Offshore Compliant Platforms

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Offshore Compliant Platforms

Analysis, Design, and Experimental Studies

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This Work is a co-publication between John Wiley & Sons Ltd and ASME Press

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ASME PRESS

This edition first published 2020

This Work is a co-publication between John Wiley & Sons Ltd and ASME Press

Registered Offices
John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, USA
John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK

Editorial Office
The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK

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Library of Congress Cataloging-in-Publication Data

Names: Chandrasekaran, Srinivasan, author. | Nagavinothini, R., 1991– author.
Title: Offshore compliant platforms : analysis, design, and experimental studies / Srinivasan Chandrasekaran, Department of Ocean Engineering, Indian Institute of Technology Madras, Tamil Nadu, India, R. Nagavinothini, Department of Structures for Engineering and Architecture, University of Naples Federico II, Naples, Italy.
Description: First edition. | Hoboken, NJ : John Wiley & Sons, Inc., 2020. | Series: Wiley-ASME Press Series | Includes bibliographical references and index.
Identifiers: LCCN 2019050441 (print) | LCCN 2019050442 (ebook) | ISBN 9781119669777 (hardback) | ISBN 9781119669784 (adobe pdf) | ISBN 9781119669807 (epub)
Subjects: LCSH: Compliant platforms.
Classification: LCC TC1700 .C44 2020 (print) | LCC TC1700 (ebook) | DDC 627/.98–dc23
LC record available at https://lccn.loc.gov/2019050441
LC ebook record available at https://lccn.loc.gov/2019050442

Cover Design: Wiley
Cover Image: © paranyu pithayarungsarit/Getty Images

Set in 9.5/12.5pt STIXTwoText by SPi Global, Pondicherry, India

Printed and bound by CPI Group (UK) Ltd, Croydon, CR0 4YY

10 9 8 7 6 5 4 3 2 1

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Foreword by Professor Purnendu K. Das

Advances in technology and industry maturity make offshore wind an increasingly attractive investment. Although still relatively expensive, it has advantages of being deployable sooner and faster than many other nonrenewable energy sources. Compared to other renewable sources, offshore wind turbine technology has advantages in scalability. Recent growth and innovation have driven costs to more competitive levels and significant future investments in Europe and globally. Current drawbacks include high capital costs due to the large fabrication, installation, and maintenance costs involved; it is estimated that over 20% of total project costs are directly linked to the foundation structures and their construction.

The book describes the detailed analysis and design procedures of compliant offshore structures with a special focus on new-generation platforms like the triceratops and buoyant leg storage and re-gasification platforms. The book aims to describe the detailed preliminary design of a triceratops in ultra-deep water. A detailed analysis under environmental loads that are inherent in offshore locations, such as waves, wind, and currents, is presented. A new methodology for the dynamic analysis of a triceratops under ice loads, predominantly in ice-covered regions, is also explained, with detailed parametric studies. Because offshore platforms are also prone to accidental loads arising due to fires and ship–platform collisions, the detailed dynamic analysis under such loads discussed in the book will be of great assistance to both researchers and practicing structural consultants.

I hope this book will serve as a ready reference for engineers in this field who want to study floating wind turbines structures. I wish the book all success.

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Foreword by Dr. Atmanand N.D.

The use of renewable energies is vital for addressing issues due to global warming and climate change. But the cost of production of renewable energy has not hit an all-time low as yet, and oil and gas continue to be the major sources of energy.

In the recent past, offshore oil drilling and production platforms have begun moving toward ultra-deep water due to the depletion of oil and gas resources near shore. In addition, the arctic region is opening for new offshore platforms. This necessitates a novel geometric form with reduced response to extreme waves and, in turn, the extreme loading conditions that prevail in ultra-deep water. Compliant offshore platforms are highly popular due to their form--dominant design characteristics. However, their significant hull motion in deepwater conditions and high sea conditions leads to a need for alternate design procedures, because the present ones are not suitable for ultra-deep water. Detailed analysis and design procedures for new-generation offshore platforms are frequently debated in conference proceedings. But this book demystifies the technological know-how by presenting a lucid explanation that is useful and innovative. For example, the discussion of a new methodology for the dynamic analysis of a triceratops under ice loads in ice-covered regions, with detailed parametric studies, is noteworthy. Such structures are prone to accidental loads arising due to fires and ship–platform collisions, so both designers and researchers should be familiar with the detailed dynamic analysis under such loads. The comprehensive picture presented in this book of the dynamic response behavior of this novel platform under different types of loads is scarce elsewhere in the literature.

