Abstract for the 16th Int'l Symp on Transport Phenomena and Dynamics of Rotating Machinery, Honolulu, April, 2016

Model tests of surface piercing propellers with quasi-steady test technique

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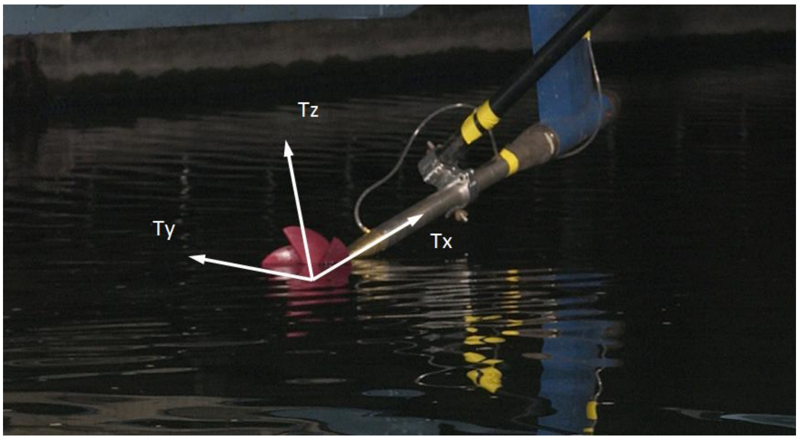
Abstract

Alongside waterjets, surface piercing propellers are widely used for high speed crafts due to both their merits on the propulsive efficiency and also the fact that they do not need shafts and appendages in the water that reduce the resistance of a high speed craft a lot. However, the dynamic loads on the propeller shaft, the side and vertical forces, the ventilation phase change from partial ventilation to full ventilation have important impacts on the performance of a surface piercing propeller. CFD calculations have not yet developed to investigate all the details of those complicated phenomena in order to support the design of a surface piercing propeller. Model tests play still important roles for the development of a surface piercing propeller series.

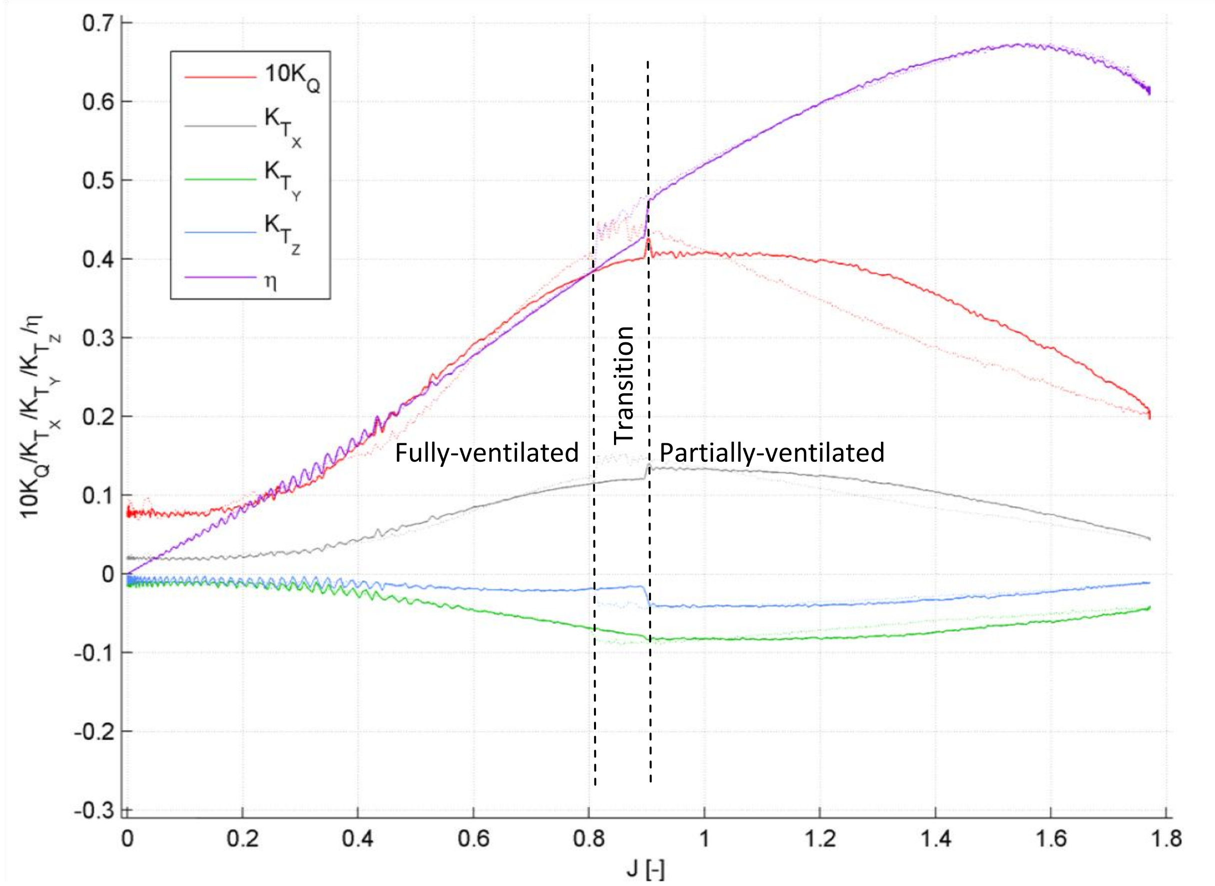
In order to understand the physics and to investigate the loads on surface piercing propellers in an efficient way, MARIN has developed, in the past years, a quasi-steady open water test method with dedicated propeller shaft force transducer so that the propeller thrust, torque and the propeller side and vertical forces can be measured simultaneously.

