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# Fluid-structure interaction using the coupled FE-SPH method

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## ABSTRACT

Water impact with structures is important for both the aerospace and marine industries. Aircraft must be designed to cope with ditching, this is a particularly critical case for helicopters as they often operate over water at comparatively low altitude. For the maritime and offshore industry extreme wave impact and green water loading, meaning deck submergence, are major sources of damage.

The requirement is for a reliable technique for predicting the structural response to extreme water loading. This is a complex problem involving the interaction of non-linear fluid behaviour with non-linear structural behaviour (large deformations, contact, material plasticity and damage). The explicit finite element method is the established method for simulating the crash and impact response of structures and is implemented in numerous commercial and research codes. Due to the well known problems with mesh-tangling this method is not suitable for modelling the fluid and the method much be coupled with another method, such as SPH, appropriate for modelling the fluid behaviour.

Previous work at Cranfield [1] has developed and demonstrated a contact algorithm for coupling meshless and finite element discretisations, allowing complex interaction in three dimensional simulations. A primary application of this method was the simulation structural impact on water. More recently this approach has been extended to wave loading of offshore structures through development of appropriate initial and boundary conditions for the fluid component. All developments were implemented within the existing tool which consists of the LLNL-DYNA3D code [2] coupled to a 3D SPH solver developed at Cranfield University.

This paper will discuss the coupled FE/SPH approach. Then it will present results from simulations of the impact of rigid and deformable specimens with water, compare them with published experimental data, and illustrate the current capabilities of the coupled approach. The difficulty of modelling this type of fluid-structure interaction is in correctly representing the fluid interaction with the structure so that the loading of the structure is correct. The simulation results show that good correlation can be seen between simulation and experiment for accelerometer and strain gauge data. The simulation results will also be used to illustrate where the existing fluid model limits the

accuracy of the simulations, such as representing cavitation and air entrapment.

References:

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