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Numerical and experimental research of new methods for wall interference reduction in wind tunnels of transonic and low supersonic velocities

S.L. Chernyshev[1], A.I. Ivanov[2], E.V.Streltsov[3] and A.O. Volkova[4]

[1-4]Central Aerohydrodynamic Institute (TsAGI), 1 Zhukovsky St., Zhukovsky, Moscow Reg., 140180, Russian Federation, [2] ivanov_a_i@list.ru, [3]evg.streltsov@gmail.com, [4]a.volkova.mipt@gmail.com

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The process of designing and creating a new generation of transonic and supersonic wind tunnels is closely related to the development of efficient methods of the wall interference reduction. Along with the application of the permeable (perforated and slotted) walls, the possibilities of using alternative types of boundaries are investigated. One of the most promising approaches is generation of the homogeneous jet-boundary conditions on the solid walls of the wind tunnel test section using the near-wall jets or controlled boundary layer [1].

The further development of this concept is the combination of a controlled boundary layer and perforated walls of the wind tunnel test section. Series of experiments with 3D [2] and 2D models were carried out in the transonic TsAGI T-112 wind tunnel to evaluate the effectiveness of the new approach. In parallel with the experimental investigation, numerical simulation of the flow with different boundary conditions was performed using the ANSYS CFX and "Electronic wind tunnel" EWT-TsAGI software packages [3]. Numerical simulation of flow around the models with various test section boundaries has made it possible to substantially reduce the volume of the wind tunnel tests and to select optimal parameters of the boundary condition.

Significant errors in measuring the balance characteristics of the model are caused by wave perturbations at low supersonic velocities (up to approximately M=1.5), because the model itself generates a set of shock waves and rarefaction waves. These wave perturbations interact with flow boundaries, reflect to the zone of the model location and distort the flow field near its rear part. A numerical investigation has shown that the application of a controlled boundary layer or combined boundaries can significantly reduce the level of the reflected wave disturbances and improve the accuracy and reliability of the wind tunnel test results.

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