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Course keeping in stern - quartering waves.

'Steady as she goes' can be harder than you think

Many mono- and multihulls face problems with course keeping, especially in stern-quartering waves, report Frans Quadvlieg and Reint Dallinga.

First, let's dispense with some misconceptions: course keeping problems don't only occur at high speeds and in rough seas; they don't just affect high-speed ships like semi-displacement monohulls or wave piercing catamarans, but are a challenge for contemporary ferry designs.

In particular, a number of questions must be asked:

- Which aspects affect course keeping ability in waves; are these the same which cover calm water course keeping ability?
- What is the relationship between wave induced forces and the possible reaction forces of hull, skeg and rudders?
- What are the effects of (optimised) control algorithms on the course keeping ability?

SMB offers new opportunities

MARIN's new longer and wider Seakeeping and Manoeuvring Basin, in combination with the large excursions allowed by the carriage in the following mode, offer an opportunity to explore these problems and to find some useful answers. Tests were carried out with a model of a contemporary twin screw high-speed monohull, self-propelled and equipped with active rudders and active fin stabilisers. Several aspects of the ship were varied: rudder area, rudder type, autopilot settings and skeg area. The skeg and rudder combinations were selected to represent two extremes in terms of course stability. A large skeg arrangement, in combination with flap rudders, and a small skeg arrangement, in combination with normal rudders, were adopted. Tests in regular and irregular stern-quartering waves focussed on a combination of ship speeds, wave periods and headings that combine relatively low frequency of wave encounter with relatively high wave induced yaw excitation. Several hypotheses towards the most sensitive areas of ship speed, wave direction and wave frequencies were tested.

Model test results

Measurements comprised the motion response of the vessel, lift and drag of individual stabiliser fins and rudders and propeller thrust. In the absence of information on the characteristics of prototype autopilot systems and stabiliser systems, basin 'practice' was used to select the gains. Maximum rudder angle and rate of turn were limited to practical prototype values. The test results in waves confirmed the expected relation between the ship speed, wave heading and wave period, wave excitation forces and ship reaction. Calm water tests confirmed a clear relationship between course keeping ability in calm water and in waves. All results suggested that settings of the autopilot and constraints on the rudder rate of turn in stern-quartering waves are crucial in the determination of course keeping ability, as confirmed by many full-scale observations on manual steering in stern-quartering waves.

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