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

Fluid-structure coupling of linear elastic model with compressible flow models with multilevel time stepping

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Keywords: *Fluid-structure interaction, coupling conditions, linear elastic model, compressible flow*

Cavitation erosion is caused in solids exposed to strong pressure waves developing in an adjacent fluid field. The knowledge of the transient distribution of stresses in the solid is important to understand the cause of damaging by comparisons with breaking points of the material. The modeling of this problem requires the coupling of the models for the fluid and the solid. One common approach is to iterate the coupling condition in each time step solving alternatingly the fluid and solid model as in [3].

Alternatively, a strategy based on the solution of coupled Riemann problems that has been developed in [1]. This concept is exemplified for the coupling of a linear elastic structure with an ideal gas. The coupling procedure relies on the solution of a nonlinear equation. Existence and uniqueness of the solution is proven.

The wave speeds in the solid are in general significantly higher than in the fluid imposing a smaller time step for the solid solver. In [1] all computations were performed using a synchronyzed timestepping for the fluid and solid solver. Thus, the CFL-number in the fluid was much smaller than in the solid. In order to avoid an unnecassary small time step in the fluid solver, we develop a multilevel local timestep algorithm in the adaptive RKDG solver [2]. By numerical simulations we will verify the improvement in the computational time without spoiling the accuracy.

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