
CEDRIC LEBLOND ET JEAN-FRANÇOIS SIGRIST, Service Technique et Scientifique, DCNS Propulsion / LEPTIAB,
Université de La Rochelle

Semi-analytical methods for the study of transient fluid-structure interaction problems

We study semi-analytical methods related to the effects of highly transient loads on underwater vehicles. Firstly, simple fluid-structure interaction models are derived so as to highlight the physical phenomena occurring in this problem. More precisely, interactions between circular thin shells or elastic structures and the radiated field by an underwater explosion are considered. The approach is based on the classical methods of Laplace transform in time, Fourier series expansions and separation of variables in space. Secondly, an extension of this approach is proposed for more complex geometries. It is based on Laplace transform in time, in vacuo eigenvector expansion with time-dependent coefficients for the structural dynamics and boundary-integral formulation for the fluid. The projection of the fluid pressure on the in vacuo eigenvectors leads to a fully coupled system involving the modal time-dependent displacement coefficients, which are the problem unknowns. They are simply determined by matrix inversion in the Laplace domain. This fluid-structure numerical method is exact in the sense that classical early-time or doubly asymptotic approximations are not made. This appears to be a versatile approach which can be efficiently and extensively used for design purposes, once part of the numerical resolution has been performed one time for a given geometry.