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The effect of small forward speed on prediction of wave loads in restricted water depth

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Abstract. Wave load prediction at zero forward speed using finite depth Green function is a well-established method regularly used in the offshore and marine industry. The forward speed approximation in deep water condition, although with limitations, is also found to be quite useful for engineering applications. However, analysis of vessels with forward speed in finite water depth still requires efficient computing methods. In this paper, a method for analysis of wave induced forces and corresponding motion on freely floating three-dimensional bodies with low to moderate forward speed is presented. A finite depth Green function is developed and incorporated in a 3D frequency domain potential flow based tool to allow consideration of finite (or shallow) water depth conditions. First order forces and moments and mean second order forces and moments in six degree of freedom are obtained. The effect of hull flare angle in predicting added resistance is incorporated. This implementation provides the unique capability of predicting added resistance in finite water depth with flare angle effect using a Green function approach. The results are validated using a half immersed sphere and S-175 ship. Finally, the effect of finite depth on a tanker with forward speed is presented.

Keywords: green function; shallow water; forward speed; potential theory; added resistance; flare angle

1. Introduction

The recent trend in building ultra large vessels such as the Maersk Triple E class container ship, Prelude FLNG and SHI's 330m long FPSO created renewed interest in understanding the behavior of floating structures with forward speed in deep and restricted water depths. The large draft of these vessels requires consideration of seabed clearance for most harbors and even for operating condition in the open seas. Also, to design channels connecting the harbor to sea, it is important to study the vertical motions of a ship to ensure no grounding occurs during the passage. For this, the prediction of the hydrodynamic coefficient and 6DOF motion of the vessel traveling with a steady forward speed in finite water depth is of interest.

The second order drift forces are also very important for designing mooring systems and side by side offloading operations. Finite depth effects must be considered in the calculation of drift forces and the corresponding effect on vessel motion to ensure the mooring line tension and vessel offsets are within the bounds for safe operation. It was found that the water depth effects on

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