Performance in waves – part 2

This part of the article presents an example application of SHIPFLOW MOTIONS to a study of an alternative forebody for the KVLCC2 with the purpose of illustrating some of the capabilities of the program.

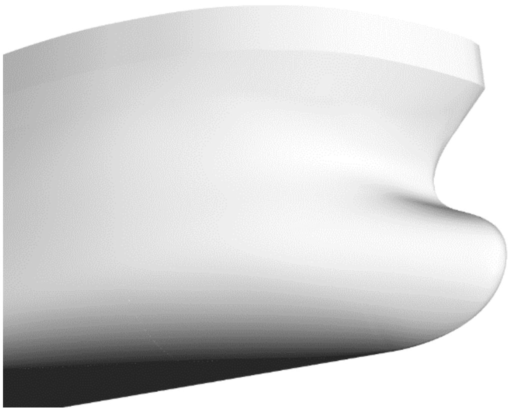
In order for a designer to efficiently design a ship while considering the performance in waves, a capable, computationally efficient and easy to use method for the prediction of motions and resistance in waves is almost mandatory. SHIPFLOW MOTIONS is a fully nonlinear potential flow method aimed at providing the designer with a tool with these traits.

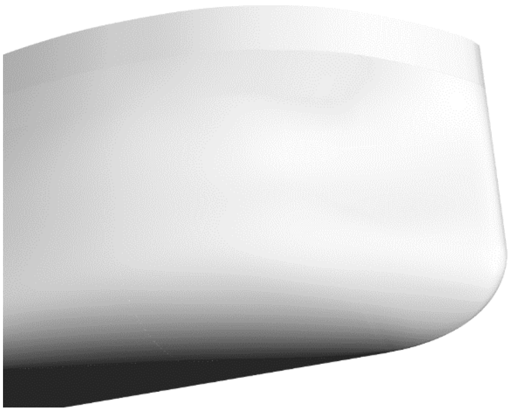
The first part of this article presented validation results for the added resistance of the KVLCC2 hull sailing in regular head waves, showing that the method is capable of predicting added resistance due to both radiation and reflection/diffraction.

This part aims to illustrate some of the capabilities of the program by applying it to a study of the effects of modifying the forebody of the KVLCC2.

Case description

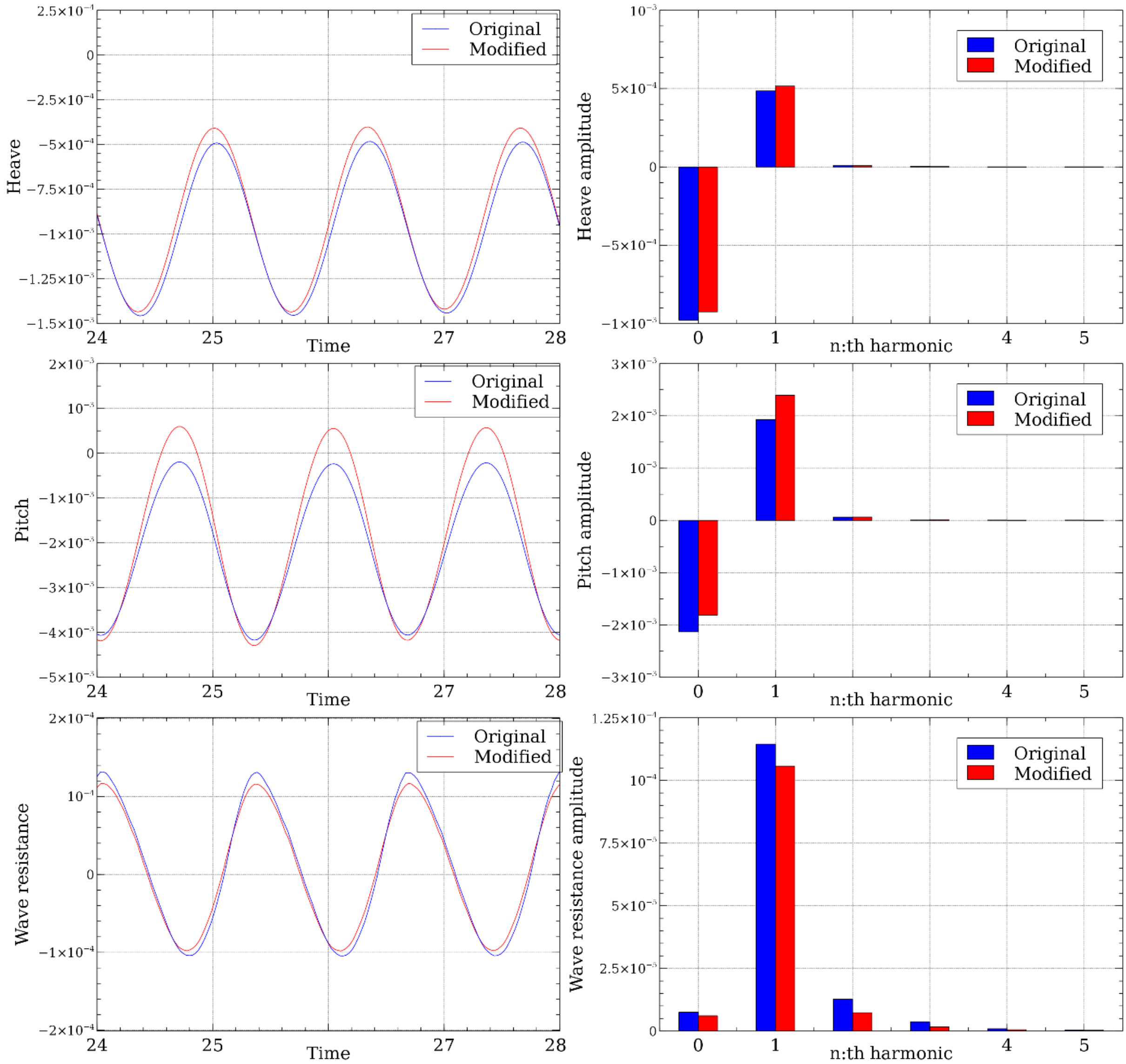
The purpose of the study is to investigate the effect of changing the bow shape of the KVLCC2 hull. A modified version of hull with a vertical stem was produced. The original (left) and the modified bow (right) is presented in figures below.





