PFEM-FEM coupling for fluid-structure interaction problems involving free surfaces and large solid deformations

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ABSTRACT

The present work focuses on the solution of fluid-structure interaction problems involving free surfaces and deformable structures. Free-surface flows are often encountered in reality, but the numerical solution of such problems remains a challenge, especially when the flow interacts with some flexible structure.

The Particle Finite Element Method (PFEM) is nowadays a well-established Lagrangian method for the study of free-surface flows [1, 2]. The key feature of this method is the continuous remeshing of the computational domain through an efficient Delaunay triangulation, based on which the equations are solved using classical Finite Elements [3].

In this work, the PFEM is coupled to *Metafor* [4], an in-house non-linear Finite Element solver, through an original partitioned strategy, based on block Gauss-Seidel iterations with dynamic relaxation [5, 6]. The main advantages of using a partitioned approach are that independent formulations can be employed for the fluid and the solid domains, and that the capabilities of already existing codes can be exploited at their best. In particular, in the problems proposed in this work, the solid structures can undergo very large deformations, and complex material laws, including plasticity for instance, can be easily taken into account.

The techniques developed in this work are assessed through many examples, ranging from civil engineering problems, such as a dam break against a deformable obstacle, to aerospace applications, such a bird strike. Results are compared to those available in the literature, whenever possible.

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