Comparative Analysis of Simulation Results Using CFD with Reference to Wortmann FX 63-137 Airfoil

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Abstract

The primary devices used for testing the aerodynamic properties of aircraft constructions are aerodynamic and water tunnels. They enable to visualize the flow and measurement of the moving liquid parameters, which serve to determine aerodynamic characteristics. However, they entail constructing a physical model. Therefore, at present two systems (i.e., CAD/CAM/CAE software) are exploited for analyses in the design phase. The software makes is possible to create virtual 2D and 3D models, as well as examining their properties [1].

The aim of this paper is to make a comparative analysis of the obtained findings of simulation testing with regard to the flow, taking into consideration the aerodynamic parameters by means of the following software packages: COMSOL Multiphysics® [4], XFOIL, SOLIDWORKS®, Ansys® on the example of Wortmann FX 63-137 airfoil. The presented computational findings of the flow around the model have been compared with the data obtained experimentally [2].

The Wortmann FX 63-137 airfoil's geometry has been chosen on the basis of the coordinates [3], which will prevent an error resulting from a poor preparation of the computational model. After including the airfoil's data into the numerical software packages, the simulations were conducted. The obtained results using COMSOL have been depicted in Figure 1. For the simulation, the SST turbulence model is used to simulate the single-phase flow of a compressible fluid at low Mach numbers, including the Wall Distance Initialization option, solving the equations of momentum and continuity equations for the conservation of mass.

The results of the computations for pressure coefficient distribution are shown in Figure 2. On the basis of these values, it is possible to calculate the forces affecting the airfoil by applying numerical integration of the pressure coefficient cp.

The analysis of lift force coefficients showed a similar course of characteristics and a considerable similarity of the findings, obtained in simulation by the SST method from COMSOL, and k-ϵ from Ansys in relation to the experimental data, as shown in Figure 3.

Reference

[1] M. Białecki et al., Analiza porównawcza wyników numerycznego modelowania opływu profilu NACA 63-209, PTMTS, MECHANIKA W LOTNICTWIE
ML-XV, pp. 103-117 (2012)
[2] A. P. Broeren et al., Summary of Low-Speed Airfoil Data, Soar Tech Publications, Vol.1 (1995)
[3] Airfoil Data Information http://airfoiltools.com
[4] Flow Around an Inclined NACA 0012 Airfoil, CFD Module Application Library Manual, COMSOL

Figures used in the abstract

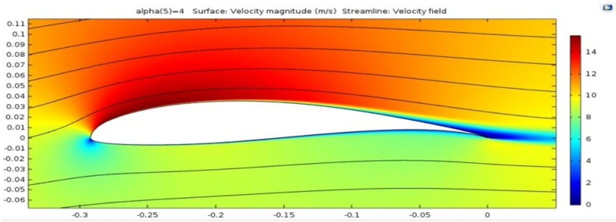

Figure 1: Velocity around Wortmann FX 63-137 – COMSOL.

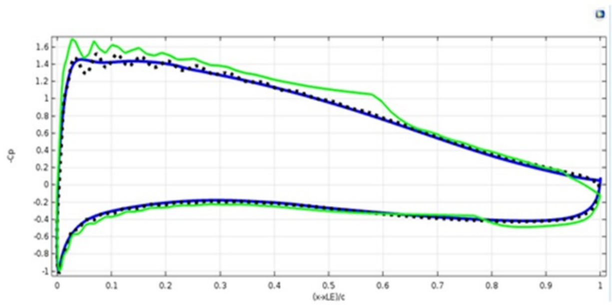

Figure 2: Pressure coefficient.

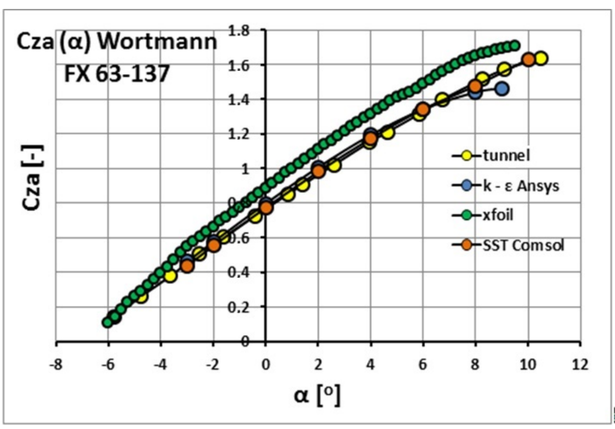

Figure 3: Lift coefficient Wortmann FX 63-137 airfoil.