The flow separation development analysis in subsonic and transonic flow regime of the laminar airfoil

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Introduction

Wind tunnel tests of a laminar airfoil have been performed at the Institute of Aviation in Warsaw. The main goal of the investigation was to study the separation process development in subsonic and early transonic flow regime. The airfoil chord was 0.2 m. During wind tunnel test the natural laminar-turbulent transition was applied. The Mach numbers were 0.3 and 0.7. Reynolds number were approximately equal to $1.22.10^6$ and $2.85.10^6$ respectively. The angle of incidence was increased up until the flow was fully separated. During the experimental research, chosen test methods such as pressure measurements and Schlieren visualization were applied. Wind tunnel results were analysed in terms of aerodynamic coefficients and flow separation type identification. The wind tunnel investigation revealed that separation phenomena at subsonic and transonic flow regime affected in a different manner on the airfoil aerodynamic performance. This was mainly because of the change of the flow pattern influencing on the separation process.

Approach

The wind tunnel research was carried out in the trisonic N-3 wind tunnel at the Institute of Aviation. The N-3 wind tunnel is a closed circuit blow-down type with a partial flow recirculation [1]. Dimensions of the test section are: the cross-section 0.6 x 0.6 m, the length 1.5 m. The tested 2D airfoil model was of the laminar type with maximum thickness 15% c and the chord length 0.2 m. The V2C airfoil shape was designed by Dassault Aviation (France) and described in [2].

During the investigation, pressure measurements and colour Schlieren visualization were applied. In order to measure pressure distribution (thus lift and pithing moment of the airfoil), pressure taps were located on the upper and lower surface of the airfoil. The aerodynamic rake was used for momentum loss in wake measurement, from which aerodynamic drag was determined. The V2C laminar airfoil shape with pressure orifices distribution indication is presented on Fig. 1.

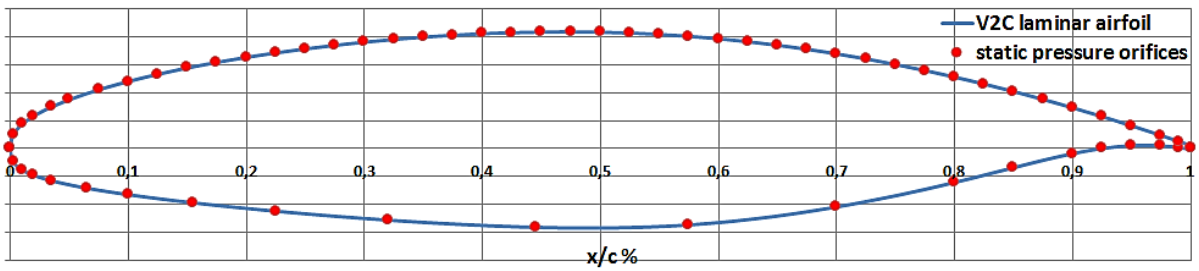

Figure 1: The static pressure orifices location at V2Cairfoil

Tests conditions

At the beginning of the investigation, the wind tunnel run for fixed angle of incidence 0^0 and chosen Mach numbers in range 0.3-0.8 was conducted. Afterwards, the 2D airfoil model was tested at two Mach numbers: 0.3 and 0.7. Reynolds numbers were approximately equal $1.22.10^6$ and $2.85.10^6$ respectively. The angle of incidence was increased from 0° up to the full separation occurrence. For the airfoil model natural laminar-turbulent transition was applied.

Acknowledgment

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References

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