

Code of practice for

# Maritime structures —

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

UDC [624.034.3/.4 + 69.034.3/.4]

Confirmed December 2011
----------------------------

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW

---



[This is a preview. Click here to purchase the full publication.](#)

# Committees responsible for this British Standard

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

- Association of Consulting Engineers
- British Ports Association 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 Board of BSI and comes into effect on 30 June 1989

© BSI 10-1999

The following BSI references relate to the work on this standard:  
Committee reference CSB/17  
Draft for comment 86/12351 DC

ISBN 0 580 16761 5

## Amendments issued since publication

Amd. No.	Date of issue	Comments

# Contents

	Page
Committees responsible	Inside front cover
Foreword	v
<hr/>	
Section 1. General	
1.1 Scope	1
1.2 Definitions	1
1.3 Symbols	1
<hr/>	
Section 2. Environmental loads	
2.1 General	3
2.2 Return period and limiting conditions	3
2.3 Combined loading	3
2.4 Wave loading	3
2.4.1 Wave climate	3
2.4.2 Description of wave loading	3
2.4.3 Basic design principles	3
2.4.4 Simple estimates of forces and motions	4
2.4.5 Physical models	6
2.4.6 Computational models	6
2.5 Wind loading	6
2.5.1 General	6
2.5.2 Basic wind speed (3 s gust)	6
2.5.3 Design wind speeds	6
2.5.4 Force coefficient	8
2.5.5 Trim and heel	8
2.5.6 Simplified method of evaluating wind loading	8
2.6 Current loading	10
2.6.1 General	10
2.6.2 Design speed	10
2.6.3 Force coefficients	10
2.6.4 Evaluation of model tests and theoretical formulae	11
2.6.5 Simplifications in design	13
<hr/>	
Section 3. Moorings	
3.1 General	14
3.2 Types of moorings	14
3.2.1 General	14
3.2.2 Anchor leg moorings	14
3.2.3 Mooring dolphins and booms	16
3.3 Selection of mooring system	18
3.3.1 Operational and environmental considerations	18
3.3.2 Commonly adopted mooring systems	19
3.4 Design of anchor leg mooring	19
3.4.1 Checklist of design activities	19
3.4.2 Environmental and geotechnical data	19
3.4.3 Selection of number of mooring legs	20
3.4.4 Length of mooring line	20
3.4.5 Selection of mooring components	20
3.4.6 Capacity of mooring components	20
3.5 Analysis of moorings	21
3.5.1 General	21

	Page
3.5.2 Methods of analysis	21
3.5.3 Mooring line characteristics	21
3.5.4 Directional effects	22
3.5.5 Factors of safety	22
3.6 Design of mooring dolphins and booms	23
3.6.1 Dolphins	23
3.6.2 Mooring booms	23
3.6.3 Fendering and guides	23
3.7 Anchors	23
3.7.1 Types	23
3.7.2 Anchor holding power	24
3.7.3 Summary of features	25
3.7.4 Manufacture and certification	25
3.8 Mooring equipment	26
3.8.1 Chains	26
3.8.2 Chain fittings	27
3.8.3 Wire ropes	29
3.8.4 Fibre ropes	29
3.8.5 Winches, windlasses and capstans	30
3.8.6 Permanent mooring buoys	30
3.8.7 Miscellaneous fittings	31
3.9 Maintenance and inspection of moorings	31
3.9.1 General	31
3.9.2 Admiralty type and general inshore moorings	31
3.9.3 Floating docks and pontoons	31
3.9.4 Light vessel and similar moorings in exposed locations	31
3.9.5 Single point moorings (SPMs)	31
3.9.6 Inspection of wire rope during service	32
3.9.7 Inspection of fibre rope during service	32
3.9.8 Inspection of chain during service	32
3.9.9 Inspection of connections in service	32
3.9.10 Inspection of anchors	33
<hr/> Section 4. Floating structures	
4.1 General	34
4.2 Loads	34
4.2.1 Types	34
4.2.2 Load conditions	34
4.2.3 Load factors	35
4.3 Codes and classification society rules	35
4.3.1 General	35
4.3.2 Steel structures	35
4.3.3 Concrete structures	35
4.4 Stability	35
4.4.1 General	35
4.4.2 Stability calculations	36
4.4.3 Intact stability	38
4.4.4 Damage stability	38
4.5 Motion response	38
4.5.1 General	38

