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Application of the MLM to evaluate the hydrodynamic loads endured in the event of aircraft ditching

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Ditching is an extremely rare event for an aircraft when it is forced to make a controlled emergency landing on water, as a consequence of fuel starvation for example. During the impact phase, the aircraft structure is subjected to severe hydrodynamic loads. In particular, the certifying authorities ask to demonstrate that appropriate design measures have been taken to minimize immediate injury to persons on board and to make it possible for them to escape before the shipwreck. These requirements as well as the necessity to improve understanding of the physical effects involved during an aircraft ditching have motivated the development of methodologies for the estimation of hydrodynamic impact loads. In particular, we aim at determining the influence of the structural shape, structural deformation, and aircraft dynamics on the hydrodynamic loads.

In the literature, several classes of methods devoted to the evaluation of hydrodynamic loads have been experienced, such as numerical methods involving a mesh for the fluid (Volume of Fluid methods for instance) or meshless methods (Smoothed Particle Hydrodynamics). Nevertheless, these numerical methods involve stability issues and significant computation costs. An alternative to numerical methods consists in using analytical methods, based on the potential flow formalism. In the present work, a possible variant based on the MLM (Modified Logvinovich Model) is presented. The mathematical framework of the MLM method has been introduced by Korobkin [1].

The MLM deals with the water impact of a 2D rigid section. The problem of the water impact of a 3D body is then replaced by a series of 2D water impacts (2D+t strategy). The impacting rigid sections are replaced by plates of similar extension so that the equations are based on the Wagner approximation. The real shape of the section is finally introduced via a Taylor expansion.

Some results obtained with the industrial code ELFINI® developed by Dassault Aviation are then presented. A set of test-cases with a growing complexity is detailed so that a step-by-step evaluation of the method is led. First, a series of 2D water impacts of elementary geometric bodies with imposed or free movement is performed. Then, we compare 3D high speed water impacts of metallic bodies with experimental results. Finally, we will discuss the further extension to the simulation of the water impact of a full scale generic business jet.

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REFERENCE

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