

Breakwaters and closure dams

On the cover picture:

Ship approaching a harbour, Willem Gruijter jr, (1817-1880)

Oil on Panel, 23 × 34 cm, Belasting- en Douanemuseum, Rotterdam

A ship is approaching a harbour, protected by a breakwater made from woodwork (palisade). Harbour approach indicated by a lighthouse, with an oil lamp. On the breakwater is fire basket as leading light. A wooden buoy is floating in front.

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Preface

This book is primarily a study book for graduate students. It has been prepared for students in Coastal Engineering at the Delft University of Technology. The consequence is that, in addition to treating the latest insights into the subject matter, it places the developments in their historic perspective, at least when this contributes to better understanding. It also means that this book cannot replace comprehensive textbooks or original scientific publications. The book focuses on understanding of the design process, but is certainly not a design manual. The reader is strongly advised to consult the original references rather than blindly following this textbook.

In the curriculum of Delft University, the course on breakwaters and closure dams is preceded by a variety of courses on subjects such as fluid mechanics, hydraulic engineering, coastal engineering and bed, bank and shore protection, design process, and probabilistic design. Therefore it is assumed that the reader is familiar with this knowledge and it will not be discussed in detail in this book.

At first sight it seems strange to combine in one book the design of two rather dedicated types of structures with distinctly different purposes, however from an educational point of view this is not so.

In both cases the design process requires that due attention should be paid to:

- the functional requirements
- the various limit states to which a structure will be exposed in relation to the requirements
- the various limit states that occur during construction phases
- the relation between these limit states and the occurrence of certain natural conditions

The differences between closure dams and breakwaters will enable us to focus attention on the above mentioned considerations.

In addition to this, there are also quite a number of similarities. In this respect, we refer to the construction materials, such as quarry stone, concrete blocks and caissons, which are widely used in both types of structures. The same applies to a wide range of construction equipment, both floating and rolling, and, last but not least, the interdependence between design and construction.

It is good to mention here that the design of closure dams, and more specifically closure dams in estuaries, has undergone a major development in the period between 1960 and 1985, when the Delta Project in the Netherlands was being executed. Only recently in Korea similar closures works have been executed. Also some experiences from these works are included in this book. In the view of the accelerated sea level rise it is anticipated that more works of this kind will be needed in future.

Breakwaters, and specifically various kinds of rubble mound breakwaters, underwent a tremendous development in the period 1985-1995. After that, the pace of innovation seemed to slowing down, although monolithic breakwaters were gaining attention in the following decade. In the most recent years focus of research was on the effect of shallow water conditions, optimising the use of the quarries (the Icelandic breakwaters) as well as research on variations on the rubble mound breakwater, like the (semi-)submerged structures, breakwaters with a longer berm and new concrete elements. Therefore, the present study book does not represent a static subject. This necessitates that both the teacher and the student should continuously observe the latest developments.

The first edition of this book (2001) was written by Kees d'Angremond and Ferd van Rooden. This second edition has been updated by Henk Jan Verhagen. New additions to the book to be mentioned are the treatment of wave statistics, the spectral approach in the stability formula, the shallow water conditions and the Icelandic breakwaters. The book has been brought in line with the Rock Manual (2007) and with the European Standard on Armour Stone (EN 13383).

Valuable contributions in the form of comments and/or text were received from: Marcel van Gent (Deltares), Jentsje van der Meer (independent consultant), Jelle Olthof (Delft University of Technology and Royal Boskalis Westminster), Gerrit Jan Schiereck, (Delft University of Technology), Sigurður Sigurðarson (Icelandic Maritime Administration) and Shigeo Takahashi (Japanese Port and Airport Research Institute). Many others contributed in a variety of ways, including correcting text and preparing figures. We are especially grateful to Margaret Boshek, who checked both the English spelling as well as the readability of the book.

Henk Jan Verhagen, Kees d'Angremond
Delft, January 2009

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