

Developing a reliable method of estimating drag from far field measurements

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Calculating the drag force on a body using a momentum integral analysis is a common experimental technique. However, there is no widely accepted, standardized method for applying this technique. In working towards developing a reliable method of estimating the drag from such an analysis the effects of control volume boundary placement and common approximations on drag estimates are examined. Wind tunnel wake measurements were performed behind a NACA 0018 airfoil operating at a Reynolds number of 100,000 for four angles of attack. A separation bubble forms on the upper surface of the airfoil for the three lower angles of attack, while at the highest angle the flow separates without reattachment. Wake velocity profiles were measured with a cross-wire probe at several downstream locations, ranging from 1 to 4.5 chord lengths downstream of the trailing edge. Flow velocity in the outer flow was determined from wall pressure measurements along the upper and lower surfaces of the test section. The data acquired were used to investigate the variability in drag estimates obtained by momentum integral analysis when different simplifying assumptions are applied. The results show that drag estimates can vary by up to 200% due to the simplifying assumptions employed. In addition to this, the results show that drag estimates vary significantly based on the downstream position of the measurement plane. A conclusion drawn from these findings is that it is important to present a detailed description of the drag estimation technique used for analysis. The study also generated a few guidelines for employing a momentum integral analysis on airfoils operating under low-Reynolds number conditions.