	Page
4.5.2 Basic design considerations	39
4.5.3 Formulae for natural frequency	39
4.5.4 Equations for natural frequency angular displacement	40
4.6 Longitudinal strength	40
4.6.1 General	40
4.6.2 Static analysis	40
Section 5. pontoons, floating docks and floating breakwaters	
5.1 General	42
5.2 pontoons	42
5.2.1 General	42
5.2.2 Siting	42
5.2.3 Loads	42
5.2.4 Design considerations	42
5.2.5 Mooring of pontoons	43
5.2.6 Accessways	44
5.3 Floating docks	44
5.3.1 General	44
5.3.2 Siting	44
5.3.3 Loads	44
5.3.4 Design considerations	45
5.3.5 Floating dock moorings	46
5.3.6 Construction and trials	46
5.4 Floating breakwaters	47
5.4.1 Suitability and limitations	47
5.4.2 Layout	48
5.4.3 Types	48
5.4.4 Design	48
5.4.5 Mooring design	48
5.4.6 Installation	48
5.4.7 Long-term performance	48
Appendix A Bibliography	49
Appendix B Wind speed map	50
Appendix C Typical drag embedment anchors	51
Figure 1 — Wave particle amplitude of motion versus water depth	5
Figure 2 — Longitudinal drag coefficient for rectangular pontoon in deep water	11
Figure 3 — Transverse drag coefficient for rectangular pontoon in deep water	12
Figure 4 — Longitudinal drag coefficient at various water depths for rectangular pontoon with current head on	12
Figure 5 — Transverse drag coefficient at various water depths for rectangular pontoon with current beam on	13
Figure 6 — Admiralty type mooring buoy	14
Figure 7 — Single anchor leg mooring	15
Figure 8 — Catenary anchor leg mooring or single point mooring (SPM) for tankers	16
Figure 9 — Various arrangements of spread buoy moorings	17
Figure 10 — Dolphins used to restrain a landing stage	18
Figure 11 — Mooring boom	18

	Page
Figure 12 — Fluke to shank angle	24
Figure 13 — Comparison of chain strengths	27
Figure 14 — Chain fittings	28
Figure 15 — Metacare M, centre of gravity G and centre of buoyancy B	37
Figure 16 — Righting lever ( $GZ$ )	37
Figure 17 — Areas for moment versus heel angle	38
Figure 18 — Trochoidal profile	41
Figure 19 — Typical curves for longitudinal strength	41
Figure 20 — Typical use of pontoons	43
Figure 21 — Typical section through floating dock	45
Figure 22 — Stability of floating dock	46
Figure 23 — Mooring arrangement for a floating dock	47
Figure 24 — Maximum 3 s gust speed in metres per second at 10 m above the sea surface with an average recurrence period of 50 years	50
Figure 25 — Typical drag embedment anchors	51
Table 1 — Wind speed factors for use over the open sea	7
Table 2 — Wind force coefficient $C_f$ for rectangular bodies	9
Table 3 — Typical current drag coefficients for wall-sided boxes	11
Table 4 — Suggested criteria for selecting the capacity of mooring components	21
Table 5 — Chain catenary: geometry and tension applicable at all water depths	22
Table 6 — Approximate anchor efficiency	24
Table 7 — Typical inspection schedules	31
Table 8 — Partial load factor $\gamma_{FL}$ for floating structures	35
Table 9 — Typical values of metacentric height and range of stability	36
Table 10 — Derivation of trochoidal profile	41
Publications referred to	Inside back cover

# Foreword

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

This code of practice contains material which is both for the information and guidance of engineers and material which forms recommendations on good practice. As such conformity with its recommendations is not obligatory and variations from its recommendations may well be justified in special circumstances and engineering judgement should be applied to determine when the recommendations of the code should be followed and when they should not.

A code of practice is intended for the use of engineers having some knowledge of the subject. It embodies the experience of engineers successfully engaged on the design and construction of a particular class of works so that other reasonably qualified engineers may use it as a basis for the design of similar works.

It is not intended that it should be used by engineers who have no knowledge of the subject nor that it should be used by non-engineers.

A code of practice represents good practice at the time it is written and, inevitably, technical developments may render parts of it obsolescent in time. It is the responsibility of engineers concerned with the design and construction of works to remain conversant with developments in good practice, which have taken place since the publication of the code.

Following suggestions from the Maritime and Waterways Board of the Institution of Civil Engineers, the Standards Committee for Civil Engineering Codes of Practice set up an ad hoc panel to make further studies. The panel's report, presented in 1975, concluded that existing British codes were inadequate for the special aspects of maritime structures and that there was a need for such a code.

A format was proposed that divided the work into two distinct stages.

The standard will be issued in seven Parts 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<sup>1)</sup>;*
- *Part 4: Design of fendering and mooring systems;*
- *Part 5: Recommendations for the dredging of waterways and for land reclamation<sup>1)</sup>;*
- *Part 6: Design of inshore moorings and floating structures;*
- *Part 7: Design of breakwaters and training walls<sup>1)2)</sup>.*

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 is Mr J T Williams OBE, C Eng, FICE, F I Struct E and the following were members of the Technical Committee.

R W Bishop<sup>3)</sup> OBE, B Sc (Eng), C Eng, FICE  
 D F Evans C Eng, FICE, F I Struct E  
 M D Hazel<sup>3)</sup> B Sc (Eng), C Eng, FICE  
 D Kerr MICE  
 P Lacey C Eng, FICE, F I Struct E, FIHT, FRSA  
 J Read MA, C Eng, FICE  
 T F D Sewell<sup>3)</sup> B Sc (Eng), C Eng, FICE  
 P D Stebbings B Sc (Eng), C Eng, FICE  
 D Waite C Eng, F I Struct E, MICE, FFB  
 C J Whitlock<sup>3)</sup> M Sc, C Eng, FICE

<sup>1)</sup> In preparation.

<sup>2)</sup> To be issued initially as a draft for development.

<sup>3)</sup> Past member.