8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

A fluid shell SPH method for simulation of fluid leakage in case of severe impact

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Key Words: *SPH, Fluid structure interaction, impact, elasto plastic rupture.*

ABSTRACT

This presentation is devoted to the formulation of a full SPH method for simulation of leakage of fluid filled thin vessels resulting from a severe impact.

The paper first presents the SPH method used for solid representation. The method has to be consistent and also stable. The first requirement is achieved by use of MLS shape functions and the second one as proposed by T Belytschko and co-workers [1] by a total Lagrangian formulation and the addition of so called stress points. A very small amount of artificial viscosity is added to harden the stability in case of severe impact loadings.

An original Reissner Mindlin MLSPH formulation is then proposed which is stable and consistent. The thick (and also thin) shell is modelled with only one layer of “particles”. The consistency is here more difficult to address because of the shear and bending properties of the medium. The stability is also more difficult to control especially in case of shock loads. A simple solution is proposed. The proposed formulation is developed in elasto-plasticity based on Ilyushin [2] and Crisfield theory of generalised plasticity. A very simple rupture criterion is proposed.

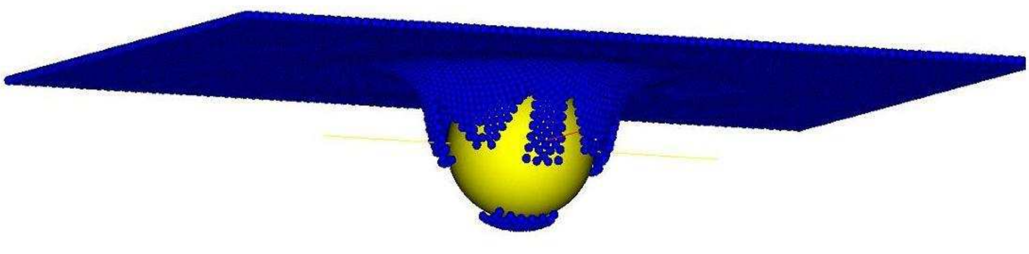
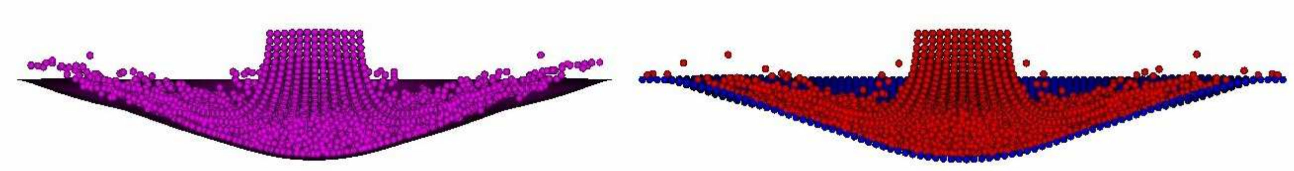


Figure 1: shell SPH perforation example.

The fluid SPH method is based on the usual updated Lagrangian formulation. The interaction is treated with the Pinballs method to avoid the air cushion effects which result from the so called "natural" method. The implementation in an explicit dynamics formulation is straight forward.

Examples of applications shall be presented for non linear shell responses including plasticity and failure. Fluid structure interaction problems shall also presented for academic cases first and a comparison with an original experiment shall also be presented.



Fluid SPH Shell FE Fluid SPH Shell SPH

Figure 2: academic example of fluid structure impact.

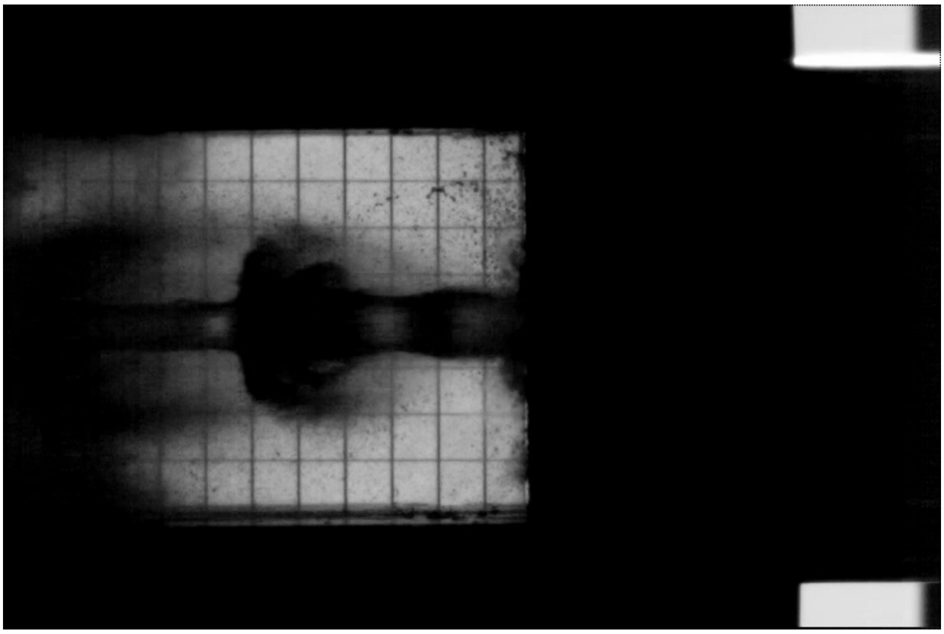


Figure 3: experimental fluid flow after the plate perforation due to fluid shock wave.

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