COUPLED FLUID-STRUCTURE INTERACTION SIMULATIONS FOR AERO-ELASTIC BENCHMARK CASES

Bettina Landvogt

Fraunhofer SCAI

ABSTRACT

The aerospace industry was one of the first branches to use numerical simulation to improve the performance of wings and airplanes in general. Finite Element Methods and especially Computational Fluid Dynamics have been used for many different aerospace applications during the last decades and are quite established in the research and development procedures.

The investigation of the aero-elastic behaviour of wings is one of the most important issues in this context. To get a clear picture of the interaction occurring between the deformable wing and the air flowing around the wing a coupled fluid-structure interaction simulation is necessary. Although FSI simulations have been used for a long time there are still a lot of problems and challenges to encounter when using coupled FSI simulations for real-life applications.

The most important aspect is perhaps the verification of the results of the coupled simulations. Several benchmark and test cases have been set up in wind tunnels to obtain experimentally measured values. Two of these test cases will be used to compare the results of coupled FSI simulations with the values measured in different experimental settings: the “High Reynolds Number Aero structural Dynamics” (HIRENASD) example and one of the AGARD test cases.

Several scenarios for the two test cases will be presented. The boundary conditions, e.g. the flow velocity and pressure difference, the material properties and the settings of the CFD and FEA solver need to be adapted to the experimental values. Dynamic behaviour – e.g. a buffeting or flutter analysis of the wing – and steady state phenomena are investigated. Concerning the mesh motion and the stability of the coupled simulation the usual challenges have to be faced. To get meaningful comparisons of the experimental and the numerical data the different data sets have to be analysed carefully.

Results of non-linear fluid-structure interaction simulations will be presented and compared to the experimental findings. The FEA simulations are performed with Nastran and Abaqus; Fluent and open source codes like SU2

and OpenFOAM are used for the CFD simulation of the air flow around the wing. The coupling is realized with the code-independent tool MpCCI.