

## Calculation of ship manoeuvres

MARIN internal use only

# FreSim

The computer program FreSim is a simulation tool for manoeuvres with slender high-speed ships. The mathematical model is incorporated in a user-friendly PC program, validated with extensive model tests and full-scale measurements. As a result, a practical tool is available for designers and ship owners to verify their ship's compliance with the IMO manoeuvring standards or standards imposed by other regulatory bodies.

### Applications

FreSim is a practical tool to be used in the design process. It is based on elementary ship data, which are available in the design. Several standard manoeuvres can be simulated, like turning circle, zig-zag tests, acceleration or crash stop manoeuvres. In addition, scripts can be defined according to which the ship can make user defined manoeuvres. The program is also capable of conducting series of manoeuvres, such as a set of manoeuvres for IMO verification or reversed spiral series. The influence of wind and current can also be taken into account.

### Input

Required data for the program is limited: elementary data of rudders, propellers and skegs should be supplied. Because hull form details are incorporated in the modelling, an elementary hull form description is necessary. However, it is possible to import hull offsets.

### Output

Output of FreSim is presented in the form of data such as the required manoeuvring results. In addition, time histories of manoeuvring data are presented. Plots of the data can be generated. For the manoeuvring series, a summary of all manoeuvres is generated.



*Courtesy Royal Netherlands Navy*

### Validation

With the help of ship trials and model test data the simulation program is validated. Various navy ships have been simulated. Calculated and measured results are compared in terms of the IMO criteria but also more detailed manoeuvring characteristics. Validation results of the course checking and course keeping abilities of the ships are positive at all tested conditions. The turning ability and initial turning ability appeared more difficult to predict, but the results are reliable enough to indicate potential dangers. Crash stop results are considered good, especially considering the fact that many phenomena, which occur during the stopping of vessels, are still not understood.



## Theory

In spite of all hydrodynamic knowledge it is still difficult to predict manoeuvrability characteristics. A complete theoretical flow calculation is not yet feasible. Therefore, it was decided to use a semi-empirical model description on theoretical basis, based on model test results. The so-called cross flow drag model is developed based on extensive model tests and theoretical considerations. In this model the lateral forces on the ship are calculated in relation to the local drifting speed during the manoeuvre. Herewith the ship is split up in a number of strips.

Based on these local coefficients the 'overall', non-linear hydrodynamic coefficients are calculated. Compared to the conventional approach, this approach produces a much more reliable and robust mathematical model, giving meaningful results for any ship.

For more information please contact the department [Maritime Simulation & Software Group](#);

T +31 317 49 32 37

E [msg@marin.nl](mailto:msg@marin.nl)