Validation of Aeroelastic Aspects of new CFD Solver CODA with AEROSTABIL Windtunnel Experiment

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ABSTRACT

Currently the new CFD solver CODA is developed by ONERA, DLR and Airbus [1]. To validate the new solver and to show new possibilities in the field of aeroelasticity with the new tool, the code is applied to the AEROSTABIL windtunnel experiment [2]. This rather interesting experiment did show aerodynamically driven limit cycle oscillations (LCO) in the Transonic Windtunnel in Göttingen (DNW-TWG) and gives the possibility to validate flutter boundaries and nonlinear aerodynamic effects which lead to the limit-cycle oscillations. The flow features of this relatively flexible clean-wing setup include transonic aerodynamics and strong flow separation. These challenging flow conditions make the experiment a very good validation case.

One important aspect of the new RANS-CFD-solver CODA is the full linearization of the code. This allows to run the linear frequency domain (LFD) solver of CODA for different turbulence models. For such demanding flow settings, the turbulence model has a strong influence on the resulting steady and unsteady pressures. The paper should therefore compare the pressures and the resulting flutter boundaries for different turbulence models with the measured flutter boundaries.

Furthermore, the nonlinear effects which lead to the limit-cycle oscillations should be validated as well. For this purpose time-domain simulation results are presented.

Previous publications have shown that a transonic double-shock system on the upper wing side leads to a destabilization of a flutter coupling which is dominated by the first bending mode. The strong shock motion at LCO motion amplitudes is the amplitude limiter [3]. Hence, it should be analysed, if the same conclusions can be drawn with the new CFD solver CODA.

[1] S. Görtz, T. Leicht, V. Couaillier, M. Méheut, P. Larrieu and S. Champagneux, 2022, “CODA: A European Perspective for a Next-Generation CFD, Analysis and Design Platform,” NATO AVT-366 Workshop on Use of Computational Fluid Dynamics and Analysis: Bridging the Gap Between Industry and Developers, 16–19 May 2022

[2] Dietz, G., Schewe, G., Kiessling, F., and Sinapius, M. (2003). Limit-cycle-oscillation experiments at a transport aircraft wing model. In International Forum on Aeroelasticity and Structural Dynamics (IFASD), Amsterdam.

[3] Bernd Stickan 2018, “Explanation of AEROSTABIL limit-cycle oscillations via high-fidelity aeroelastic simulations”, Ph.D. thesis.