BRITISH STANDARD

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Maritime structures —

Part 7: Guide to the design and construction of breakwaters

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Civil Engineering and Building Standards Policy Committee (CSB/-) to Technical Committee CSB/17, upon which the following bodies were represented:

Association of Consulting Engineers
British Ports Federation and the National Association of Ports Employers
British Steel Industry
Concrete Society
Department of the Environment (Property Services Agency)
Department of Transport (Marine Directorate)
Federation of Civil Engineering Contractors
Health and Safety Executive
Institution of Civil Engineers
Institution of Structural Engineers
Oil Companies International Marine Forum

This British Standard, having been prepared under the direction of the Civil Engineering and Building Structures Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on
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Amendments issued since publication

Date	Comments
31 January 2010	Correction to equations in **4.4.3** and **4.4.5**

Contents

Foreword

This Part of BS 6349 has been prepared under the direction of the Civil Engineering and Building Structures Standards Policy Committee.

This Part of BS 6349 consists of six sections providing guidance for the design and construction of breakwaters as follows.

— *Section 1: General;*

— *Section 2: Layout planning;*

— *Section 3: General design of breakwater structures;*

— *Section 4: Rubble mound structures;*

— *Section 5: Vertical face structures;*

— *Section 6: Composite structures.*

It has been assumed in the drafting of this British Standard that the execution of its provisions is entrusted to appropriately qualified and experienced people, for whose guidance it has been prepared. It provides information and guidance, not all of which may be directly verifiable. Depending upon the extent of information and knowledge gained in this field in the coming years, it is possible that this guide could be updated as a code of practice.

The seven Parts of BS 6349 are as follows.

— *Part 1: General criteria;*

— *Part 2: Design of quay walls, jetties and dolphins;*

— *Part 3: Design of dry docks, locks, slipways and shipbuilding berths, shiplifts and dock and lock gates;*

— *Part 4: Design of fendering and mooring systems;*

— *Part 5: Code of practice for dredging and land reclamation;*

— *Part 6: Design of inshore moorings and floating structures;*

— *Part 7: Guide to the design and construction of breakwaters.*

Parts 1 to 6 have been written as codes of practice and contain recommendations on good, accepted practice as followed by competent practitioners. Part 7 has been written as a guide.

A number of the figures and tables in this Part of BS 6349 have been provided by individual organizations who own the copyright. The details of the sources are given at the foot of each figure and BSI acknowledges with appreciation permission to reproduce them.

The full list of the organizations which have taken part in the work of the Technical Committee is given on the inside front cover. The Chairman of the Committee was Mr P Lacey CEng, FICE, FIStructE, FIHT, FRSA and the following were members of the Technical Committee.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to vi, pages 1 to 84, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

1.1 Scope

This Part of BS 6349 provides guidance on the design and construction of breakwaters.

Breakwaters are structures which provide protection to harbours and structures such as sea intakes against wave action and this Part of BS 6349 gives guidance on the main types of breakwater. Floating breakwaters are not included.

Coastal structures such as groynes, revetments and training walls are not covered, although certain aspects of design may be found to be relevant to them.

NOTE The titles of the publications referred to in this British Standard are listed on the inside back cover. The numbers in square brackets used throughout the text relate to the bibliographic references given in Appendix A.

1.2 Definitions

For the purposes of this Part of BS 6349, the definitions in BS 6349-1 apply together with the following.

1.2.1
rubble mound breakwater

a structure composed primarily of rocks dumped or placed upon the sea bed. An outer layer, or layers, of more massive rock or precast concrete units provides an armour layer to protect the less massive rock core from wave attack. A concrete crest structure which contributes to the function of the breakwater may be constructed on the mound

NOTE Examples of rubble mound breakwaters are shown in Figure 6.

1.2.2
vertical face breakwater

a breakwater in which wave attack is resisted primarily by a vertically faced structure extending directly from sea bed level

NOTE Examples of vertical face breakwaters are shown in Figure 18.

1.2.3
composite breakwater

a submerged rubble mound foundation or breakwater surmounted by a vertically faced structure projecting above sea level

NOTE Examples of composite breakwaters are shown in Figure 30.

Section 2. Layout planning

2.1 General

This section considers the planning of breakwater layout to achieve the harbour protection function. Guidance is given on navigational aspects, wave penetration, environmental effects and data collection.

2.2 Harbour layout

2.2.1 General

Wave energy can enter a harbour by penetration through the entrance between the breakwaters, by overtopping and by transmission through permeable breakwater structures. The types of breakwater structures used and their detailed design therefore influence the wave climate within the harbour, and for this reason breakwater layout cannot be entirely separated from design of the structures; an iterative process is often needed in determining the optimum solution.

Port planning requirements for the number, size and locations of cargo handling facilities will determine the overall dimensions of the harbour. These considerations are outside the scope of this Part of BS 6349. References are given in **2.1.1** of BS 6349-2:1988.

Breakwaters can also be required to protect an approach channel from littoral drift or to stabilize or train the alignment of a tidal entrance.

The siting and layout of the breakwaters to provide the necessary degree of protection to the harbour are determined by the need for the following:

a) sheltered conditions for ships at berth or anchorage;

b) manoeuvring and turning areas for ships within the harbour;

c) an adequate stopping distance for ships entering the harbour entrance at a safe navigating speed.

2.2.2 Navigational aspects

Criteria for depth and width of approach channels are given in clause **18** of BS 6349-1:1984, criteria for manoeuvring inside harbours are given in clause **19** of BS 6349-1:1984, and criteria for the acceptable wave conditions for moored boats and ships are given in clauses **30** and **31** of BS 6349-1:1984. Suitable conditions should also be provided to enable tugs and mooring vessels to work satisfactorily.

The presence of the breakwaters produces special navigation conditions at the harbour entrance. Currents can be generated across a harbour entrance as a result of the deflection of currents and by wave diffraction around the head of the breakwater. Wave reflections can occur from the breakwaters, and as a vessel moves from the open sea to sheltered water there are significant changes in environmental conditions affecting the vessel over a short distance.

A wide harbour entrance, to ease navigation, conflicts with the objective of limiting wave penetration, and some compromise is needed. Navigation is not always possible in exceptional wind and wave conditions.

The advice of experienced mariners is essential in determining the optimum layout of breakwaters at the harbour entrance, taking into account the economic aspects of cost and any limits on navigation and port operation.

Models and ship simulators, described in clause **18** of BS 6349-1:1984, can be valuable aids to the planning of the harbour entrance and breakwater layout.

2.2.3 Wave penetration

The most important determinant of harbour response is wave penetration through the entrance. It is first necessary to establish wave conditions just outside the entrance, then to determine the effect of the entrance in permitting waves to enter the harbour and finally to determine the response at critical positions within the harbour.

Guidance on establishing the offshore wave climate is given in clause **22** of BS 6349-1:1984, and methods of deriving inshore wave conditions at the harbour entrance are given in clause **23** of BS 6349-1:1984. Wave direction is important and, whilst the greatest shelter to the harbour area should be provided against the largest waves, lesser wave conditions from different directions can be important in designing the layout.

Consideration should be given to fairly frequent wave conditions as well as to rare events, as the former can affect down-time and economy of operation whereas the latter will affect safety. Acceptable limits on ship movement are given in **31.4** of BS 6349-1:1984.