

VALIDATION OF SEAKEEPING CFD SIMULATIONS IN HEAD AND OBLIQUE WAVES USING THE NAVAL HYDRO PACK

Inno Gatin¹, Vuko Vukčević¹, Hrvoje Jasak^{1,2}

¹*Faculty of Mechanical Engineering and Naval Architecture, Ivana Lučića 5, 10000 Zagreb, Croatia, {inno.gatin, vuko.vukcevic, hrvoje.jasak}@fsb.hr*

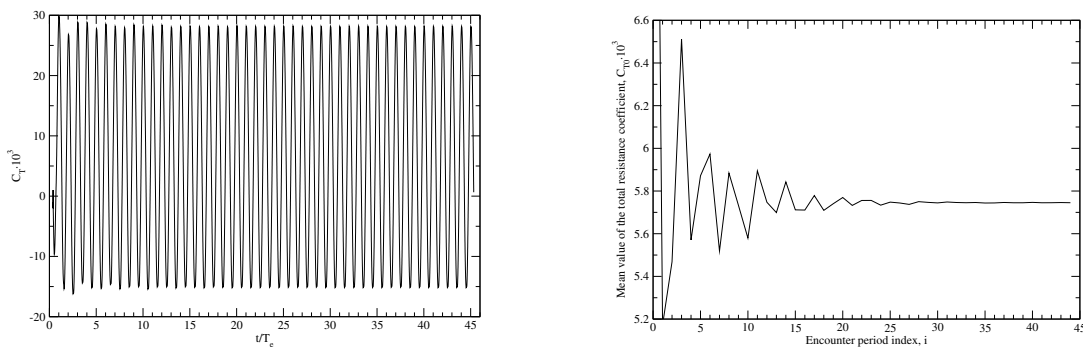
²*Wikki Ltd, 459 Southbank House, SE1 7SJ, London, United Kingdom, h.jasak@wikki.co.uk*

Keywords: *Seakeeping, Validation and Verification, regular and irregular waves, head and oblique waves, Naval Hydro Pack, foam-extend.*

An overview of validation and verification studies of seakeeping simulations is given in this work. A detailed validation and verification study is performed for KRISO Container Ship (KCS) hull for design Froude number in head waves and oblique waves for various wave parameters and heading angles. Grid and periodic convergence studies are performed for all cases, and the results are compared to experimental measurements. In addition, zero speed and low Froude number seakeeping results for regular and irregular head and oblique waves are presented for the Duisburg Test Case (DTC) container ship model. Enhanced body motion–fluid flow coupling is used in the latter simulations resulting in significant reduction of the required CPU time. Solution decomposition SWENSE (Spectral Wave Explicit Navier–Stokes Equations) [1, 2] method is used for wave modelling with implicit relaxation zones, while embedded free surface model [3, 4] is employed for accurate interface representation. The methodology is implemented within the `Naval Hydro pack` based on `foam-extend`.

For KCS hull five head waves cases are presented with varying wave parameters, where the total resistance, heave and pitch motions are reported. For oblique cases, five headings are simulated with the model free to pitch, roll and heave. All simulations are performed for design Froude number $Fr = 0.26$. Periodic uncertainty is assessed using moving window FFT (Fast Fourier Transform), as shown on an example of periodic convergence on Figure 1: the time domain signal is shown on the left and the periodic convergence throughout successive periods is shown on the right. Figure 2 shows the comparison of total resistance harmonics with experimental results for different wave parameters for head waves cases. It can be observed that results for head waves agree well with the experimental data.

For the DTC hull a total of 17 seakeeping cases are simulated. Six regular head waves cases are conducted for low Froude number $Fr = 0.056$ with different wave parameters, and an irregular JONSWAP spectrum head waves case. For the oblique wave cases, a total of ten conditions are simulated with different parameters and heading angles. All regular wave cases are performed on three grids to perform a grid convergence study amounting to a total of 49 simulations.



(a) Time domain total resistance signal.

(b) Periodic convergence of the mean value of total resistance.

Figure 1: Periodic convergence assessment.

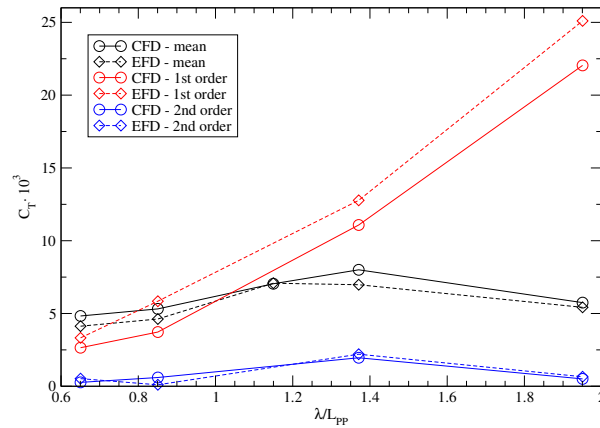


Figure 2: Total resistance transfer function.

References

- [1] V. Vukčević and H. Jasak, “Decomposition Model for Naval Hydrodynamic Applications, Part I: Computational Method,” *Submitted to Ocean Engineering*, 2015.
- [2] —, “Decomposition Model for Naval Hydrodynamic Applications, Part II: Verification and Validation,” *Submitted to Ocean Engineering*, 2015.
- [3] —, “Embedded Free Surface Method in Polyhedral Finite Volume Framework: Part I: Computational Method,” *Submitted to Journal of Computational Physics*, 2015.
- [4] V. Vukčević, H. Jasak, and I. Gatin, “Embedded Free Surface Method in Polyhedral Finite Volume Framework: Part II: Verification and Validation,” *Submitted to Journal of Computational Physics*, 2015.