

TITRE DE LA THESE

An efficient method for the calculation of the free-surface Green function using ordinary differential equations

Résumé

The boundary element method (BEM) with constant panels is a common approach for wave-structure interaction problems. It is based on the linear potential-flow theory. It relies on the frequency-domain free-surface Green function, which is the focus of this thesis.

First, the mathematical expressions and numerical methods for the frequency-domain free-surface Green function are investigated. Twelve different expressions are reviewed and analyzed. Several existing numerical methods are compared including their computational time and accuracies.

Then, a series of ordinary differential equations (ODEs) for the time-domain and frequency-domain free-surface Green functions and their derivatives are derived. These ODEs can be used to better understand the properties of the Green function and can be an alternative way to calculate the Green functions and their derivatives. However, it is challenging to solve the ODEs for the frequency-domain Green function with initial conditions at the origin due to the singularity. This difficulty is removed by modifying the ODEs by using new functions free of singularity. The new ODEs are then transformed in their canonic form by using a novel definition of the vector functions. The canonic form can be solved with the initial conditions at the origin since all involved terms are finite. An expansion method based on series of logarithmic function together with ordinary polynomials which is very efficient for low frequency problems is also developed to obtain analytical solutions.

Finally, the ODE-based method to calculate the Green function is implemented and an efficient BEM solver is obtained. The removal of irregular frequencies is included. The new solver is validated by comparison of hydrodynamic coefficients to analytical solutions for a heaving and surging hemisphere, and to numerical results obtained with a commercial solver for a box barge and the KCS container ship.

Mots-clés: potential flow, Green function, ordinary differential equation, frequency domain, boundary element method

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