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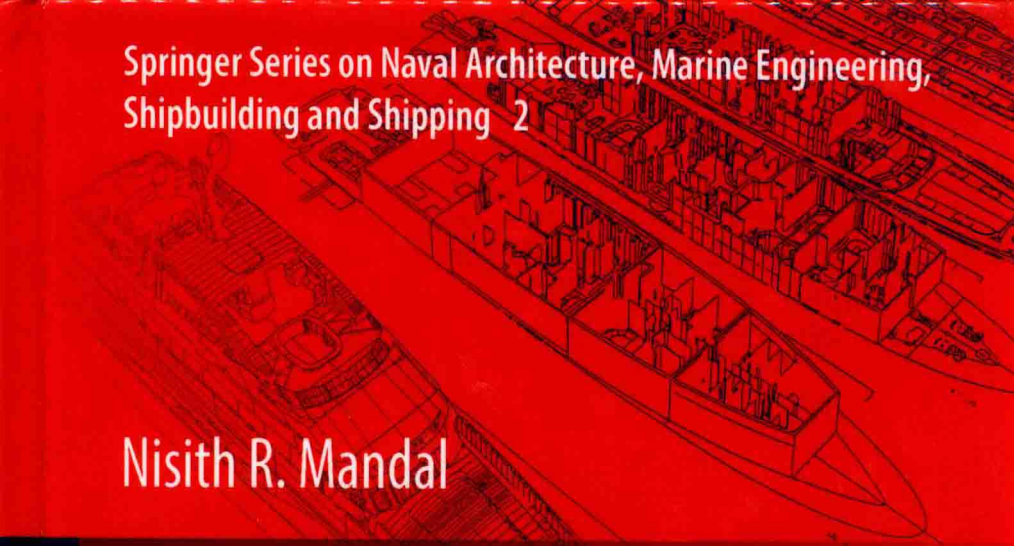

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Ship Construction and Welding

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Preface

This book aims to introduce various aspects of ship construction starting from ship types, material of construction, welding technology to accuracy control. This book is the outcome of my experience of teaching Ship Construction and Welding Technology, Design and Construction of Ocean Structures, Marine Construction and Repair Techniques as regular and elective courses in undergraduate and graduate curricula during about past 30 years in the Department of Ocean Engineering and Naval Architecture at IIT Kharagpur. While teaching and working in this field, I felt the lack of a suitable book covering the various basic aspects of ship types, its structural components, materials, and aspects of its welding and dimensional control. This inspired me to get on this job and provide the budding naval architects with a comprehensive book on ship construction and welding. The contents of the book have been logically organized and spread over 21 chapters.

It starts with introducing to the novice reader the various types of ships based on cargo type and functionality and also the basic characteristics of shipbuilding industry. It then goes on to describe the various loads experienced by the ship structure and thereby working out suitable structural arrangement to sustain these loads. This forms the background to the introduction of the types of framing system, basic structural components, structural subassemblies and assemblies. All of these are explained with necessary illustrations and details. The book then goes on to work out the midship sections of some of the most widely used ship types, explaining the design strategy based on functionality. The book also includes the aspects of structural compensation for unavoidable discontinuities in ship structure.

Next the book covers various aspects of material of construction. It includes material description, classification requirements and different methods of steel material preparation. Subsequently different methods of metal cutting, plate and section forming are introduced along with the concept of line heating for obtaining compound curvature plates.

The reader is then introduced to various welding techniques related to ship-building industry. Here different fusion welding methods, power sources, effect of welding process parameters, metal transfer mechanism are discussed in detail. The solid-state welding technique suitable for aluminum welding has also been

incorporated. The formation of weld-induced residual stresses and distortion has also been explained in detail. It then goes on to present in-process distortion control and mitigation techniques such as heat sinking, thermo-mechanical tensioning, etc. suitable for ship structural units. Finally, the book introduces various possible welding defects that one is likely to encounter in welded structures and explains the nondestructive testing methods those are relevant to ship construction.

