New WAGENINGEN CD propeller series

The open water characteristics for a large systematic series of Controllable Pitch Propellers (CPP) were recently measured at MARIN, including ducted propellers. Report outlines this extensive test programme.

Around the world people involved in ship and propeller design have been working with the open water thrust and torque characteristics of the WAGENINGEN B-series for fixed pitch propellers. However, increasingly today CPP are being used both in open configuration and in nozzles. Such CPP can operate over a wide range of speeds and they are installed on navy vessels, merchant ships, tugs and offshore supply vessels but also on offshore units with DP capabilities.

To support the design, selection and use of CPP and to enable the modelling of the thrust and torque characteristics of these propulsors in DP simulations for example, MARIN has developed a newly designed, systematic CPP and ducted CPP series. Thrust, torque and blade spindle torque in open water conditions are measured at model scale in all positive and negative inflow conditions. As each propeller with a specific design pitch can be operated over a range of operational pitch, an extensive test programme has to be conducted.

Quasi-steady technique To enable an efficient measurement procedure, a new so-called quasi-steady open water test technique has been developed and verified. With this new method (ref. below) forward speed and rpm are varied over the measurement run and in this way the complete open water characteristics in all quadrants are derived from a limited number of runs. MARIN's numerical milling machine is used to build alloy models because lightweight propeller models are required when using this approach. To measure the blade spindle torque a dedicated test hub is used where one of the blades is fitted to a torque sensor.

The research work is carried out in a Joint Industry Project so that the actual series could be selected and designed following input from several leading propeller designers and manufacturers and the costs and results can be shared. So far, 22 companies are participating and this has led to the extension of the series to 31 propellers in 46 configurations, presented in the table below. The design pitch is given for each propeller in the table. Each propeller with a specific design pitch is then tested over the complete range of operational pitch settings.

C-4.40	P/D	0.8, 1.0, 1.2, 1.4
C-4.55	P/D	0.8, 1.0, 1.2, 1.4
C-4.70	P/D	0.8, 1.0, 1.2, 1.4
C-5.75	P/D	1.0, 1.2, 1.4, 1.6
D-4.40	P/D	0.0, 0.8, 1.0, 1.2, 1.4 in duct 19A and 37
D-4.55	P/D	0.0, 0.8, 1.0, 1.2, 1.4 in duct 19A and 37
D-4.70	P/D	0.0, 0.8, 1.0, 1.2, 1.4 in duct 19A and 37

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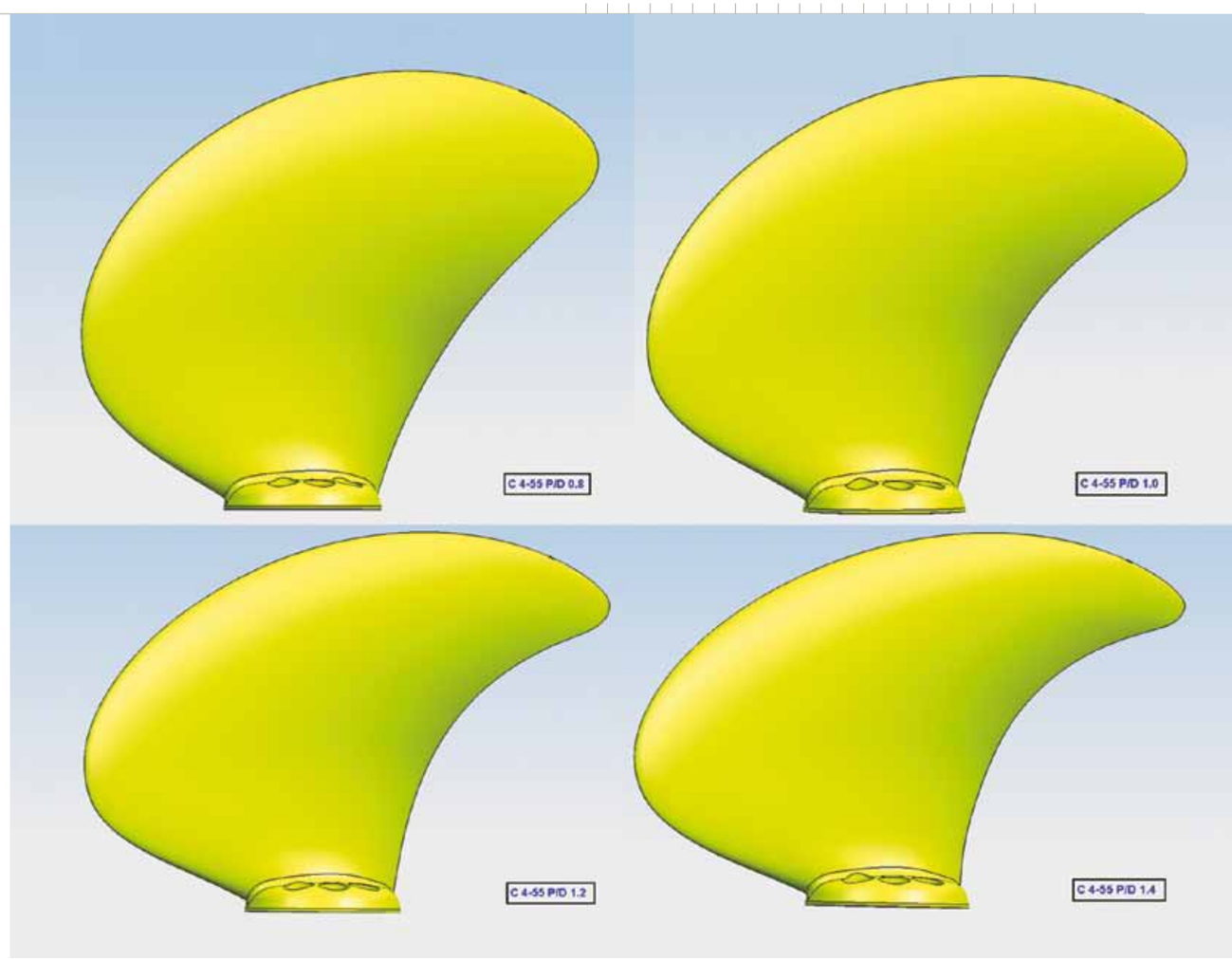

After the kick-off in September 2011 and a participant meeting in January this year, the JIP is now well underway with all propeller geometries available and most of the models already built and ready for testing. Measurements have been conducted in MARIN's Deepwater Basin and two series have already been completed and the analysed data delivered to participants. Participants have requested advanced data (post-processing) and user-friendly access to this data which MARIN is following up.

The JIP, which is still open for new series, is expected to be completed mid-2013. The contributions of new participants will be used to further extend the series.

"Quasi-Steady Two-Quadrant Open Water Tests for the Wageningen C- and D-Series"; Jie Dang et al.; 29th Symposium on Naval Hydrodynamics, Gothenburg, August 2012.