The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

Simplex Space-Time Finite Elements for Fluid-Structure Interaction

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Keywords: *Simplex Space-Time Finite Elements, Fluid-Structure Interaction*

In engineering, phenomena of fluid-structure interaction play an important role. A prominent example is aeroelasticity, where, e.g., the behaviour of elastic airplane wings has to be included in the design process in order to maximize the aerodynamic performance. But not only in aerospace engineering, also in other engineering areas one can find further examples: the blood flow through flexible arteries in bio-engineering, the deformation of wind turbine blades in energy engineering, the flexible hulls of ships exposed to wind and water in naval engineering, or the movement of flexible piston rings in automotive engineering.

In the presented work, the coupled problem is solved by time-continuous stabilized space-time finite element methods. Building on previous studies on time-dependent flow problems [1], the time-continuous simplex finite elements (C-SST) are applied on the fluid side, using an unstructured triangulation of the space-time domain. Following a boundary-conforming approach, the deformation of the coupling interface is treated via a pseudo-elastic approach [2]. On the solid side, we focus on simplified models, i.e., rigid-body or beam models, solved in the manner of time-continuous prismatic space-time finite elements (C-PST), where the spatial discretization is extruded in time, leading to a structured discretization in time. The overall solver is presented along with numerical results to underline its potential.

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