

Maritime works –

Part 4: Code of practice for design
of fendering and mooring systems

Publishing and copyright information

The BSI copyright notice displayed in this document indicates when the document was last issued.

© The British Standards Institution 2014

Published by BSI Standards Limited 2014

ISBN 978 0 580 66969 9

ICS 47.020.99; 93.140

The following BSI references relate to the work on this document:

Committee reference CB/502

Draft for comment 13/30199621 DC

Publication history

First published March 1985

Second edition, October 1994

Third (present) edition, June 2014

Amendments issued since publication

Date	Text affected
-------------	----------------------

Contents

Foreword *iii*

Section 1: General 1

- 1 Scope 1
- 2 Normative references 1
- 3 Terms, definitions and symbols 2

Section 2: Fendering 4

- 4 General principles 4
 - 4.1 Provision and overall design of fendering systems 4
 - 4.2 Selection and design of fenders 7
 - 4.3 Vessel characteristics 7
 - 4.4 Fender layout for berths and other locations 9
 - 4.5 Berthing procedure 13
 - 4.6 Berthing reactions and load distribution 15
 - 4.7 Moored reactions 18
- 5 Calculation of berthing energies 18
 - 5.1 Characteristic and design berthing energy 18
 - 5.2 Calculation of characteristic berthing energies for alongside berthing 19
 - 5.3 Calculation of berthing energies for ferry and Ro-Ro berths 22
- 6 Selection of fenders and fender types 23
 - 6.1 General 23
 - 6.2 Materials and workmanship 23
 - 6.3 Fenders using elastomeric units 23
 - 6.4 Torsion arm fenders 25
 - 6.5 Pneumatic and foam-filled fenders 25
 - 6.6 Flexible dolphins 26
 - 6.7 Shear capacity of fenders 29
 - 6.8 Fender panels 29
 - 6.9 Mounting and suspension 30

Section 3: Mooring 32

- 7 Principles of good mooring 32
 - 7.1 General 32
 - 7.2 Mooring lines 32
 - 7.3 Mooring layouts 33
- 8 Actions acting on the moored vessel 36
 - 8.1 General 36
 - 8.2 Wind and currents 36
 - 8.3 Hydrodynamic forces 36
 - 8.4 Tidal rise and fall and change in draught or trim due to cargo operations 38
 - 8.5 Ice 38
- 9 Loads on mooring points 39
 - 9.1 General 39
 - 9.2 Calculation methods 39
 - 9.3 Design of mooring point structure 41
- 10 On-shore mooring equipment 41
 - 10.1 Materials 41
 - 10.2 Mounting and fixing 41
 - 10.3 Bollards 42
 - 10.4 Quick release mooring hooks 43
 - 10.5 Capstans 43
 - 10.6 Vacuum mooring systems 44

Bibliography 45

List of figures

- Figure 1 – Geometry of vessel with bulbous bow 8
Figure 2 – Hull and cope geometry at impact 10
Figure 3 – Fender layout on a continuous quay 10
Figure 4 – Fender layout for three island berth 11
Figure 5 – Fender layout for five island berth 12
Figure 6 – Geometry of vessel approach to berth 13
Figure 7 – Ferry and Ro-Ro vessel berthing 14
Figure 8 – Hull and fender geometry at impact 17
Figure 9 – Design berthing velocity as function of navigation conditions and size of vessel 20
Figure 10 – Flexible dolphins 28
Figure 11 – Typical mooring pattern for continuous quay 34
Figure 12 – Optimum angles of mooring lines for island tanker berth 35
Figure 13 – Vessel under influence of stand-off force 37
Figure 14 – Effect of rise and fall of tide and change in draught or trim 39

List of tables

- Table 1 – Typical fendering locations 5
Table 2 – Vessel categories 6
Table 3 – Guidance on hull pressure 16
Table 4 – Coefficients of friction of fender facing materials in dry conditions 29
Table 5 – Mooring point loads for general cargo vessels and bulk carriers 41
Table 6 – Mooring bollards 42

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 46, an inside back cover and a back cover.

Foreword

Publishing information

This part of BS 6349 is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 30 June 2014. It was prepared by Technical Committee CB/502, *Maritime works*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This part of BS 6349 supersedes BS 6349-4:1994, which is withdrawn.

Relationship with other publications

BS 6349 is published in the following parts ¹⁾:

- Part 1-1: *General – Code of practice for planning and design for operations;*
- Part 1-2: *General – Code of practice for assessment of actions;* ²⁾
- Part 1-3: *General – Code of practice for geotechnical design;*
- Part 1-4: *General – Code of practice for materials;*
- Part 2: *Code of practice for the design of quay walls, jetties and dolphins;*
- Part 3: *Code of practice for the design of shipyards and sea locks;*
- Part 4: *Code of practice for 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;*
- Part 8: *Code of practice for the design of Ro-Ro ramps, linkspans and walkways.*

Information about this document

This is a full revision of the standard, and introduces the following principal changes:

- reduction of informative content, with informative guidance separated from recommendations;
- general updating to reflect latest practice;
- change in definitions of berthing mode and navigation conditions.

Use of this document

As a code of practice, this part of BS 6349 takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

¹⁾ A new part 9 is in preparation.

²⁾ In preparation.

Presentational conventions

The provisions in this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Section 1: General

1 Scope

This part of BS 6349 gives recommendations and guidance on the design of fendering systems and layouts, mooring devices and mooring system layouts, principally for commercial vessels with a minimum displacement of 1 000 t.

NOTE Some of the provisions in this part of BS 6349 might be applicable to other type of vessels such as naval vessels, provided that the particular vessel characteristics and berthing/mooring procedures are taken into account.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

ASTM F2192/05, *Standard test method for determining and reporting the berthing energy and reaction of marine fenders*

BS 6349-1:2000, *Maritime structures – Part 1: Code of practice for general criteria*

BS 6349-1-1:2013, *Maritime works – Part 1-1: General – Code of practice for planning and design for operations*

BS 6349-1-4, *Maritime works – Part 1-4: General – Code of practice for materials*

BS 6349-2, *Maritime works – Part 2: Code of practice for the design of quay walls, jetties and dolphins*

BS EN 1993 (all parts), *Eurocode 3 – Design of steel structures*

BS EN 1995 (all parts), *Eurocode 5 – Design of timber structures*

BS EN 60079-10-1, *Explosive atmospheres – Part 10-1: Classification of areas – Explosive gas atmospheres*

BS ISO 17357 (all parts), *Ships and marine technology – Floating pneumatic rubber fenders*

Other publications

[N1] US ARMY CORPS OF ENGINEERS (USACE), NAVAL FACILITIES ENGINEERING COMMAND (NAVFAC), AIR FORCE CIVIL ENGINEER CENTER (HQ AFCEC) and NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA). *Unified facilities guide specifications – Division 35: Waterway and marine construction – Section 35.59.13.16: Marine fenders*. USACE/NAVFAC, 2011.³⁾

[N2] EUROPEAN ORGANISATION FOR TECHNICAL APPROVALS. *Design of bonded anchors*. TR 029. Brussels: EOTA, 2007.

³⁾ Available from <http://www.wbdg.org/ccb/DOD/UFGS/UFGS%2035%2059%2013.16.pdf> [last accessed 25 June 2014].