A High Froude Number Time Domain Strip Theory
Applied to the Seakeeping of Semi-SWATHs

by

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Statement of originality and authority of access

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Damien Holloway
Abstract

In recent years there has been a rapid growth in the fast passenger ferry industry. Initially speed was the main selling point for designers, builders and operators, but as competition and choice have increased passengers are demanding better seakeeping performance. In addition designers and builders are starting to see the benefits of better seakeeping not only in terms of passenger comfort but in terms of structural strength and loading, allowing reduced structural weight and its many associated advantages. Two aspects of the seakeeping of fast ships are addressed in this thesis: response computation and the behaviour of semi-SWATH designs.

Motion and load prediction for the practising naval architect has traditionally been done using “strip theories”, usually one closely related to the well known theory of Salvesen, Tuck and Faltinsen. This is a low Froude number theory, and although it is still being used, often successfully, for fast ships there is no rational justification for its validity in these cases. As speeds are increasing it is becoming imperative that an equivalent analysis tool suitable for higher Froude numbers be developed. This thesis proposes such a theory, based on calculation of two dimensional hydrodynamic potentials in a fixed reference frame in place of the traditional moving one. This strip theory of necessity is a time domain theory, which also allows the possibility of introducing non-linearities, random sea input, and even slamming events (although only the first of these is discussed in any detail in the thesis). Validation has involved comparison with traditional theory and tank testing. Most notably pitch and coupling effects have shown improved predictions, but heave tends to be over predicted. The main candidates for explanation of this phenomenon are argued to be wake shedding, hull entry effects, steady-unsteady interactions and three-dimensionality.

The majority of fast ferries being built at present have very conventional hull forms below the calm waterline. These have poorer seakeeping than their slower equivalents because their natural frequencies are encountered in longer waves, and traditionally designers have relied on lifting surfaces to counteract the increased motions. As these vessels get faster this approach will become less viable in terms of forces involved and appendage drag penalty. The type of hull form that will reduce motion accelerations without too much sacrifice of drag is not obvious, and a family of semi-SWATHs has been investigated as a possible alternative hull form. The investigation shows that as speed is increased the advantages of SWATH like forms become much greater if the criterion is to reduce accelerations.
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