

Offshore Compliant Platforms

Wiley-ASME Press Series

Corrosion and Materials in Hydrocarbon Production: A Compendium of Operational and Engineering Aspects

Bijan Kermani, Don Harrop

Design and Analysis of Centrifugal Compressors

Rene Van den Braembussche

Case Studies in Fluid Mechanics with Sensitivities to Governing Variables

M. Kemal Atesmen

The Monte Carlo Ray-Trace Method in Radiation Heat Transfer and Applied Optics

J. Robert Mahan

Dynamics of Particles and Rigid Bodies: A Self-Learning Approach

Mohammed F. Daqaq

Primer on Engineering Standards, Expanded Textbook Edition

Maan H. Jawad, Owen R. Greulich

Engineering Optimization: Applications, Methods, and Analysis

R. Russell Rhinehart

Compact Heat Exchangers: Analysis, Design and Optimization Using FEM and CFD Approach

C. Ranganayakulu, Kankanhalli N. Seetharamu

Robust Adaptive Control for Fractional-Order Systems with Disturbance and Saturation

Mou Chen, Shuyi Shao, Peng Shi

Robot Manipulator Redundancy Resolution

Yunong Zhang, Long Jin

Stress in ASME Pressure Vessels, Boilers, and Nuclear Components

Maan H. Jawad

Combined Cooling, Heating, and Power Systems: Modeling, Optimization, and Operation

Yang Shi, Mingxi Liu, Fang Fang

Applications of Mathematical Heat Transfer and Fluid Flow Models in Engineering and Medicine

Abram S. Dorfman

Bioprocessing Piping and Equipment Design: A Companion Guide for the ASME BPE Standard

William M. (Bill) Huitt

Nonlinear Regression Modeling for Engineering Applications: Modeling, Model Validation, and Enabling Design of Experiments

R. Russell Rhinehart

Geothermal Heat Pump and Heat Engine Systems: Theory and Practice

Andrew D. Chiasson

Fundamentals of Mechanical Vibrations

Liang-Wu Cai

Introduction to Dynamics and Control in Mechanical Engineering Systems

Cho W.S. To

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

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

WILEY



This edition first published 2020
© 2020 John Wiley & Sons Ltd

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

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, except as permitted by law. Advice on how to obtain permission to reuse material from this title is available at <http://www.wiley.com/go/permissions>.

The right of Srinivasan Chandrasekaran and R. Nagavinothini to be identified as the authors of this work has been asserted in accordance with law.

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

For details of our global editorial offices, customer services, and more information about Wiley products visit us at www.wiley.com.

Wiley also publishes its books in a variety of electronic formats and by print-on-demand. Some content that appears in standard print versions of this book may not be available in other formats.

Limit of Liability/Disclaimer of Warranty

MATLAB® is a trademark of The MathWorks, Inc. and is used with permission. The MathWorks does not warrant the accuracy of the text or exercises in this book. This work's use or discussion of MATLAB® software or related products does not constitute endorsement or sponsorship by The MathWorks of a particular pedagogical approach or particular use of the MATLAB® software.

In view of ongoing research, equipment modifications, changes in governmental regulations, and the constant flow of information relating to the use of experimental reagents, equipment, and devices, the reader is urged to review and evaluate the information provided in the package insert or instructions for each chemical, piece of equipment, reagent, or device for, among other things, any changes in the instructions or indication of usage and for added warnings and precautions. While the publisher and authors have used their best efforts in preparing this work, they make no representations or warranties with respect to the accuracy or completeness of the contents of this work and specifically disclaim all warranties, including without limitation any implied warranties of merchantability or fitness for a particular purpose. No warranty may be created or extended by sales representatives, written sales materials or promotional statements for this work. The fact that an organization, website, or product is referred to in this work as a citation and/or potential source of further information does not mean that the publisher and authors endorse the information or services the organization, website, or product may provide or recommendations it may make. This work is sold with the understanding that the publisher is not engaged in rendering professional services. The advice and strategies contained herein may not be suitable for your situation. You should consult with a specialist where appropriate. Further, readers should be aware that websites listed in this work may have changed or disappeared between when this work was written and when it is read. Neither the publisher nor authors shall be liable for any loss of profit or any other commercial damages, including but not limited to special, incidental, consequential, or other damages.