This book will serve as a resource for understanding the basic structural behavior of new-generation complex offshore platforms and will help graduate students understand analysis methodologies that otherwise would have to be painstakingly collected from many publications. In addition, this book will be useful for practicing engineers and research scholars who wish to understand the response behavior of structures with novel geometry under combinations of extreme loads.

The principal author, Srinivasan Chandrasekaran, is a well-known academician and has authored 14 textbooks in the highly specialized area of offshore engineering. His web-based courses on offshore structural engineering are very popular and serve as reference material to teach this complex subject at both the undergraduate and post-graduate levels of engineering programs in various disciplines including civil, mechanical, aerospace, naval architecture, etc. I am sure any offshore engineer will find this book to be a wealth of resources.

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Series Preface

The Wiley-ASME Press Series in Mechanical Engineering brings together two established leaders in mechanical engineering publishing to deliver high-quality, peer-reviewed books covering topics of current interest to engineers and researchers worldwide.

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Preface

This book, *Offshore Compliant Platforms: Analysis, Design, and Experimental Studies,* describes detailed analysis and design procedures for compliant offshore structures, with a special focus on new-generation platforms like the triceratops and buoyant leg storage and regasification platforms. While the conceptual development of conventional platforms like tension leg platforms (TLPs), spar platforms, and articulated towers is presented briefly, the detailed descriptions of the design and development of new-generation platforms discussed in the book are highly novel and still in the preliminary stages of study in the existing literature.

Compliant offshore platforms are favorable candidates for deepwater oil and gas production systems due to their form-dominant design characteristics. But significant compliancy causing flexible motion in the horizontal plane requires special attention from designers because it poses critical challenges when platforms are commissioned in ultra-deep water. Therefore, a novel geometric form with reduced responses is a vital necessity to accommodate extreme loading.

This book presents a detailed analysis and design of one such novel platform: the triceratops. The authors believe that it will serve as a good reference guide for the effective design of triceratops platforms, as the clear numerical and experimental studies presented in the book will help readers understand the platforms' dynamic response behavior. A new methodology for the dynamic analysis of a triceratops under ice loads in ice-covered regions is also explained with detailed parametric studies. Offshore platforms are also prone to accidental loads arising due to fires and ship–platform collisions; the detailed dynamic analysis under such loads that is presented in the book will be of great interest to both researchers and practicing structural consultants.

In addition, this book will aid in understanding the platform's structural behavior in terms of its response, service life, and design. The book will serve as a resource regarding the basic structural behavior of complex offshore structures; it will help graduate students understand analysis methodologies and will also help researchers understand the dynamic response of such structures. Readers will learn about new structural geometries of offshore platforms and different methods of analysis for assessing their performance under special loads. The discussion of fatigue analysis and predicting service life will also help professionals during the preliminary and detailed design stages of offshore platforms. This book can serve as reference material for both academicians and offshore practicing professionals.

Both senior undergraduate and post-graduate students in the disciplines of civil, mechanical, aerospace, structural, offshore, and ocean engineering; applied mechanics; and naval architecture will find this book very useful as a standard classroom reference for analysis and design of special structures. In addition, this book will be useful for practicing engineers and research scholars studying the response behaviors of structures with novel geometry under combinations of extreme loads.

The experimental studies and numerical analyses discussed in the book are the outcomes of research work carried out recently by the authors and research scholars supervised by Srinivasan Chandrasekaran. All discussions, interpretations, and concepts conceived during the detailed research work carried out by the research scholar team are sincerely acknowledged. Administrative support extended by the Centre for Continuing Education (CCE), Indian Institute of Technology, Madras in preparing this manuscript is sincerely acknowledged.

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