With all the construction done, it is necessary to have a suitable mechanism to know the ranges of variations in structural fabrication so that one can quantitatively target the end product accuracy. To address this aspect a chapter on accuracy control has been included in this book.

I believe the contents of this book should prove useful to the students of naval architecture and ocean engineering as well as the shipbuilding professionals.

Kharagpur, India
July 2016

Nisith R. Mandal

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Without the sanction of Divine Will not even a blade of grass moves in this world. The entire work that has been done became possible only because of HIS wish and HIS mercy.

Nisith R. Mandal

About the Author

Prof. Nisith R. Mandal, B.Tech (Hons), Ph.D., FIE, FRINA is Professor at the Department of Ocean Engineering and Naval Architecture, IIT Kharagpur. Prior to joining the IIT in 1987, while working in Garden Reach Shipbuilders and Engineers Ltd. he was involved in the initiation of a modular method of ship construction. Subsequently he headed for higher studies and obtained his Ph.D. in Ship Production and Welding Technology from the Ship Research Institute, Gdansk, Poland in 1985. Since then he has been actively engaged in teaching and research in the field of welding techniques, distortion and line heating as applied to shipbuilding. He has undertaken several industrial consultancy as well as research projects in his area of expertise sponsored by various agencies like Garden Reach Shipbuilders & Engineers Ltd., Calcutta, Mazagon Dock Ltd., Mumbai, Cochin Shipyard Ltd., Department of Science and Technology, GoI, the Ministry of Surface Transport (Shipbuilding & Ship Repair Wing), GoI, Manipur Science and Technology Council, Maglev Inc., USA, Institute for Plasma Research, Ahmedabad, West Bengal Surface Transport Corporation, the Council of Scientific and Industrial Research, the Naval Research Board, etc. He has published over 75 research papers in peer-reviewed journals and for national and international conferences. He has authored three books, "Aluminum Welding", 2nd Edition, 2005, "Welding and Distortion Control", 2004, and "Welding Techniques, Distortion Control and Line Heating", 2009 published jointly by Narosa Publishing House, New Delhi and Alpha Science International Ltd., Pangbourne, UK. He has conducted several short courses for shipyard professionals on ship repair and maintenance, welding and distortion control in steel fabrication, aluminum welding in the marine industry, weld-induced distortion prediction and control, shipyard productivity—process evaluation and improvement, and distortion control in shipbuilding.

Contents

Chapter 1
Introduction to Ships

Abstract Over the years as international trade increased and also bulk transportation of goods became more and more necessary, various types of ships came into being depending on the type of cargo that needs to be carried. This trade will naturally involve very high volume of transportation of all kinds of items starting from bulk grain, ore, coal to crude, automobiles and various other kinds of farm and engineering products. Passenger ships and inter island ferries also play a very important role in transportation as well as tourism. These vessels, their outward features, i.e. the hull form may not be very different, but the internal structural arrangement will be very much dependent on the type of cargo the vessel needs to carry. The internal structural arrangement should be such that it will facilitate loading, stowage and unloading of the cargo. And needless to say, should ensure safe transportation of the cargo. It naturally implies that the structure will be able to sustain all the service loads and also at the same time the hull form should be hydrodynamically efficient.

It is well known that two third of this earth is covered with water and only one third is land. Also at the same time for the mankind to survive international trade of various kinds of goods will always remain inevitable. This trade will naturally involve very high volume of transportation of all kinds of items starting from bulk grain, ore, coal to crude, automobiles and various other kinds of farm and engineering products. Passenger ships and inter island ferries also play a very important role in transportation as well as tourism. Apart from this another very important sector is marine defence, which includes various kinds of naval craft, to name a few, frigate, corvette, seaward defence boat, landing craft, aircraft carrier, etc. In addition to all these craft, there are certain types of vessels which can be referred to as service vessels, like tugs, dredgers, pilot vessels, offshore support vessels, etc. Oceans are vast natural resource of food, minerals, energy, etc. Deep sea fishing is another area, where different kinds of fishing and fish processing vessels are used. Hence one can observe that the requirement of various kinds of ships will remain as long as mankind will be there in this earth.

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