Predicting Catamaran Resistance with NavCad

A HydroComp Technical Report
Report 105

This report comments on the use of NavCad version 4 (and prior) for the resistance prediction of catamarans. It presents a discussion of two different techniques. (**Note**: NavCad 2003 contains an explicit prediction of catamaran resistance.)

THE PROBLEM

Catamaran resistance is twice the individual hull resistance, plus an added drag due to the interference of the hulls with each other. NavCad predicts this system resistance (hulls and interference) in one of two ways - a *catamaran system solution* and a *modified monohull solution*.

The catamaran system solution directly predicts the total system resistance. The prediction algorithm combines both hull and interference resistances.

The modified monohull solution predicts individual hull resistance just as if it were a monohull. NavCad adds interference drag through correlation to catamaran model tests via the *aligned prediction* feature. With this approach, the effect of hull parameters and spacing can be explicitly evaluated.

CATAMARAN SYSTEM SOLUTION

NavCad has one algorithm for catamarans [Gronnslett, 1991]. The algorithm utilizes a set of curves for residuary resistance. A random collection of full-scale and model tests of high-speed displacement catamarans with slender symmetric demi-hulls is the basis of this algorithm.

The method does not take differences in hull separation into account. Differences in interference drag are averaged to produce a generic result. This algorithm exhibits surprisingly good accuracy, however. We surmise that this is due to two characteristics of these types of vessels.

First, the hulls are long and slender operating in a high speed range (Fn from 0.6 to 1.6). A good portion of this resistance will be frictional, which is directly calculated. Second, hull spacing has shown to have the most effect on interference resistance in the lower speed ranges near the principal wave-making hump speed (Fn from 0.3 to 0.7). Above this speed regime, there is little difference in added interference drag due to different hull spacing [Insel, 1991].

MODIFIED MONOHULL SOLUTION

The above system solution is inadequate for lower speed ranges and hull types that are not the typical "wave-piercer" or "high-speed displacement catamaran". A modified monohull solution can be used for these situations, and to improve prediction accuracy in general. This approach requires the use of model tests or full-scale trials.

The key to this approach is to work with half of the vessel. In other words, results are shown "per hull". Total resistance will then of course be twice the predicted result.

Residuary resistance coefficients from catamaran model test results are the same for one hull or two. Remember, the coefficient is a function of wetted surface. As resistance and wetted surface are both divided in half, the coefficient remains the same. Thus, Cr values can be entered directly from model test reports or trial results without correction. These Cr values include hull drag, as well as interference drag.

The first step is to choose a catamaran model test that has similar L/B and spacing as the subject design. The aligned prediction then evaluates this model and creates a correlation curve to go from predicted bare-hull drag (as a monohull) to actual catamaran drag (including interference). This correlation curve is then applied to the prediction of the design (as a monohull with its own parameters of L/B or Cp, for instance). A prediction of the demi-hull resistance, correlated to a model with similar spacing is the final result.

MODIFIED MONOHULL PROCEDURE

HydroComp supplies model test files suitable for use in a modified monohull solution [Insel, 1991].

These test are based on a transom stern, round bilge hull form. Successful use of aligned prediction calls for a broad range of L/B and spacings (S/L ratio). This series of fifteen tests includes pure monohulls (for reference) and catamarans of L/B from 7 to 11, and S/L from 0.2 to 0.5. Other tests can be entered and archived in NavCad's model/parent file system.

A systematic procedure is described below.

1. Review and select a catamaran model test report that has similar L/B and S/L ratios.
2. Enter this data into a NavCad model/parent file. Speeds and Cr values can be entered directly from the report. If a slow speed form factor was determined, this too can be entered as shown. Hull data, however, should be for one hull. Especially remember to use the wetted surface and displacement for only one hull (half of the ship).
3. Enter data for the hull design into NavCad for one hull, just as was done for the model.
4. Build a resistance prediction. First, choose a prediction method that is suitable for the range of hull parameters.
5. Choose *aligned prediction* and a resistance parameter for alignment (Rbare, Rr or Rw, if available).
6. Define the model file name and run the calculation.

MODIFIED MONOHULL EXTRAPOLATION

A slightly different approach uses the *extrapolation* feature of NavCad in place of the *aligned prediction*. Extrapolation simply uses a non-dimensional resistance/displacement ratio correlation between model and design to predict resistance. If a model and the design are quite close in shape and parameters, then extrapolation can be a successful approach.

Extrapolation creates a curve of resistance to displacement ratio versus Froude number. It has the effect of scaling a model's resistance in suitable proportion to size and speed. Total bare hull resistance can be extrapolated, as can residuary (or even wave-making) if the frictional or viscous portions are calculated from an accurate wetted surface.

HydroComp, Inc.
13 Jenkins Court, Suite 200
Durham, NH 03824 USA
Tel (603)868-3344
Fax (603)868-3366
info@hydrocompinc.com
www.hydrocompinc.com