XI International Conference on Computational Methods in Marine Engineering

Numerical assessment of hydroelastic effects in water impact experiments with pseudo-rigid impactors

A. Tassin[1,*] and N. Jacques[2]

[1] Ifremer, RDT, F-29280 Plouzané, France

[2] ENSTA Bretagne, UMR CNRS 6027, IRDL, 29806 Brest Cedex 09, France

[*] alan.tassin@ifremer.fr

ABSTRACT

The validation of water impact models and high-fidelity numerical solvers (CFD) has motivated an important number of experimental investigations with « pseudo-rigid » impactors in order to validate the ability of the different theoretical approaches to accurately simulate this type of complex free-surface flows and the induced hydrodynamic loads. Achieving « perfect rigidity » in experiments is impossible and water impact induced vibrations are well known for affecting the slamming force measurements, see e.g. (Campbell and Weynberg, 1980). In a recent paper (Tassin *et al.* 2024), we have shown that it was possible to mitigate the effect of the vibrations on the force measurements by subtracting the inertial force , due to the acceleration field of the impactor, from the force measurement recorded by the load cell. The method relies on the use of several accelerometers which record the structural response of the impactor caused by the impact. We have demonstrated that it was possible to compensate for the effect of several vibration modes and to take into account the effect of a fluid added mass increasing in time. In the present study, we investigate numerically the effect of elasticity on the water impact hydrodynamic loads. We have carried out two-dimensional numerical simulations using the Arbitrary Langrange-Euler (ALE) framework of the Finite Element solver ABAQUS/Explicit. The case of an elastic parabolic shell with a high bending stiffness is considered. We first show that it is possible to recover accurately the fluid pressure reaction force from force sensor like measurements and acceleration like measurements. Our investigations demonstrates the ability to compensate for the first 10 eigen modes of the structure with 10 node acceleration signals. Through analytical simulations using the model of Tassin *et al.* (2013), we show that the oscillations on the fluid reaction force are mainly due to an added mass effect rather than to velocity fluctuations. Indeed, there is an order of magnitude between the acceleration and velocity terms. This observation is in agreement with the conclusions presented in Tassin *et al*. (2024) for a a rigid impactor supported by a linear spring. Estimating the evolution of the added mass of the different modes of vibrations during an impact remains challenging. Different possible solutions to adress this issue will be discussed at the conference.

References

Campbell, I. M. C. & Weynberg, P. A. Measurement of parameters affecting slamming. University of Southampton, Department of Aeronautics and Astronautics, 1980.

Tassin, A., Piro, D. J., Korobkin, A. A., Maki, K. J., & Cooker, M. J. (2013). Two-dimensional water entry and exit of a body whose shape varies in time. Journal of Fluids and Structures, 40, 317-336. https://doi.org/10.1016/j.jfluidstructs.2013.05.002

Tassin, A., Hulin, F., & Jacques, N. (2024). A direct multimode method for the reduction of vibration induced oscillations on force signals during “pseudo-rigid” water impact experiments. *Journal of Sound and Vibration*, *581*, 118378. https://doi.org/10.1016/j.jsv.2024.118378