Energy controlled non-intrusive code coupling for dynamic fluid structure failure computation

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Abstract: This paper presents a non intrusive approach to couple a SPH fluid code with a FEM or SPH solid code to treat large strains and failure of solids in case of strongly non-linear fluid-structure interaction.

***K*eywords:** *fluid structure interaction, SPH method, Finite elements, Transient computations, Coupling. . .*

1 Introduction

This reliable estimation of failure of structures in case of severe dynamic loadings remains a challenge and still requires a huge computational effort. One may of course rely on experiments but these experiments are very costly and sometimes impossible to do in case of very severe accidental situations like tsunamis. One may also design small scale experiments but one has then to extend the results to scale one. The computations are interesting in this context to check that the extrapolation of results to large scale is valid. This presentation shall focus on presenting new results for solid and fluid code coupling in transient analysis and severe failure computation methods. In both cases SPH method shall be used for fluid domain.

2 Fluid SPH and solid FEM non intrusive code coupling

WE will presente a general framework for a non intrusive technique which permits coupling of codes for non linear failure analysis. The proposed coupling scheme ensures by construction a zero interface energy. The stability of the time integration of the coupled system is hence the same as the one that ensures the stability of each part. This is the main interest of the method when it is compared to most of the usual coupling methods which are based on a controlled small error of the interface forces. These methods, based on control of residual loads, ensure a very âĂIJsmallâĂİ interface energy but its sign remains uncontrolled and this will result in some cases in âĂIJunpredictableâĂİ instabilities of the coupled integrators. Example of coupling of heterogeneous structural time integrators with different time steps will be presented as well as a fluid structure case which couples of a standard finite element Newmark transient code with SPH ALE Runge Kutta (order 2) fluid model (Gravouil et all (2001),Mahjoubi et al (2011), Guidault et al (2007), Z. Li et al (2013)). One 3D fluid structure application example is presented in figure 1. One uses here the coupling of a FLUID SPH ALE code with a solid FEM Code.

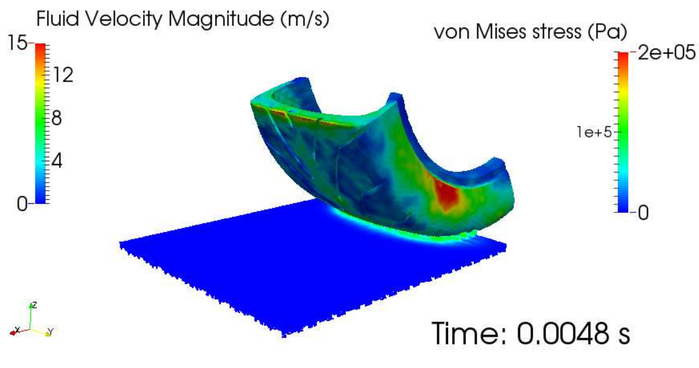

Figure 1: 3D SPH ALE FEM Coupling: a Tyre rolling on a rough wet road

3 Full SPH FSI modeling with cracking shells

The second part will present severe transient failure analysis and the associated numerical techniques. All the cases will consider dynamic crack propagation simulation. Two methods will be presented and compared. The SPH cracking shells shall be presented. The method shall be illustrated on perforation of shells filed with fluid by a missile as well as failure of tanks filled with fluid in case of impact and shock. All these cases shall be compared with experiments (Z. Li et al (2013), Caleyron et al (2011)). One fluid flow through a cracking shell is presented in figure 2

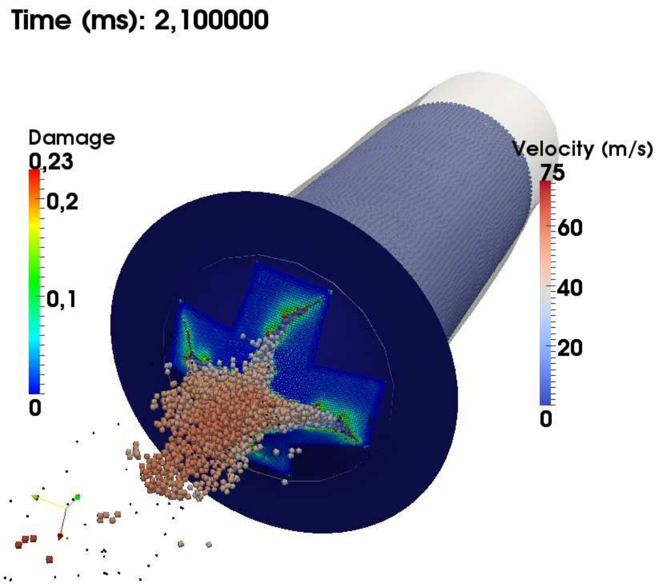

Figure 2: fluid flow through the cracked shell

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