Time series and harmonic amplitudes

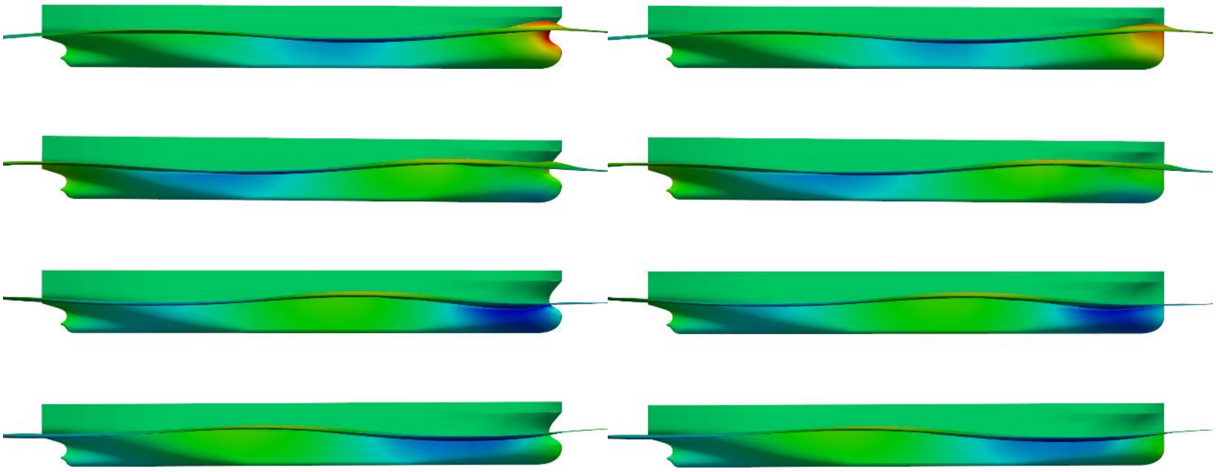
Time series of forces, motions, accelerations, wetted, etc. are written continuously to file while the computation is running. Once the solution has converged, the time series are post-processed automatically and selected quantities are saved to the output file and the report. This includes a full DFT-analysis of all time series and the spectra are also saved to file. The figure below illustrates the time series and harmonic amplitudes of the heave and pitch motion as well as the resistance for both the original and modified hull when sailing in a regular wave with wave length equal to 0.6Lpp and wave height equal to 0.01875Lpp.



Time dependent pressure distribution

For each time step, the solution is saved in order for the user to look at the time dependent velocity and pressure distribution on the hull. This may assist the designer to fine tune the hull lines or understand the effect of form changes.

