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Quasi-incompressible updated lagrangian fluid and monolithic formulation for the the fluid-structure interaction problems involving highly deformable solids

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ABSTRACT

Here a formulation is presented that enables the solution of fluid-structure interaction problems involving highly deformable solids in a strongly coupled way. Such an approach is of particular advantage when treating the FSI problems, where weak coupling techniques are inappropriate (e.g. deformation of membranes in water or air) and the strongly coupled partitioned methods suffer severe convergence problems.

Approach presented here is based upon the quasi-incompressible formulation derived for the fluid, which is called the “quasi-incompressible updated lagrangian fluid”, or FLIQ, and enables natural coupling with any solid in a natural way. The philosophy of the Particle Finite Element Method (PFEM) is adopted in the current work, that allows one to naturally deal with the free-surface flows [1].

In the proposed work, a medium such as water can be modeled assuming the compressibility close or even equal to the physical one, without the “volumetric locking” phenomenon taking place. A matrix-free method for the solution of the resulting system of equations enables efficient implementation of the proposed formulation. Simple stabilization technique, necessary when modeling fluids characterized by very high bulk moduli is proposed.

The method can be coupled with a non-linear convection-diffusion solver, which allows to include the heat equation, and thus enables

one to treat the respective variations of the fluid properties, such as e.g. viscosity. This is of particular importance when the method is applied to the solution of polymer melting problems, that arise in the field of Fire Engineering.

REFERENCES

[1] E. Onate, S.R. Idelsohn, F. Del Pin, R. Aubry, The particle finite element method. An overview, International Jour. Of Computational Methods, Vol. 1 n2, 267-307, 2004