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DITCHING NUMERICAL SIMULATIONS: RECENT STEPS IN INDUSTRIAL APPLICATIONS

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ABSTRACT

Ditching is an aircraft emergency condition that ends with planned impact of the aircraft on water. It is generally divided in three consecutive phases: controlled flight approach, impact and floatation. The impact phase is the critical one in terms of loads acting on the aircraft and affects the successive floatation phase. The high forward velocity affects the aircraft dynamics and also its structural response due to the complex hydrodynamic effects acting on the structure in contact with water.

Airworthiness Regulations require that the aircraft structure withstands (without excessive damage) impact loads allowing passengers and crew to evacuate safely the aircraft during floatation. Therefore, the analysis of ditching impact is particularly relevant to satisfy certification requirements for modern aircrafts. Numerical methods for simulating ditching take advantage of the computational capacity allowing industry to deal with complex models representing the physical phenomena which play a role in ditching.

Airbus Military (EADS-CASA) and DLR are partners of the SMAES (SMart Aircraft in Emergency Situations) consortium, founded by the European Commission within the 7th Framework Program. This paper presents recent works performed within this program by means of Explicit Finite Element (FE) analysis coupled with Smooth Particle Hydrodynamics (SPH) techniques.

This paper is focused on the analysis of forces applied into the aircraft during ditching: hydrodynamic forces (overpressure and suction forces on the fuselage) and aerodynamic forces (acting on lifting surfaces). Hydrodynamic loads are the most important forces acting on aircraft during the impact phase because they may affect the airplane's structural integrity. They may be high because a considerable mass of water is displaced in a short time. Additionally, they are also difficult to predict because they involve complex fluid-dynamics of water, water-air interaction and fluid-structure interactions. The dynamics of the aircraft, internal loads and, at the end, its internal capacity is driven by these actions. The numerical models proposed take into account all these aspects to provide a suitable design tool for aircraft manufacturers.

The aircraft configurations presented are representative for military and civil transport aircraft. The first configuration is based on the Airbus Military CN235 aircraft, which is particularly certified for ditching for the U.S. Coast Guard Operation. Simulations at this stage have been made with rigid subscale models allowing comparison with subscale ditching tests in terms of aircraft trajectory and pressures acting on the fuselage. The extension to flexible full scale aircraft is feasible using the same simulation approach and it is a main objective of Airbus Military (EADS – CASA) within SMAES in the near future.

An alternative configuration using a generic standard body transport aircraft model is analyzed by DLR. In a first study recent ditching simulations with a rigid aircraft model will be compared to results generated in the previous EC funded project CRAHVI about 8 years ago. With the increase of computational efficiency the transition to a flexible model with local mesh refinements in the lower fuselage region will be considered in a next step. Due to the expected dramatic decrease of the critical time step with the flexible model, multi model coupling techniques will be studied to reduce the computational costs.