6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

THE THEORETICAL AND EXPERIMENTAL EXPLORATION OF SUPERSONIC FLOW

A. Nastase[1],

[1] RWTH, Aachen University, Templergraben 55, 52062 Aachen, Germany
nastase@lafaero.rwth-aachen.de

Key Words: *Hybrid Navier-Stokes solutions, Non-classical three-dimensional Hyperbolical analytical solutions, Supersonic flow, Enlarged variational problems with free boundaries, Surrogate models, .*

The theoretical and experimental exploration of supersonic flow over flying configurations (FCs) was performed by using eight FC models namely: five non-optimized models of the wedged and the double edged wings, the wedged delta wing fitted with a conical fuselage, the wedged and the cambered rectangular wings and three models with inviscid global optimized (GO) shapes, it is, the delta wing alone Adela and the integrated wing-fuselage models Fadet I and Fadet II, which use the own three-dimensional hyperbolic analytical solutions (HASs), as start solutions for the design of their inviscid global optimized (GOs) shapes. The capabi-lities of these rapid, non-classical HASs, written in integrated forms , as in [1], [2], to predict the real world, were cheked in the trisonic wind tunnel of the DLR Cologne, in the frame of some research contracts of the author, sponsored by the DFG. A very good agreement between the theoretical predicted and the experimental measured lift and pitching moment coefficients for the range of angles of attack (-20 - +20) degrees, which is greater as in subsonic flow, was found. A good agreement also for the pressure coefficients for the range of angles of attack (-10 - +10) degrees was obtained. Very important conclusions for this exploration are found for flattened FCs at moderate angle of attack, namely, the more econo-mic flight with characteritic surface (instead of shock surface) is possible, the flow is laminar, as supposed here, the influence of the friction over the lift, pitching moment and pressure coefficients is neglectable, the developed software for the computation of these coefficients are confirmed and the solutions for the Navier-Stokes layer (NSL) have the HASs, as asymptotes The high performant surrogate models have inviscid GO shapes and are used in the first step of her iterative optimum-optimorum theory (OOT) .

A refinement of the start solutions was further made. These three-dimensional HASs were replaced with hybrid numerical solutions for the NSLs, which use the HASs twice: as outer flow at the NSL's edge and to reinforce the NSL's solutions, which are expressed as products of HAS with polynomes with free coefficients, which are determined by fulfilling the NSL's PDEs in a number of points, as in [1], [2]. These NSLs solutions have also analytical proper-ties due to HAS as: the correct last behaviors, have correct jumps over the singular lines, fulfill all the boundary conditions, the derivatives are exact computed , are split and speed up the computation time and are used up the second step of her iterative OOT .

REFERENCES

[1] A Nastase, Hybrid Navier-Stokes Solutions for Aerodynamical, Global Optimal Design, Proc. of EngOpt, Paper 750, Rio de Janeiro, Brazil, Ed. Jose Herskowitz 2008.

[2] A. Nastase, *Computation of Supersonic Flow over Flying Configurations*, Elsevier, Oxford UK, 2008.