

Active Roll Stabilization of a Coastal Naval Vessel Using Azimuthing Propellers

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ABSTRACT

This paper examines the reduction of ship roll motions using azimuthing propellers. An existing ship motion prediction library has been augmented to include forces from azimuthing propellers. Experimental results from the open literature indicate that forces normal to the propeller axis contribute greatly to ship lateral forces from azimuthing propellers. Numerical predictions for a Maritime Coastal Defence Vessel indicate that active roll stabilization using azimuthing propellers can reduce roll motions by 50 percent in a seaway while still maintaining good coursekeeping. Further improvement to roll and coursekeeping properties could be obtained by optimization of control systems for azimuthing propellers.

KEYWORDS

Azimuthing propeller, roll, ship motions, stabilization.

INTRODUCTION

Wave-induced ship motions are of concern to ship operators due to their adverse effects on performance of both crew and ship systems. For crew members, ship motions can lead to problems such as sea sickness, loss of postural stability (e.g., tipping), and fatigue. For navies, ship motions can prevent completion of important tasks, such as operation of helicopters and replenishment at sea.

Various methods are available for reducing wave-induced ship motions with the objective of increasing

human comfort and ship operability. Most efforts to reduce ship motions are directed toward roll because significant reductions in ship roll motions can often be achieved. Lloyd (1989) gives an overview of roll stabilization devices. Among navies, active roll stabilization is often employed using either rudders (Baitis and Schmidt, 1989) or stabilizer fins (Lloyd, 1975).

In recent years, azimuthing propellers have become frequently used on ships, in part because of their contribution to ship maneuverability. The Canadian Navy's Maritime Coastal Defence Vessels (MCDVs, also known as the Kingston class) are among contemporary naval vessels having azimuthing propellers. Each MCDV has two Z-drive units, whereby the engines are located in the main hull and each propeller is driven by an articulated shaft arrangement.

The MCDVs were originally intended for operations in coastal waters; however, they are now often required to operate in the open ocean. The Canadian Navy is interested in reducing motions of these ships to increase crew comfort and ship performance in heavy seas. This paper considers the reduction of roll motions using the existing azimuthing propellers. Numerical predictions in the time domain have been used to examine the potential for reduction of roll motions.

PREDICTION OF SHIP MOTIONS IN WAVES

Navies commonly use predictions of ship motions in waves to assist with design and operation of vessels. Early work (e.g., Salvesen, Tuck, and Faltinsen, 1970) used the two-dimensional hull force approximations of