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Effect of boundary conditions on 3-D separation over an airfoil

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Boundary conditions greatly affect the wake topology around a finite-span, low aspect ratio airfoil. Two sets of boundary conditions were imposed on the airfoil and their effect was explored in water tunnel experiments. First, the model was cantilevered from a wall where the thickness of the boundary layer, at the junction between the airfoil and the wall, was about half the airfoils span. The second model was with two free ends, where the model was held by a thin rod attached to the wall. In both cases, the airfoils had a NACA 0015 profile with an aspect ratio of 2, and were tested at a range of angles of attack and chord Reynolds numbers of 600 and 1,000. In addition, the airfoils were either unswept or 30 degrees swept back. Stereo particle image velocimetry and dye flow visualization were used to capture the flow field. It was found that for the unswept case, the boundary layer greatly affected the flow structures in the wake, with a dual vortex system forming at the tip. However, for the sweep case, the spanwise velocity component pushed the wake towards the tip and the effect of the boundary condition was smaller compared to the unswept cases.

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