Interaction of a channel flow with a vibrating airfoil

Martin Ruzicka[1] M. Feistauer[2] J. Horacek[3]

The subject of the contribution is the numerical simulation of the interaction of two-dimensional incompressible viscous flow in a channel and a vibrating airfoil. A solid airfoil with two degrees of freedom, which can rotate around the elastic axis and oscillate in the vertical direction, is considered. The numerical simulation consists of the finite element solution of the Navier-Stokes equations coupled with the system of ordinary differential equations describing the airfoil motion. High Reynolds numbers considered ($10^5 - 10^6$) require the application of a suitable stabilization of the finite element discretization. The time dependent computational domain and a moving grid are taken into account with the aid of the Arbitrary Lagrangian-Eulerian (ALE) formulation of the Navier-Stokes equations. A special attention is paid to the time discretization and the solution of the nonlinear discrete problem on each time level is performed. As a result a sufficiently accurate and robust method is developed, which is applied to the case of flow induced airfoil vibrations with large amplitudes after loosing the aeroelastic stability. The computational results are compared with known aerodynamical data and with results of aeroelastic calculations obtained by NASTRAN code for a linear approximation.

[1]Charles University Prague, Faculty of Mathematics and Physics, Sokolovska 83, 186 75 Praha 8, Czech Republic,
mart.in.ruza@seznam.cz
[2]Charles University Prague, Faculty of Mathematica and Physics,
feist@karlin.mff.cuni.cz
[3]Institute of Thermomechanics, Academy of Sciences of the Czech Republic,
jaromirh@it.cas.cz