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://lcn.loc.gov/2019050441>

LC ebook record available at <https://lcn.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

Contents

	List of Figures	<i>ix</i>
	List of Tables	<i>xiii</i>
	Foreword by Professor Purnendu K. Das	<i>xv</i>
	Foreword by Dr. Atmanand N.D.	<i>xvii</i>
	Series Preface	<i>xix</i>
	Preface	<i>xxi</i>
1	Common Compliant Platforms	1
1.1	Introduction	1
1.2	Tension Leg Platforms	8
1.3	Guyed Tower and Articulated Tower	19
1.4	Floating Structures	21
1.5	Response Control Strategies	24
1.5.1	Active Control Algorithm	25
1.5.2	Semi-Active Control Algorithm	25
1.5.3	Passive Control Algorithm	26
1.5.4	Friction Dampers	27
1.5.5	Metallic Yield Dampers	27
1.5.6	Viscous Fluid Dampers	27
1.5.7	Tuned Liquid Dampers	29
1.5.8	Tuned Liquid Column Damper	30
1.6	Tuned Mass Dampers	31
1.7	Response Control of Offshore Structures	36
1.8	Response Control of TLPs Using TMDs: Experimental Investigations	38
1.9	Articulated Towers	44
1.10	Response Control of ATs: Analytical Studies	48
1.11	Response Control of ATs: Experimental Studies	52
1.11.1	MLAT Without a TMD	53
1.11.2	MLAT with a TMD	56

2	Buoyant Leg Storage and Regasification Platforms	59
2.1	Background Literature	60
2.1.1	Buoyant Leg Structures	62
2.1.2	Floating Production and Processing Platforms	63
2.2	Experimental Setup	64
2.3	Experimental Investigations	65
2.4	Numerical Studies	72
2.5	Critical Observations	76
2.6	Stability Analysis of the BLSRP	85
2.7	Fatigue Analysis of the BLSRP	90
3	New-Generation Platforms: Offshore Triceratops	95
3.1	Introduction	95
3.2	Environmental Loads	96
3.2.1	Regular Waves	96
3.2.2	Random Waves	97
3.2.3	Wind	98
3.2.4	Currents	100
3.3	Fatigue Analysis of Tethers	101
3.4	Response to Regular Waves	104
3.5	Response to Random Waves	108
3.6	Response to Combined Actions of Wind, Waves, and Current	113
3.6.1	Deck Response	116
3.6.2	Buoyant Leg Response	120
3.6.3	Tether Tension Variation	122
3.7	Summary	123
4	Triceratops Under Special Loads	125
4.1	Introduction	125
4.1.1	Ice Load	126
4.1.2	Impact Load Due to Ship Platform Collisions	129
4.1.3	Hydrocarbon Fires	131
4.2	Continuous Ice Crushing	134
4.2.1	The Korzhavin Equation	135
4.2.2	Continuous Ice Crushing Spectrum	136
4.3	Response to Continuous Ice Crushing	138
4.3.1	Response to Ice Loads	139
4.3.1.1	Deck and Buoyant Leg Responses	139
4.3.1.2	Tether Response	140

