11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

INNOVATIVE SPH METHODS FOR AIRCRAFT DITCHING

Paul H.L. Groenenboom[1], James Campbell[2], Luis Benítez Montañés[3] and Martin Siemann[4]

[1] ESI-Group, Delft, Radex Innovation Centre, Rotterdamseweg 183 C, 2629 HD Delft, The Netherlands. pgr@esi-group.com, www.esi-group.com
[2] School of Engineering, Cranfield University, Bedfordshire, MK43 0AL, UK. j.campbell@cranfield.ac.uk, www.cranfield.ac.uk
[3] AIRBUS MILITARY - Structural Dynamics and Aeroelasticity Dept., P^o John Lennon, s/n, 28906 Getafe, Spain. Luis.Benitez@military.airbus.com, www.airbusmilitary.com
[4] German Aerospace Center - Institute of Structures and Design (DLR-BK), Pfaffenwaldring 38-40, 70569 Stuttgart, Germany. martin.siemann@dlr.de, www.dlr.de/bk/en

Key Words: *Fluid-structure interaction, Smoothed Particle Hydrodynamics, Aircraft Ditching, Hydrodynamic Phenomena.*

Smoothed Particle Hydrodynamics (SPH) offers a powerful method for simulation of fluid flow studies involving interfaces that may change rapidly in shape and topology. Within the EC-FP7 SMAES project [1, 2] two numerical codes – including the VPS/PAM-CRASH code – have been employed in which SPH is combined with finite element structural models to simulate aircraft ditching. The interaction between the structure and fluid is treated by interaction of the smoothed particles and entities characterizing the finite element models of the structures in contact with the water. Within the SMAES project development of the SPH method has focussed on two key areas: modelling physical phenomena and computational performance. This paper will provide an overview of both areas.

Physical phenomena involved with ditching of aircraft and the approach to simulate them numerically will be discussed. These phenomena include cavitation, suction between the aircraft and the water, ventilation and flight aerodynamics. The quality of the SPH solution has been improved by the introduction of various innovative methods, i.e. pressure correction and new particle regularization algorithms. Evaluation of the hydrodynamic pressures at the wetted surfaces will also be addressed.

Significant advances have been made with respect to the computational performance of the SPH simulation by introduction of special types of periodic boundary conditions and damping zones to mitigate the effects of free surface waves at the boundaries of the computational domain. Furthermore, an algorithm which allows for the generation of particle distributions with varying size and inter-particle distance will be discussed. The algorithm allows conducting simulations with a fine discretization in the impact zone and a gradual increase away from this region of interest, safeguarding a good quality of the distribution. This innovative feature helps to overcome the compromise between accuracy and runtime which usually is limited by the total number of particles.

The effectiveness of this approach will be demonstrated for a number of benchmark studies including vertical wedge impact. Validation of this approach against experiments of plate impact at conditions resembling actual aircraft ditching will be discussed in another contribution.

REFERENCES

[1] J. Campbell, Prediction of aircraft structural response during ditching: An overview of the SMAES project. *Aerospace Structural Impact Dynamics International Conference*, Wichita, Kansas, USA, 2012

[2] L. Benítez Montañés, H. Climent Máñez, M. Siemann, M. and D. Kohlgrüber, Ditching Numerical Simulations: Recent Steps in Industrial Applications. *Aerospace Structural Impact Dynamics International Conferenc*e, Wichita, Kansas, USA, 2012.