The Fixed Grid Fully Non-linear Potential Flow Model REEF3D::PTF - Examination of Different Methods for Solving The Laplace Equation at the Free Surface

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Fabian Knoblauch[1], Ahmet Soydan[2], Weizhi Wang[3], Hans Bihs[4]

[1,2,3,4]Department of Civil and Environmental Engineering,
Norwegian University of Science and Technology,
Høyskoleringen 7a, 7491 Trondheim, Norway
email[1]: fabian.knoblauch@ntnu.no
email[2]: ahmet.soydan@ntnu.no
email[3]: weizhi.wang@ntnu.no
email[4]:hans.bihs@ntnu.no

ABSTRACT

The evaluation of wave loads acting on marine structures is crucial for their design. Non-linear waves in extreme sea states result in especially high loads on the structures and therefore should be considered in the safety evaluation of marine structures. For numerical modeling of non-linear ocean waves and extreme sea states, fully non-linear potential flow solvers have proven to be a suitable tool [1]. compared to common CFD solvers, fully non-linear potential flow solvers allow for accurate wave representation at a fraction of the usual computational costs [1] and have therefor become a well-established tool for nonlinear wave simulation in the recent years. A mayority of nowadays non-linear potential flow solvers uses a sigma coordinate grid, for increased computitional stability [2]. This impedes the implementation of floating structures [2] . Therefore a fully nonlinear potential flow solver using a fixed coordinate grid is needed, to allow for future implementation of a floating algorithm. For a fixed grid potential flow solver, a method for defining the Laplace Equation stencil across the free surface is needed. The choice of the free surface treatment method is significant for the potential flow solver's stability and precision.

In this study, a fixed grid fully non-linear potential flow solver is built and different free surface treatment methods are implemented in the Laplace Equation solving scheme. The solver's stability and precision is evaluated in different test cases. The modeled results from different free surface treatment methods are compared to the results of a potential flow solver using a sigma coordinate grid and to experimental data.

The fixed grid potential flow solver is developed as part of the framework REEF::3D

The highly reduced computational costs of a potential flow solver make it preferable over a CFD simulation, when several different designs and layouts shall be tested. A fully nonlinear potential flow solver, able to implement floating structures, would therefore allow a tighter integration of the numerical analysis into the design process. A frequent evaluation of the loads on design concepts benefits the iterative progress and creates clearity regarding the design's safety. The development of a fixed grid fully non-linear potential flow solver is the first major step towards this.

REFERENCES

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