

Propeller Design Optimization for Tunnel Bow Thrusters in the Bollard Pull Condition

by

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Abstract

Tunnel bow thrusters are often used by large ships to provide low-speed lateral maneuverability when docking. Required to provide high thrust while essentially at a standstill, the design point for these thrusters is the bollard pull condition. Traditionally, the term bollard pull refers to the amount of force a tug can apply to a bollard when secured to a pier. Here, the bollard pull condition is used to describe a propeller with no flow over it except for that induced by its own rotation. Conventional propeller design is primarily performed for an optimal vessel speed or range of speeds. OpenProp, a propeller design code based on lifting line theory, is a numerical model capable of design and analysis of such propellers. It has been experimentally validated for standard design conditions in an external flow, but until now has been incapable of design with no external fluid velocity component applied. Recent updates to the model now allow for bollard pull design work. This project is the first application of the OpenProp model update. Propellers are designed for both open water and ducted (tunnel) applications in OpenProp. Propeller geometry design refinement by coupling MTFLOW, an Euler Equation viscous flow solver, with PBD-14, a lifting surface design program for marine propulsors is examined. An experimental apparatus is constructed to test the propeller designs and validate the OpenProp model. A range of off-design operating conditions are analyzed and results are presented.

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