4.3.2	Effect of Ice Parameters	140
4.3.2.1	Ice Thickness	140
4.3.2.2	Ice Crushing Strength	143
4.3.2.3	Ice Velocity	144
4.3.3	Comparison of Ice- and Wave-Induced Responses	145
4.4	Response to Impact Loads	147
4.4.1	Parametric Studies	151
4.4.1.1	Indenter Size	151
4.4.1.2	Collision Zone Location	152
4.4.1.3	Indenter Shape	153
4.4.1.4	Number of Stringers	154
4.4.2	Impact Response in the Arctic Region	154
4.5	Deck Response to Hydrocarbon Fires	156
4.6	Summary	158
5	Offshore Triceratops: Recent Advanced Applications	161
5.1	Introduction	161
5.2	Wind Turbines	161
5.3	Wind Power	163
5.4	Evolution of Wind Turbines	163
5.5	Conceptual Development of the Triceratops-Based Wind Turbine	164
5.6	Support Systems for Wind Turbines	164
5.6.1	Spar Type	165
5.6.2	TLP Type	165
5.6.3	Pontoon (Barge) Type	165
5.6.4	Semi-Submersible Type	166
5.6.5	Triceratops Type	166
5.7	Wind Turbine on a Triceratops	166
5.8	Response of a Triceratops-Based Wind Turbine to Waves	166
5.8.1	Free-Decay Response	166
5.8.2	Response to Operable and Parked Conditions	169
5.8.3	Effect of Wave Heading Angles	170
5.8.4	PSD Plots	171
5.8.5	Tether Response and Service Life Estimation	172
5.9	Stiffened Triceratops	173
5.9.1	Preliminary Design	173
5.9.2	Response to Wave Action	175
5.9.3	Effect of Wave Direction	177
5.10	Triceratops with Elliptical Buoyant Legs	179

5.10.1 Conceptual Development 180

5.10.2 Response of a Triceratops with Elliptical Buoyant Legs
to Wave Action 182

5.11 Summary 186

Model Test Papers 187

References 209

Index 223

List of Figures

- 1.1 A typical tension leg platform. 9
- 1.2 TLP mechanics. 10
- 1.3 Active control strategy. 25
- 1.4 Semi-active control strategy. 26
- 1.5 Block diagram for passive control strategy. 26
- 1.6 Pall friction damper. 27
- 1.7 Metallic yield damper. 28
- 1.8 Viscous fluid damper. 28
- 1.9 Tuned liquid damper: (a) circular; (b) rectangular. 29
- 1.10 Tuned liquid column damper. 30
- 1.11 Tuned mass damper. 32
- 1.12 Schematic diagram of an idealized system. 32
- 1.13 Schematic diagram of a spring-mass system with a TMD. 33
- 1.14 Mass used in the TMD. 39
- 1.15 Response of a TLP and TMD ($\mu = 1.5\%$). 41
- 1.16 Response of a TLP and TMD ($\mu = 3.0\%$). 41
- 1.17 Surge RAO of a TMD. 42
- 1.18 Comparison of surge response ($H_S = 8$ m; $T_P = 12$ seconds). 42
- 1.19 Comparison of surge response ($H_S = 8$ m; $T_P = 16$ seconds). 43
- 1.20 Comparison of surge response ($H_S = 8$ m; $T_P = 20$ seconds). 43
- 1.21 Comparison of surge response ($H_S = 8$ m; $T_P = 32.5$ seconds). 44
- 1.22 Comparison of pitch response ($H_S = 8$ m; $T_P = 12$ seconds). 45
- 1.23 Comparison of pitch response ($H_S = 8$ m; $T_P = 16$ seconds). 45
- 1.24 Comparison of pitch response ($H_S = 8$ m; $T_P = 20$ seconds). 46
- 1.25 Comparison of pitch response ($H_S = 8$ m; $T_P = 32.5$ seconds). 46
- 1.26 Articulated tower. 47
- 1.27 Analytical model. 49
- 1.28 Variation of responses for different frequency ratios. 51
- 1.29 Variation of responses for different frequency ratios with a TMD. 52