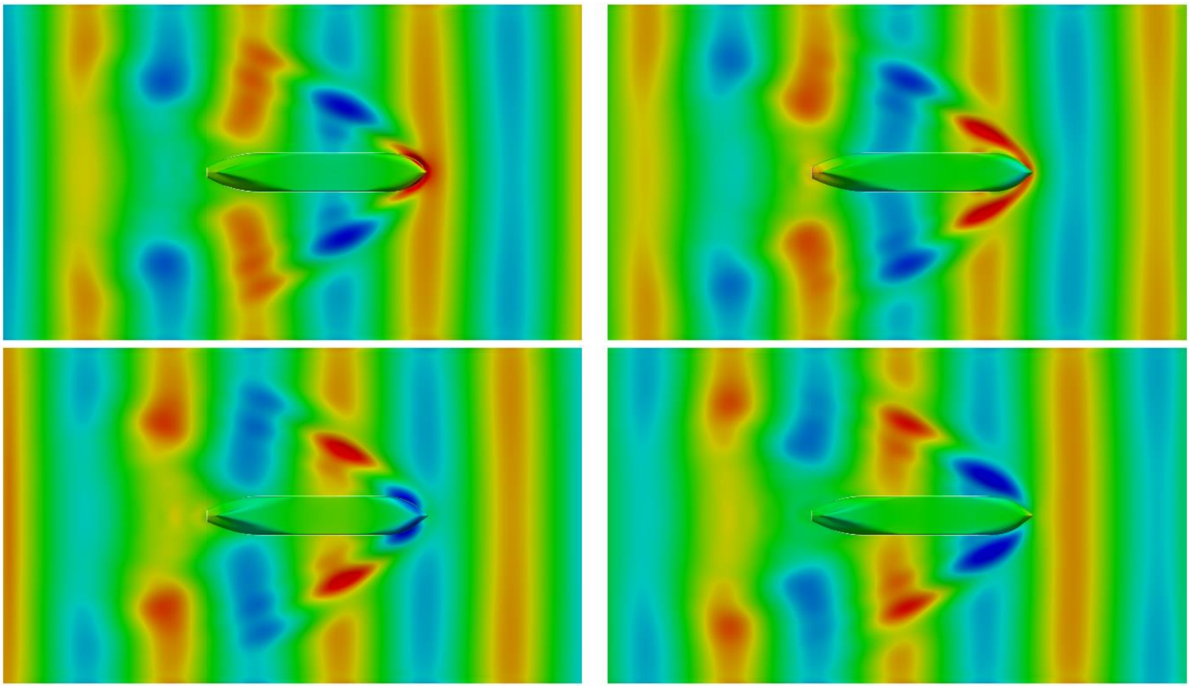
In the figures below, the dynamic pressure distribution for the two hulls are presented side-by-side over the quarters of a wave encounter period. The wave length is equal to 0.8Lpp and a wave height equal to 0.01875Lpp.



Wave pattern

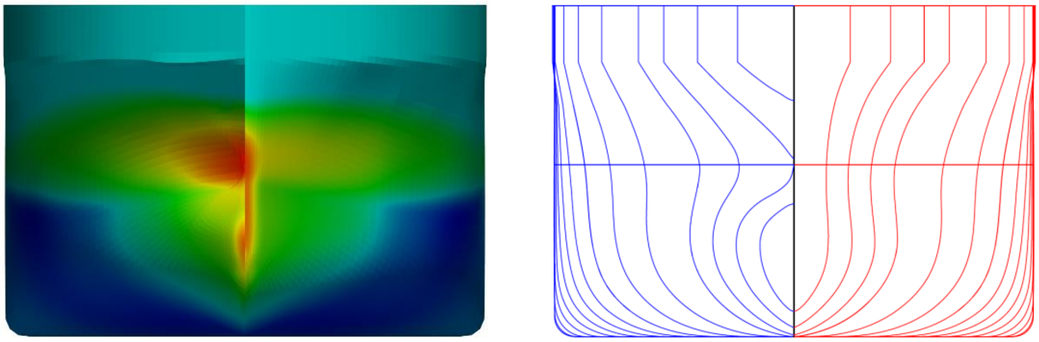
As an effect of the fully nonlinear free surface model, the potential field is not divided into separate componenents but rather treated as a whole. This means that the wave pattern includes the steady ship generated waves, the incident waves as well as the radiated, reflected and diffracted waves and the interaction between them all at once. Studying the wave pattern may assist the designer in the same was as for calm water cases.

The figures below illustrates the instantaneous wave pattern for KVLCC2 sailing in a regular wave with a wave length equal to 0.8Lpp and a wave height equal to 0.01875Lpp.



Temporal statistics

It is often very useful for the designer to be able to review the time-dependent solutions but another possibility that sometimes turn out to be very useful is to assess the time-averaged pressure distribution on the hull. This may help the designer to, for example, identify features of the hull form that contribute more to the resistance. In the figure below, the dynamic pressure distribution is time averaged for the two hull variants and are shown side-by-side. In this example it can be seen that the extended waterline of the modified hull efficiently reduced area and magnitude of the high pressure region around the waterline.



Discussion and conclusion

An example case with a forebody comparison has been used to illustrate some of the capabilities of SHIPFLOW MOTIONS.

Output data from computations are post-processed to a large extent by the program and provides the user with quick information.

The time-dependent solution provides valuable information for the designer.

Computations were performed directly from CAD geometry with the standard FINE mesh. A minimum input of speed, draft wave length and wave height was required to run these computations. Otherwise the computations were set up automatically.

SHIPFLOW MOTIONS accuracy, robustness, extensive automation and relatively low computational time make it a very capable design tool for with regards to performance in waves.