Figure 1: Naval Combatant 5415

New unstationary test techniques in the MARIN basin

To determine mathematical models, Planar Motion Mechanism (PMM) and rotating arm tests have traditionally been used but with the introduction of the Computerised Planar Motion Carriage (CPMC) 30 years ago, flexibility was added. The installation of a CPMC over a very large basin such as MARIN's Seakeeping and Manoeuvring Basin adds even more flexibility. And now new, unstationary CPMC tests have been introduced. A recent campaign on the "naval combatant 5415" has been carried out deploying the new tests, which aim to reduce testing time and costs.

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The naval combatant 5415 (see figure 1) has been model tested at various institutes in the world. As seen, the model is a typical naval surface ship. At MARIN, this ship is used to carry out Free Running Manoeuvring tests, PMM tests, rotating arm tests, but also the new types of unstationary CPMC tests.

New techniques

The aim of the new testing techniques is to reduce the testing time and hence, improve efficiency and reduce the costs of captive model test campaigns. Usually, these model test campaigns are used when customers require detailed mathematical models. These mathematical models may be necessary for fast-time, or real-time simulator studies. The objective of these studies is that a mathematical model can be constructed out of a range of measured combinations of drift angles, rotation rates, rudder angles and propeller revolutions.

Unstationary tests

Now, how does it work? In traditional captive tests, each run consists of one combination of drift angle, rotation rate, rudder angle, ship speed and propeller RPM. Each run lasts long enough to get a good answer. In unstationary tests, during a test run the parameters are changing very slowly to an almost stationary value. This could manifest itself in a run where the model has a constantly changing drift angle. Such an approach can lead to very strange trajectories. Figure 2 shows a range of these trajectories as carried out with the naval combatant in MARIN's Seakeeping and Manoeuvring Basin. The first figure shows a traditional rotating arm test, while the second figure shows a traditional PMM test. At the maximum transverse amplitude, the ship has achieved a rate of turn and this rate of turn is the value that is used in the mathematical model.

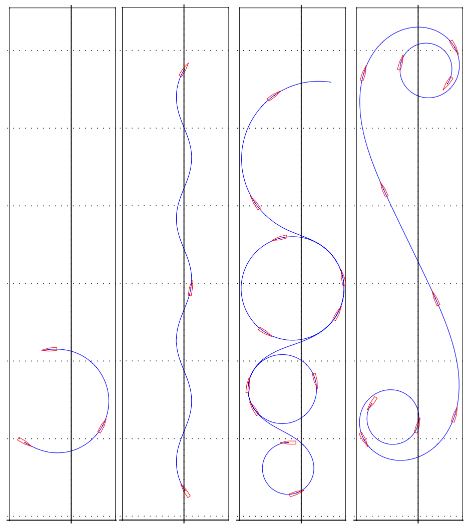

Figure 2: Conventional and unconventional testing trajectories

The third figure gives the unconventional manoeuvres. Figure 3 shows how in one run through the Seakeeping and Manoeuvring Basin four radii are tested and hence, information is obtained on four steady states. A photograph is shown with the trajectory of the naval combatant in the Seakeeping and Manoeuvring basin. The captive connection between the towing carriage and the model can be seen. A yoke is mounted which allows the model to trim and sink during the tests. But the motions in all other directions are restricted, so that forces and moments can be measured.

Does it work?

So to the million-dollar question, do these results give the same answers as a traditional approach? Figure 3 shows a sample of the results. It compares the results of a test with a continuously changing drift angle, with results obtained using traditional captive drift tests. The right hand figure shows the typical trajectory, while the left hand figure is showing the correspondence of the results. A near perfect match is achieved!

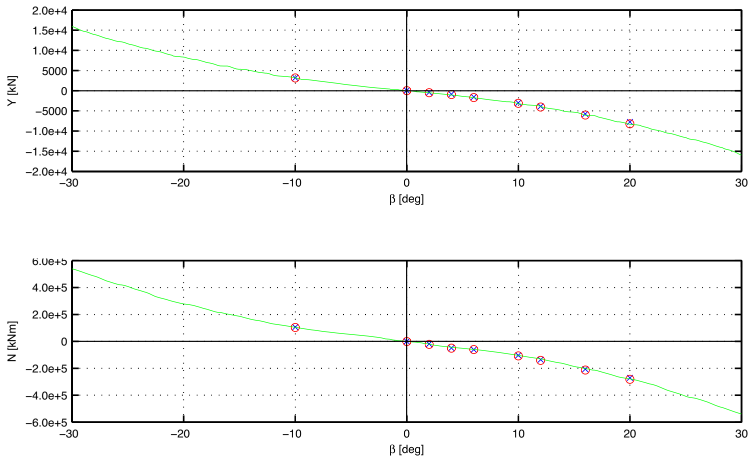

Figure 3: Side force and yawing moment from stationary (red) and instationary (green) tests

And the future?

The range of applications goes further. Not only a continuously changing drift angle or rate of turn is possible, also a continuously changing combination of rate of turn and drift angle can be done. The results of these measurements are displayed and indeed, using fewer model tests, they provide a complete description of forces and moments for the creation of a mathematical model.