DEVELOPMENT OF FAST CRAFT SEAKEEPING DESIGN METHODOLOGY

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Special dedicates for;

Father; En. Ahmad bin Talib,

Mother; Pn Norzila binti Mohd. Din,

First brother and his family; Norazlan, Rozimah, Afif, Hariz & Nafiz,

Second brother and his family; Norafzanizam, Suryani, Nabiha & Amzar,

Younger sister; Nurul Afiqah,

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ABSTRACT

The objective of this study is to develop a method for choosing the best hull form parameter for fast craft. Hull form parameters play a major role in influencing the seakeeping of the vessels. One of the problems for the designer is to choose which parameter to be changed and by how much should the parameter be changed to be most effective. Often changes in one parameter will affect other parameters. Thus, this project describes the methodology for modifying the hull form in the preliminary design stages to obtain the optimum hull form with minimum motion and hence generate a hull form with better seakeeping characteristics. To ensure a clear relationship between changes in hull parameters and seakeeping performance, the hull form was varied systematically, forming a design space containing 25 variants. The modification and computation of seakeeping characteristics were carried out using Maxsurf computer softwares. Assessments of the variants were carried out using criteria such as vertical accelerations, lateral accelerations and roll motions. By developing design surfaces, the optimum hull form was identified.

ABSTRAK

Objektif pengajian ini adalah untuk membina suatu kaedah dalam memilih parameter yang terbaik bagi bentuk badan kapal untuk kapal yang berhalaju tinggi. Parameter rangka kapal memainkan peranan yang besar dalam mempengaruhi gerak laku kapal (seakeeping). Antara masalah yang dihadapi oleh pereka adalah untuk memilih parameter mana yang perlu diubah dan berapa banyak parameter tersebut perlu diubah supaya lebih berkesan. Seringkali perubahan dalam satu-satu parameter akan mempengaruhi parameter-parameter yang lain. Oleh itu, kajian ini menerangkan kaedah dalam mengubah suai bentuk badan kapal pada peringkat awal rekabentuk untuk memperolehi kapal yang paling optimum dengan gerakan yang minimum, yang mana akan menghasilkan bentuk badan kapal yang mempunyai ciri-ciri gerak laku kapal yang lebih baik. Bagi memastikan pertalian yang jelas di antara perubahan bentuk badan kapal dengan prestasi gerak lakunya, bentuk badan kapal diubah secara sistematik bagi mewujudkan 25 calon badan kapal baru. Ubahsuai dan perkomputeran ciri-ciri gerak laku kapal dihasilkan dengan menggunakan perisian komputer Maxsurf. Penilaian bagi rangka kapal yang berlainan dihasilkan dengan menggunakan kriteria seperti pecutan menegak, pecutan mendatar dan gerakan olengan. Melalui pembinaan permukaan rekabentuk (design surfaces), bentuk badan kapal yang paling optimum dapat dikenalpasti.

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LIST OF SYMBOLS

NO. OF SYMBOLS	TITLE
U	Ship Speed
g	Acceleration due to gravity
L	Ship Length
LCB	Longitudinal center of buoyancy
C_B	Block Coefficient
Fn	Froude Number
µ	Heading angle in degree
$S_\zeta(\omega)$	Wave spectral density
$\bar{\zeta}$	mean of many wave amplitude measurements
$\bar{H}$	mean of many wave height measurements
$\bar{T}_P$	mean of many wave period measurements between successive peaks
$\bar{T}_T$	mean of many wave period measurements between successive troughs
$\bar{T}_{Z+}$	mean of many wave period measurements between successive zero upcrossings
$\bar{T}_{Z-}$	mean of many wave period measurements between successive zero downcrossings
$\bar{T}$	mean of many wave period
$\bar{T}_0$	modal wave period
$\bar{\zeta}_{1/3}$	mean of highest third amplitudes or significant amplitude
$\bar{H}_{1/3}$	mean of highest third wave heights or significant wave height

m_0	variance of the surface elevation relative to the mean (mean square)
σ_0	standard deviation of surface elevation to the mean (root mean square)
RAO	Response Amplitude Operator
MSI	Motion Sickness Incidence
RMS	Root Means Square
AMV	Advance marine vehicles
ACV	Air cushion vehicles
SES	Surface effect ship
AP	Aft perpendicular
FP	Forward perpendicular
ITTC	International Towing Tank Conference
VCG	Distance from keel to center of gravity of ship
JONSWAP	Joint North Sea Wave Project

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CHAPTER 1

INTRODUCTION

1.1 Introduction

In recent years there is a growth in the number of fast craft due to the needs in the field of fast transport of marine vehicles in light and expensive cargo, the transportation of passengers at high speeds and the possible use for surveillance and patrol functions. This has drawn considerable interest of both shipowner and designers and also researchers to the faster speed ships. Recently, there has been considerable development in regard to high performance vessels. The problems related to the seakeeping investigation of advanced marine vehicles are considerably different from those for conventional surface vessels. There are many advanced marine vehicles such as planning craft, catamaran, air cushion vehicles, surface effect ship, small waterplane area twin hull ship (SWATH) and hydrofoils. However, advance marine vehicles are designed for different missions and tasks, which may require either high speed operation or, in some cases, a more stable platform.

Designing a fast craft hull form is an iterative process in which a range of requirements must be satisfied. This form must provide an adequate capacity to carry a given payload at a required speed in a defined sea area. In general, the designer's main priority is to satisfy certain statutory requirements such as stability, strength and freeboard. Economic requirements will generally limit the size of the vessel. Once the size of the vessel is fixed decisions regarding the proportions and shape of hull form are governed by powering requirements in calm water conditions. However a fast craft is required to operate at high speeds and often in adverse weather conditions. It is found that high accelerations and extreme effects like slamming can significantly degrade the operational capabilities of planing craft. Therefore in the operation of planing craft a greater emphasis is placed on good seakeeping performance and seakeeping considerations are of primary importance in the design of this type of vessel. The hull form should be modified in order to improve the seakeeping performance.

Nowadays, most ship design contracts require the assessment of seakeeping performance characteristics. Modern computational methods and sophisticated computing facilities allow the designer to analyse the seakeeping performance characteristics of a new design at the earliest stages in the design process. It can be said that these computational tools are now widely accepted as inexpensive alternatives to model testing. However this capability to assess the seakeeping performance does not necessarily lead to a better design. The designer needs a design methodology which relates the seakeeping performance to ship form.

Hull form parameters play a major role in influencing the seakeeping of the vessels. One of the problems for the designer is to choose which parameter to be change and how much should the parameter be change to be most effective. Often changes in one parameter will affect other parameters. Thus, this project describes the methodology for modifying the hull form in the preliminary design stages to obtain the minimum hull form design and hence generate a hull form with better seakeeping characteristics.

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