Numerical Hydrodynamic Study on the Effects of Body-Curvature During Ditching

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ABSTRACT

In this paper, we discuss the effects of the body curvature on the high-forward-speed water entry problem. The flow caused by aircraft ditching or planing craft slamming is characterized by a complex time-dependent wetness that is often coupled with the resulting structural dynamical response. The interaction of the complex body geometry and three-dimensional nature of the flow pose significant challenges for analytical solution development. The majority of the previous studies of this problem have been focused on pure vertical motion and flat-plate geometries, we focus on the effects of body surface curvature and large forward speed.

The present numerical study assumes the air-water flow to be governed by the Navier-Stokes equations of an incompressible two-phase but single-fluid medium. The volume-of-fluid method is employed to track the air-water interface.

The numerical framework is validated through the comparison with experiment of the force and pressure at distinct points on the body for plates that are either flat, concave, or convex. The simulations show that the body curvature produces a slight increase in the hydrodynamic force for the case of a concave plate and a reduction in force for the convex plate. An underprediction of the highly localized maximum pressure is observed between the numerical and experimental results, suggesting that a higher mesh resolution is required to fully resolve this feature. Finally, the numerical results are used to provide data for the air-water interface profile and the pressure distribution on the entire plate.