1.30	Variation of responses for different frequency and mass ratios with a TMD.	52
1.31	Geometric details of the model.	54
1.32	Model of a TMD.	54
1.33	Free-vibration time history.	55
1.34	Surge response of a MLAT without a TMD.	55
1.35	Surge RAO for TMD-1.	56
1.36	Surge RAO for TMD-2.	56
1.37	Surge RAO for TMD-3.	57
1.38	Comparison of RAOs for 3 cm wave height.	57
1.39	Comparison of RAOs for 5 cm wave height.	58
1.40	Comparison of RAOs for 7 cm wave height.	58
2.1	Schematic diagram of the BLSRP installed in a wave flume.	64
2.2	Experimental setup and arrangements: (a) side view; (b) hinged joint; (c) roller at the base plate for guiding the mooring line; (d) load cell; (e) ratchet mechanism for adjusting the tension; (f) plan arrangement.	66
2.3	Orientation of the BLSRP for the wave heading angle.	69
2.4	Response of the BLSRP (0°, 0.1 m wave height).	70
2.5	Details of the hinged joint in the numeric model.	73
2.6	Response of the BLSRP (30°, 15 m).	74
2.7	Tether tension variations in mooring lines.	76
2.8	Power spectral density plots of buoyant leg 1 (0°, 6 m, 10 seconds).	78
2.9	Power spectral density plots of the deck (0°, 6 m, 10 seconds).	80
2.10	Numerical model of the BLSRP (normal case).	87
2.11	Numerical model of the BLSRP with postulated failure.	89
2.12	Dynamic tether tension variation in postulated failure cases.	91
2.13	Mathieu stability for the BLSRP in postulated failure cases.	92
3.1	Typical regular wave profile (H = 2 m, T = 5 s).	96
3.2	PM spectrum for different sea conditions.	99
3.3	Two-dimensional random wave profile.	99
3.4	API spectrum plot for different wind velocities.	101
3.5	Wind-generated current velocity profile.	102
3.6	Service life estimation methodology.	103
3.7	Triceratops model.	104
3.8	Experimental model of a stiffened triceratops.	105
3.9	Plan of the triceratops.	105
3.10	RAOs of the deck and buoyant legs with regular waves.	107
3.11	Deck response given different wave heading angles.	109
3.12	Tether tension variation in rough sea conditions.	110
3.13	Deck surge and heave PSD plots in very high sea conditions.	111
3.14	Pitch response of the deck and buoyant legs in very high sea conditions.	112

- 3.15 Maximum deck response in very high sea conditions. 114
- 3.16 Tether tension spectrum with very high sea conditions. 115
- 3.17 Maximum tether tension in very high sea conditions. 115
- 3.18 Deck response with high sea conditions (w – waves, w + w – waves+wind, w + w + c – waves+wind+current). 117
- 3.19 Phase plots in the surge DOF with very high sea conditions. 119
- 3.20 Buoyant leg response with high sea conditions. 120
- 3.21 Tension spectrum with very high sea conditions. 123
- 4.1 Random ice force and vibration of the structure. 128
- 4.2 True stress–strain curve of AH36 grade steel. 130
- 4.3 Different shapes of indenters. 131
- 4.4 Time–temperature curves for different fire conditions. 132
- 4.5 Reduction factors for yield strength, proportional limits, and linear elastic range for carbon steel. 133
- 4.6 Variations in the thermal conductivity of carbon steel. 133
- 4.7 Variations in the specific heat of carbon steel. 134
- 4.8 Variations in the thermal strain of carbon steel. 134
- 4.9 Spectral density plot given different ice velocities. 137
- 4.10 Spectral density plot given different ice forces. 137
- 4.11 Ice force–time history. 138
- 4.12 PSD plots for normal ice sea conditions with ice load on two buoyant legs. 141
- 4.13 PSD plots of tether tension variation in normal sea conditions. 143
- 4.14 Total deck response for different ice thicknesses. 144
- 4.15 Total deck response for different ice crushing strengths. 145
- 4.16 Total deck response for different ice velocities. 146
- 4.17 PSD plots of the deck in open water and ice-covered load cases. 147
- 4.18 Methodology of impact analysis. 148
- 4.19 Numerical model of buoyant legs and indenters. 149
- 4.20 Force versus nondimensional deformation curve. 150
- 4.21 Deck surge responses for impact loads on buoyant leg 1. 150
- 4.22 Force–deformation curves for different indenter sizes. 151
- 4.23 Force–deformation curves for different impact locations. 152
- 4.24 Force–deformation curves for different indenter shapes. 153
- 4.25 Force–deformation curves for different numbers of stringers. 154
- 4.26 Force–deformation curve of buoyant legs at different temperatures. 155
- 4.27 Deck plate of a triceratops. 156
- 4.28 Scale deck plate model. 157
- 4.29 Hydrocarbon fire cases. 158
- 4.30 Temperature variations in plates and stiffeners. 159
- 5.1 Numerical model of a triceratops with a wind turbine. 168
- 5.2 Pitch RAO of the triceratops. 168

