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Accuracy Test Results in 2-D Transonic Wind Tunnels: Problem of Boundary Layer Control

B. Rašuo[1]

ABSTRACT

The principal factors which influence the accuracy of two-dimensional wind tunnel test results are analyzed. The influences of Reynolds number, Mach number and wall interference with reference to solid and flow blockage (blockage of wake) as well as the influence of side-wall boundary layer control are analyzed [1].

The purpose of this paper is to point out the principal factors which contribute to the greatest extent to the inaccuracy and diversity of results of measuring aerodynamic values expressed through lift-curve slope ($a = dC_L/d\alpha$) of conventional symmetrical NACA 0012 airfoil.

In the case of the simulation of transonic flow, the situation becomes even more complex when defining the aerodynamic flow parameters. The effects of solid and flow blockage are even more evident, the side-wall boundary layer becomes thicker, the areas of separated flow and shock waves are created, which cannot be eliminated even by the full presence of the ventilated transonic walls. All this makes it even more difficult to define the exact aerodynamic parameters measured in wind tunnels [2].

In order to create correct two-dimensional flow conditions and uniform spanwise loading of the airfoil model, it is necessary to apply side-wall suction, i.e. the control over the boundary layer along the side walls of the wind tunnel. Most frequently the removed quantity of air is expressed through the ratio of normal component of flow velocity through the wall, to the velocity of undisturbed flow (far upstream from the model) V_n/V_∞. In all tests made by the VTI-Aeronautical Institute the velocity ratio has been within the limits $V_n/V_\infty = 0.0050 - 0.0054$.

References

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[1] Aeronautical Department, Faculty of Mechanical Engineering
University of Belgrade
Kraljice Marije 16, 11120 Belgrade 35, Serbia
brasuo@mas.bg.ac.rs