Chapter 1

Introduction

1.1 Background

The maritime industry is continuing to develop in response to new technology and customer demands. In 1998 the world's fast ferry market has been valued at approximately US $4.5billion of which there are approximately 700 of such vessels around the world. Stena, for example, recently paid around £65M for their latest new vessel [37].

In recent years fast ferries which are capable of speeds in excess of 40 knots in water depth less than 10m have been operational. As high-speed operations near sensitive shorelines increase, complaints from the public on extensive wave wake or wake wash from these fast vessels increase also. Although the leading waves in the wash are very small in terms of wave amplitude compared to storm waves, they have a very long period and build in height rapidly in shallow water at the shoreline thereby causing substantial surges on beaches as well as breaching sea walls at high tide. This wake wash is likely to have environmental effects such as shoreline erosion as well as endangering swimmers and small boats. During 1997, as a consequence of public concern, the Danish Maritime Authority (1997) issued a governmental order which requires that the high-speed craft operator/owner has to show evidence that the ship-generated waves do not exceed a prescribed wave height criterion in shallow water along the entire route. Similar criteria exist for other regions, such as the Puget Sound, Seattle, some navigable inland waterways in the Netherlands and the River Thames, UK [59]. There are other areas which are equally sensitive to damage such as the Paramatta River in Australia, the Solent (i.e. particularly the route between Southampton and Isle of Wight), Nantucket, the Mare Island Channel and the East Bay Estuary in San Francisco Bay.

Wake wash or normally known as wash results from ship-generated waves. There is a general awareness of the importance of ship-generated waves in design. However, until recently, ship-generated waves analysis has not been fully considered in design studies except as one of ship's resistance component resulting from the energy expended in generating a wave pattern. As the design spiral is the traditionally accepted way of representing the ship design process, wash was not considered to be a part. The main dimensions and form are clearly fixed by other considerations. One may think of wash as another spoke of the wheel because the elements of design which affect wash are also directly related to ship performance such as resistance, stability, seakeeping, deadweight capacity etc.

There is a misconception in the public that wake wash is directly proportional to speed i.e. the faster the boat is going, the more wake it makes and the more energy that it is putting into the water and the more that will wash up on the beach. This is true when dealing with large displacement hulls (tankers, bulk carriers, etc) but not with lightweight high speed ferries particularly multihulls [97]

A large number of papers on this subject have been published since the early nineteenth century. However, emphasis has generally been placed on the determination of a ship's resistance resulting from the energy expended in generating a wave pattern and not on the effect of these waves.

1.2 Problem Definition

1.2.1 Background

The wake wash generated from high-speed craft is an important issue for shipbuilders and ship operators in seeking more environmental-friendly designs. The wash from a passing ship can be regarded as a pollutant. Over the past years, complaints from marine environment authorities have increased.

In the United Kingdom, a ship's wake wash project has been to be completed by the middle of year 2003, by a consortium of universities and companies working on a project known as SWIM (Ships Wash Impact Management) project and funded by the EPSRC (Engineering and Physical Sciences Research Council). The three-year project will bring together studies of the generation, propagation and impact of high-speed ship's wash. The University of Southampton is part of the consortium, which involved a major role in one of the three work packages known as WP1-Wash Generation. A vast experimental work has been carried out at various model testing facilities such as at SIHE, GKN, Qinetic Haslar etc. The author has been involved in most of this experimental work.

1.3 Scope of the Present Work

The research area of high speed displacement craft is wide. Therefore the present study will mainly concentrate on the wash, resistance and seakeeping produced by the proven hull form, one of the NPL series. This hull form also has been slightly modified by incorporating cylindrical bulbous bows into it.

The main objectives of this research are,

- Model experiments to provide a better understanding of the basic physics of wash, resistance and seakeeping of high speed displacement catamaran fitted with bulbous bows operating in deep and shallow water.
- Further model experiments in regular waves to study the influence of bulbous bows and wave lengths on the added resistance, pitch, heave and wash.
- To compare the experimental results of wash cuts with thin ship theory.
- To provide potential ship designers with a useful data base of wash, resistance and seakeeping of high speed displacement catamaran fitted with bulbous bows.

1.4 Outline of the Thesis

Chapter 2 presents an overview of the previous reported research on wake wash for design. In particular it draws our attention to the limited availability of literature covering wake wash generated by high speed displacement craft. A description of the current wake wash research methodologies used, together with their important elements and characteristics are also given.

In Chapter 3, a description of the bulbous bow design for high speed displacement craft together with their important parameters and characteristics are presented. This chapter also describes the tank testing for monohull and catamaran configurations at the Lamont and SIHE tanks. The experimental results i.e. the effect of bulbous bows on the resistance components, sinkage and trim are presented. The effect of bulbous bows on waves wash are also given.

Chapter 4 describes the experimental work in regular waves at SIHE tank. In addition to total model resistance, heave and pitch, the wave cuts in waves are also recorded. The wash deduced from these wave cuts were compared to the wash obtained in calm water previously in Chapter 3. The effect of bulbous bows on resistance, heave, pitch and as well as wash are also described.

Considering the variation in water depth and ship speed, it is prudent to continue the experimental work mentioned in Chapters 3 and 4 into a shallow water condition as reported in Chapter 5.

Having recognised the need to supplement the experimental work with theoretical investigation, a computer program using thin ship theory has been used to compare the measured and calculated wave cuts as described in Chapter 6. This covers the experiments in three different establishments namely Lamont, SIHE and GKN towing tanks. The computer program also gives a theoretical values of wave pattern resistance coefficients. It should be noted that this wave pattern resistance coefficient, C_{wp} is only part of the wave-making resistance coefficient, C_w.

Finally, in Chapter 7, the research results are discussed, recommendation for future research are made and conclusions drawn. This presentation includes the bulbous bows ranking and design trade-off of Wash, Resistance and Seakeeping on high-speed displacement craft performance.