Taking the advantage of MARIN's Depressurized Wave Basin (DWB) where the ambient pressure can be reduced down to as low as 30mBar, with advanced underwater high speed video cameras which are synchronized with the loads measurements, and combined with the quasi-steady test technique, some details of the flow phenomena of a surface piercing propeller blade are reveled. This includes the studies on the influence of the blade Froude number on the performance, the side and vertical forces characteristics, the transition from the partial ventilation to full ventilation and the hysteresis effects, the ambient pressure influence on the performance of a surface piercing propeller, etc.

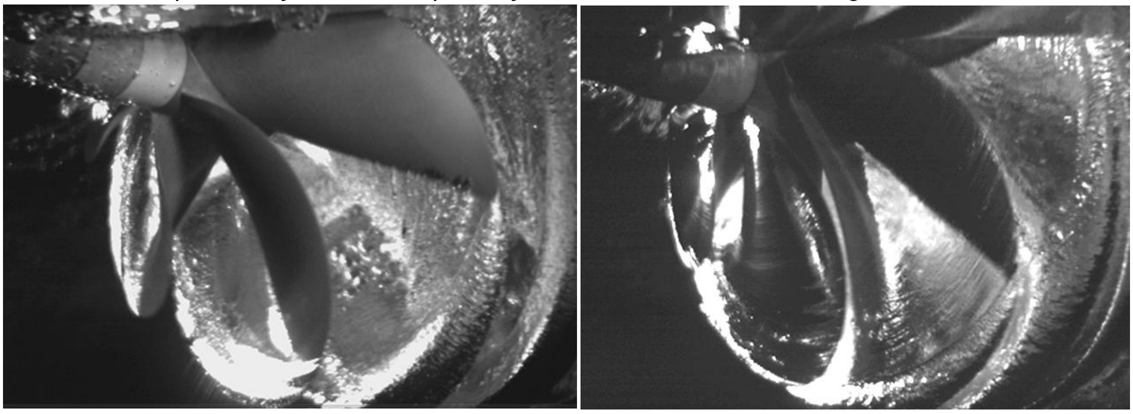
In this paper, the test set-up will be discussed and the quasi-steady test technique will be given and investigated. The focus of the paper will be on the test techniques, the characteristics of the loads on propellers, the investigation of the test conditions and the physics of surface piercing of a propeller blade.



An example of a test set-up and the coordinate system of the forces

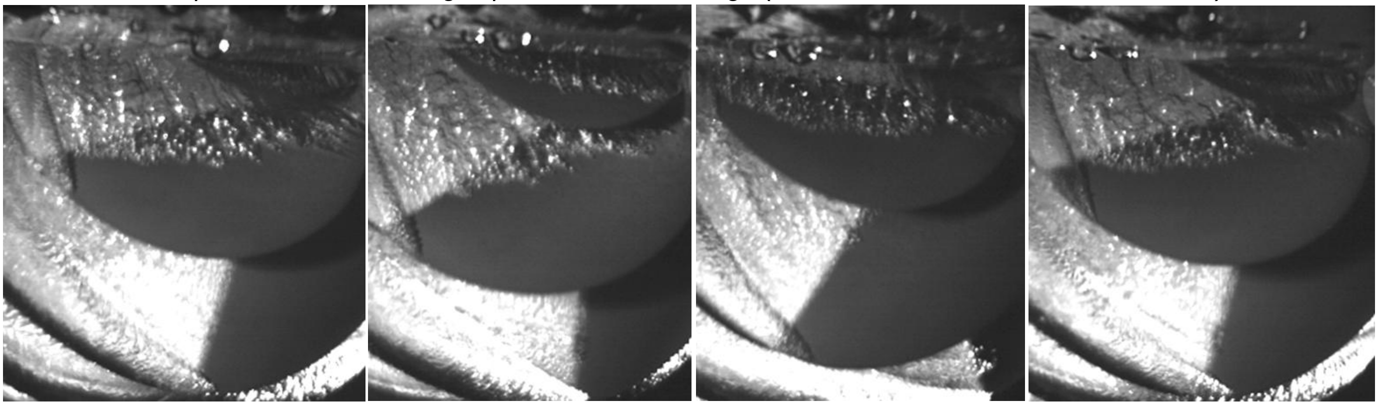


An example of fully-ventilated, partially-ventilated and transition regimes for an SPP



Partially-ventilated *Fully-ventilated*

Examples of underwater high speed video recordings (blade submersion 0.6R, inclined shaft)



Sequence of blade entrance (partial ventilation, blade submersion 0.6R, inclined shaft)