

## Calculation of ship manoeuvres

### **SURSIM**

The computer program SURSIM is a simulation tool for manoeuvres with displacement ships. The mathematical model is incorporated in a user-friendly PC program, validated with model tests and full-scale measurements. As a result of this combination, a practical tool is available for designers and ship owners to verify their ships' compliance with the IMO manoeuvring standards.

#### **Applications**

SURSIM 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, overshoot manoeuvres, start and stop manoeuvres. In addition, scripts can be defined according to which the ship can make user defined manoeuvres. With these scripts, for example the effect of bow thrusters can be evaluated. The influence of wind and current can also be brought into account.

#### **Input**

Required data for the program is limited: elementary data of rudders, propellers and skegs should be supplied. An elementary hull form description is necessary. However, it is possible to import hull offsets. Model tests to assess the manoeuvrability are often too costly in this stage and require much more detailed information which is not yet available.

#### **Output**

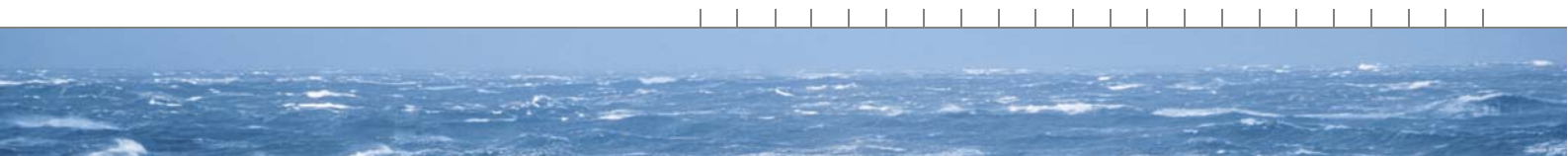
Output of the program is presented in the form of data such as the required manoeuvre results. In addition, time histories of manoeuvring data are presented. Plots of the data can be generated.

#### **Validation**

With the help of ship trials the simulation program is validated. Many ships, built at Dutch and foreign shipyards, varying in length between 70 and 320 metres, have been simulated. Calculated and measured results are compared in terms of the IMO criteria. The results of validations of the turning ability and initial turning ability are positive at all tested conditions. Course checking and course keeping abilities appeared difficult to predict for full ships with low L/B ratio, but the results are reliable enough to indicate potential dangers. Crash stop results are considered relatively good, especially considering the fact that many phenomena, which occur during the stopping of vessels, are still not understood. The used cross flow drag model was found to work well up to water depths of 2.5 times ship draft.



*Courtesy Nedlloyd*

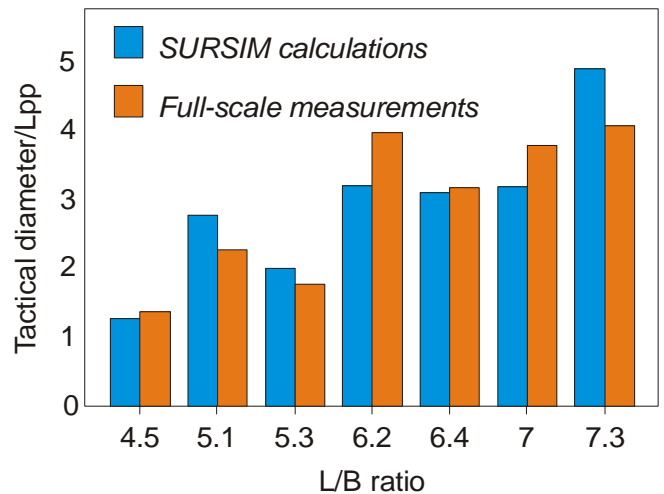


## Theory

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 was 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 the geometric qualities of each strip (width, draught and area) the cross flow drag coefficients are calculated.

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 which gives meaningful results for any ship.

Comparison of full-scale trials and SURSIM results



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