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An XFEM approach for fluid-structure interaction in the presence of cracks

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ABSTRACT

In this talk, we are going to present an approach that is capable of simulating the interaction of flows with cracking structures. Attempts to perform such simulations with arbitrary Lagrangean-Eulerian (ALE) methods would face a number of difficulties. The most important cause of these difficulties is that the propagating crack introduces a very sliver region into the fluid domain at each time step. Adapting the ALE mesh to handle such sliver regions greatly affects the quality of the mesh, and in turn influences the solution accuracy. This problem is circumvented by making use a fixed-grid approach for fluid-structure interaction based on the eXtended Finite Element Method (XFEM) in this work.

An XFEM based method to handle fluid-structure interaction (FSI) problems, as proposed in [1,2], is used in our simulations. An edge based stabilization is used to obtain stable numerical results in the presence of very small cut volume cells [3]. One of the main difficulties of performing XFEM based FSI simulations is the accurate integration of the weak form over the cut elements. This is achieved by using the recently developed moment fitting method [4]. In the current implementation, the crack is allowed to propagate only at the inter-element boundaries. This means that XFEM is used only for the fluid domain, but an extension to include XFEM-crack formulation is possible.

In this talk, the formulation will be presented along with numerical results demonstrating the applicability of the approach and the effect of FCSI both on the solid and on the fluid domain.

REFERENCES

[1] A. Gerstenberger and W. A. Wall. An extended finite element method/Lagrange multiplier based approach for fluid-structure interaction. *Comput. Methods. Appl. Mech. Eng.*, Vol. **197**, 1699–1714, 2008.

[2] A. Gerstenberger and W. A. Wall. An embedded Dirichlet formulation for 3D continua. *Int. J. Numer. Meth. Engng.*, Vol. **82**, 537–563, 2010.

[3] B. Schott and W. A. Wall. A new edge-based stabilized XFEM approach for 3D incompressible Navier-Stokes equations. In preparation.

[4] Y. Sudhakar and W. A. Wall. Quadrature schemes for arbitrary convex/concave volumes and integration of weak form in enriched partition of unity methods. *Comput. Methods. Appl. Mech. Eng.*, Submitted.