

Review

PALMER A and CROASDALE K (2012) *Arctic offshore engineering*. World Scientific Publishing, Singapore, 327pp. ISBN-10: 9-814368-77-6, ISBN-13: 978-9-814-36877-3, hardback, US\$128.

This book is an interesting account of most of the work done over the past 40 or so years in the quest to take oil, gas and minerals from Arctic areas in a safe and environmentally friendly manner. Although there are other books that cover the properties and distribution of sea ice, no other book that I know covers the forces on Arctic offshore structures in as much detail as this one. I enjoyed reading it and would recommend it to a newcomer to the field as a useful overview, with some reservations.

I was surprised to find no details of the authors' education, expertise and experience in a foreword or preface. Personally, I know that they are well qualified to write such a book, but a newcomer to this area of research might not, and would want to hear about their backgrounds. They combine academic and industrial experience, which is unusual, and welcome, in a textbook. They each have their own writing style, as one can tell from reading the different chapters. They do not say for whom the book is intended: I assume for a new researcher in this field, or for a post-graduate university course in Arctic engineering. Experienced practitioners will enjoy reading it (I learned a lot about pipelines), but it is not a detailed treatise on all aspects of the subject. That would require a much longer book. The two indexes at the end are very basic: one has geographical place names, and the other is a simple general index with few details and no names of people. The book would also benefit from a map, or maps, showing the many places mentioned. An excellent collection of references are listed at the end of each chapter, and this is an invaluable feature and one of the highlights of the book. The science and engineering are illustrated by case studies of actual projects that the authors have been involved in, including pictures and some full-scale data, both of which I particularly liked.

I was distressed to find a large number of typographical or minor grammatical errors (53 in total). An editor, even one with little scientific background, could have caught most of these. Some other lapses are more serious: a density minimum, rather than maximum, for sea water is referred to (p. 33); figure 5.7 is confusing, with three labels but four symbols and four lines; figure 7.5 has the axes 'round the wrong way' according to the text; and on p. 292 a 'reduced velocity' is suddenly mentioned but with no explanation of what it is. These items are unfortunate and marred my overall enjoyment of the book.

The first chapter is a surprising and very interesting summary of the human context of the Arctic from early mankind to the present day. The authors accomplish this in 16 pages, quite a feat. I did not expect such a chapter but it is welcome. Chapter 2 discusses the biological and physical environment of the Arctic. Both chapters succeed in putting the engineering in the proper context, and remind

us that people live in the Arctic and that the environment is indeed fragile.

Chapter 3 discusses ice mechanics. It contains a good description of the fracture of ice and its fracture toughness. The authors point out that fracture, not creep, is usually but not always the dominant process for engineering application, and briefly discuss linear and nonlinear fracture mechanics, without the reams of mathematics found in more detailed discussion of the subject. The modelling of ice is touched on, and they remind us of the scaling laws that have been proposed over the years and the different manner in which such model tests, therefore, should be conducted.

Chapters 4, 5 and 6 are what I was expecting as the meat of the book. They cover ice forces on fixed structures in the sea, both sloping and vertical-sided, and the forces due to rubble and ridged ice, as well as the forces on floating structures. Chapter 4 outlines the design of the various structures that have been used in the Arctic, discusses the general concept of forces on such structures, and the various modes of failure that can occur, which are critical to the forces generated. The concepts of limit stress, limit force and limit momentum are introduced. Crushing is detailed because this is an important mode of failure for vertical-sided structures, while bending failure of the ice is more important for sloping structures. The complicating effects of adfreeze are also considered, as well as velocity effects, which turn out to be not very significant. Chapter 5 points out that ice does not usually occur as uniform level sheets but consists of broken, ridged and rubble ice. Forces due to such ice are calculated for both vertical and sloping structures and can be considerable. Multi-leg structures are also discussed. Chapter 6 is shorter and discusses the loads on floating moored platforms in conditions of managed and unmanaged ice.

Arctic marine pipelines are studied in detail in chapter 7. The main problem with pipelines is seabed ice gouging, and the chapter explains its origin and how the scouring depth should be estimated. The different methods for constructing such pipelines are illustrated, and details of specific pipeline projects (Northstar, Oooguruk and Nikaitchuq) are given. Transport of oil by tanker from the Arctic is also considered, with brief mention of the Manhattan project of 1969.

The book concludes (chapters 8 and 9) with a discussion of environmental concerns, human factors and safety issues. Oil spills and possible remedial measures are outlined, as well as the decommissioning of abandoned structures in the Arctic. Evacuation systems, on-ice safety and the psychological effects of isolated living are outlined.

I enjoyed the book very much and would recommend it to anyone starting out in this area of research. It is reasonably priced for a book of this nature at US\$128 in hardback, or strangely at a more expensive US\$140 as an e-book.

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