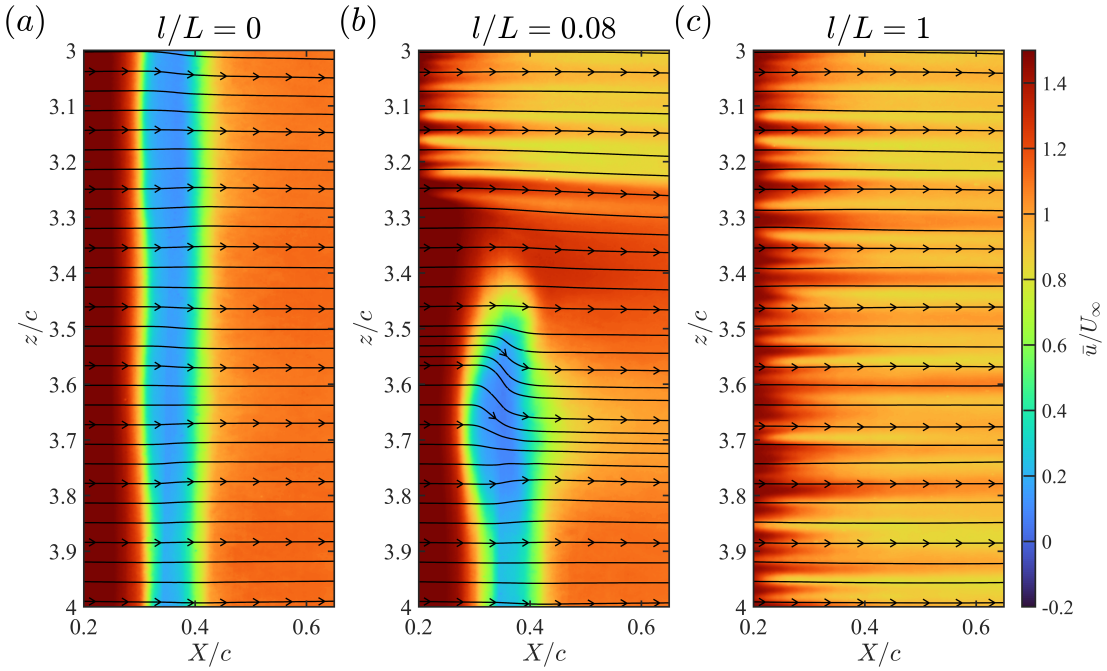

Figure 1: Time-averaged chordwise velocity in a measurement plane parallel to the chord. Distance between the measurement plane and the maximum model thickness location: $\sim 0.01c$. Black curves with arrows in (*b*) mark streamlines. l: spanwise length of the roughness strip. L: model span. Spanwise extent of the localized roughness strip in (*b*): $2.75 < z/c < 3.25$.

Email address for correspondence: *syarus@uwaterloo.ca*