- 5.3 PSD plot of the surge free-decay response. 169
- 5.4 PSD plot of the roll free-decay response. 169
- 5.5 Frequency response to operable and parked conditions. 170
- 5.6 PSD plots for different DOF. 172
- 5.7 Dynamic tether tension variation. 172
- 5.8 Plan and elevation of a stiffened buoyant leg. 174
- 5.9 Fabricated model of a stiffened buoyant leg. 176
- 5.10 Fabricated model of a ball joint. 177
- 5.11 Surge, heave, and pitch RAOs of the deck and buoyant legs with 0° incident waves. 178
- 5.12 Surge, heave, and pitch RAOs of the deck and buoyant legs with 90° waves. 179
- 5.13 Surge, heave, and pitch RAOs of the deck and buoyant legs with 180° waves. 180
- 5.14 Effect of wave direction on the stiffened triceratops. 181
- 5.15 Cross section of the buoyant legs. 182
- 5.16 Plan view of the triceratops with circular and elliptical buoyant legs. 183
- 5.17 Total force–time history, given high sea conditions. 185

List of Tables

1.1	Major fixed platforms constructed worldwide (as of 2017).	3
1.2	Tension leg platforms constructed worldwide.	20
1.3	Properties of a TMD in the model and prototype (scale 1 : 100).	39
1.4	Results of free oscillation tests of the TLP model.	40
1.5	RMS value of surge responses in the presence of random waves.	44
1.6	RMS value of pitch responses in the presence of random waves.	47
1.7	Mechanical properties of the Perspex material used for the model.	53
2.1	Structural details of the BLSRP.	67
2.2	Natural periods and damping ratios.	68
2.3	Maximum response of the BLSRP model (0°, 0.1 m).	72
2.4	Maximum response amplitudes (numerical studies; 6 m wave height).	83
2.5	Geometric properties of the BLSRP for the stability study.	88
2.6	Maximum tension amplitude in the tethers in postulated failure cases.	90
2.7	Mathieu parameters in postulated failure cases.	92
2.8	Fatigue life (rounded off) of tethers under eccentric loading.	93
3.1	Characteristics of random sea conditions.	97
3.2	Comparison of responses to regular waves.	108
3.3	Deck response to different sea conditions.	110
3.4	Comparison of deck responses to high sea conditions.	112
3.5	Tension variation and service life of tethers of buoyant leg 1.	115
3.6	Characteristics of sea conditions.	116
3.7	Tether tension variation with combined actions of wind, waves, and current.	122
4.1	Mechanical properties of marine DH36 steel.	131
4.2	Ice sea conditions.	138
4.3	Deck response to different sea conditions.	139
4.4	Deck response to open water and ice-covered load cases.	146
4.5	Collision speed and impact duration.	148
4.6	Mechanical properties of DH36 steel at a 0.001/s strain rate.	155

5.1	Properties of the triceratops-based wind turbine.	167
5.2	Variation in RAO with changes in the wave heading angle.	171
5.3	Service life estimation of the triceratops.	173
5.4	Geometric parameters of the offshore triceratops.	175
5.5	Mass properties of the triceratops.	176
5.6	Response of the triceratops given rough sea conditions.	184

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.

Professor Purnendu K. Das B.E., M.E., Ph.D., C.Eng, CMar.Eng, FRINA,
FIStruct.E, FIMarEST
Director
ASRANet Ltd.
Glasgow

*Ex-Professor of Marine Structures, University of Strathclyde, Glasgow, UK
Visiting Professor, University of Montenegro, Montenegro*

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.

Dr. Atmanand N.D.
Director, Chair IOCINDIO (UNESCO)
National Institute of Ocean Technology
Chennai
India

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.

The series publishes across the breadth of mechanical engineering, comprising research, design and development, and manufacturing. It includes monographs, references and course texts.

Prospective topics include emerging and advanced technologies in Engineering Design; Computer-Aided Design; Energy Conversion & Resources; Heat Transfer; Manufacturing & Processing; Systems & Devices; Renewable Energy; Robotics; and Biotechnology.

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.

Srinivasan Chandrasekaran
R. Nagavinothini