World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:13, No:05, 2019

Supersonic Flow around a Dihedral Airfoil: Modeling and Experimentation Investigation

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Abstract : Numerical modeling of fluid flows, whether compressible or incompressible, laminar or turbulent presents a considerable contribution in the scientific and industrial fields. However, the development of an approximate model of a supersonic flow requires the introduction of specific and more precise techniques and methods. For this purpose, the object of this paper is modeling a supersonic flow of inviscid fluid around a dihedral airfoil. Based on the thin airfoils theory and the non-dimensional stationary Steichen equation of a two-dimensional supersonic flow in isentropic evolution, we obtained a solution for the downstream velocity potential of the oblique shock at the second order of relative thickness that characterizes a perturbation parameter. This result has been dealt with by the asymptotic analysis and characteristics method. In order to validate our model, the results are discussed in comparison with theoretical and experimental results. Indeed, firstly, the comparison of the results of our model has shown that they are quantitatively acceptable compared to the existing theoretical results. Finally, an experimental study was conducted using the AF300 supersonic wind tunnel. In this experiment, we have considered the incident upstream Mach number over a symmetrical dihedral airfoil wing. The comparison of the different Mach number downstream results of our model with those of the existing theoretical data (relative margin between 0.07% and 4%) and with experimental results (concordance for a deflection angle between 1° and 11°) support the validation of our model with accuracy.

Keywords : asymptotic modelling, dihedral airfoil, supersonic flow, supersonic wind tunnel
Conference Title : ICAS 2019 : International Conference on Aeronautical Sciences
Conference Location : Berlin, Germany
Conference Dates : May 21-22, 2019