
**Ships and marine technology —
Combined rigging for deep-sea
mooring**

*Navires et technologie maritime — Gréement combiné pour
l'amarrage en haute mer*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 4, *Outfitting and deck machinery*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Ships and marine technology — Combined rigging for deep-sea mooring

1 Scope

This document specifies types, dimensions, tests and other technical requirements for combined rigging used for deep-sea mooring (hereinafter referred to as “combined rigging”).

This document is applicable to the combined rigging consisting of high modulus polyethylene (HMPE) fibre ropes, mooring chains, and shackles used for mooring and positioning offshore structures with depths of 1 000 m to 5 000 m.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 18692-3, *Fibre ropes for offshore stationkeeping — Part 3: High modulus polyethylene (HMPE)*

ISO 20438:2017, *Ships and marine technology — Offshore mooring chains*

3 Terms and definitions

No terms and definitions are listed in this document.

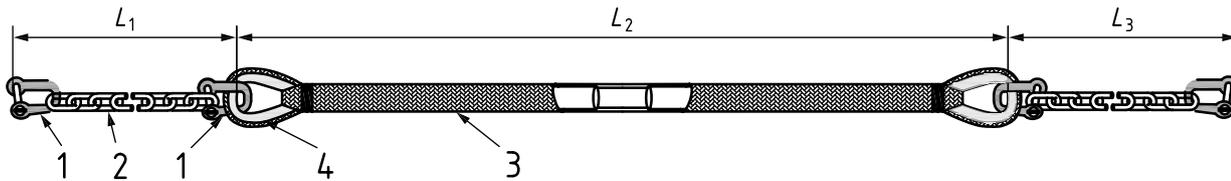
ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

4 Design

4.1 Structural types of combined rigging

The combined rigging consists of fibre ropes, mooring chains and shackles, as shown in [Figure 1](#).



Key

- L_1 length of the outlet end of mooring chains which connects with windlasses
- L_2 length of the middle part of combine rigging which is fibre rope
- L_3 length of the end of mooring chains which connects with anchors
- 1 shackle
- 2 mooring chain
- 3 fibre rope
- 4 thimble

Figure 1 — Combined rigging diagram

4.2 Combination design

4.2.1 The strength design of the combined rigging shall meet the following requirements:

- a) The strength of the fibre rope shall meet the minimum breaking strength at the end of service time.
- b) The ratio of the fibre rope and mooring chain shall be in accordance with [Annex A](#).
- c) The strength of the mooring chain shall meet the minimum breaking strength at the end of service time, and the corrosion allowance of the mooring chain should be as specified in [Annex B](#).
- d) The strength ratio of the mooring chain and fibre rope shall be 1,05 ~ 1,1. The size of the end link shall be 1,2 times that of the common link.
- e) The size of the shackle shall be identical to the size of the end link.

4.2.2 The length design of combined rigging shall meet the following requirements:

- a) The creep of the fibre rope shall be considered in the length design of L_1 and L_3 of mooring chain.
- b) The length of L_1 of mooring chain shall keep the fibre rope below the water surface from the period of structure installation finished until it is retired.
- c) The length of L_3 mooring chain shall keep the fibre rope from any friction with the seabed from the period of structure installation finished until it is retired.

5 Performance

5.1 Overall performance

5.1.1 The components of each combined rigging shall be firmly and reliably connected. The components of different combined rigging of the same specification shall be interchangeable.

5.1.2 The overall performance of the combined rigging specified in this document shall meet the design service time of not less than 10 years.

5.2 Fibre ropes

5.2.1 Composition

The fibre rope consists of a core rope, a particle-resistant isolating layer, a protective layer and thimbles at two ends.

5.2.2 Fibre rope performances

5.2.2.1 The raw material of fibre rope shall be HMPE fibre with high tenacity. The average tenacity shall not be less than 2 500 MPa (2,5 N/tex). If the protective layer is polyester fibre, the minimum tenacity shall be 730 MPa (0,73 N/tex). If other materials are used in the rope, they shall be identified according to the rope design / manufacturing specification, and the test method shall be in accordance with ISO 18692-3.

5.2.2.2 The strength of the braided fibre rope shall meet the minimum breaking strength (MBS) of the rope in [Table 1](#). The MBS of the rope shall be in accordance with ISO 18692-3. The minimum tenacity of the core rope shall be 1 300 MPa (1,3 N/tex). All test samples shall meet the minimum value of this document. The rope shall be constructed so as to prevent the infiltration of size from exceeding 20 µm or the size agreed by relevant parties.

Table 1 — Minimum breaking strength of fibre rope

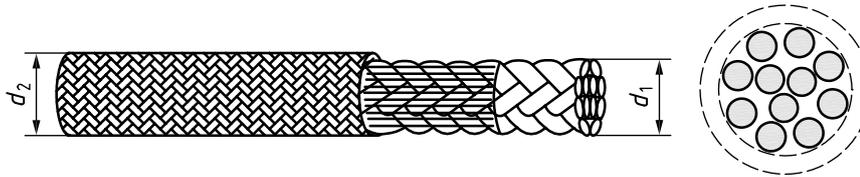
Reference number ^a	MBS (kN)
63	2 500
71	3 200
80	4 000
90	5 000
100	6 300
106	7 100
112	8 000
118	9 000
125	10 000
132	11 200
140	12 500
150	14 000
160	16 000
170	18 000
180	20 000

^a The reference number refers to the diameter of the core rope of the fibre rope. The actual diameter of the fibre rope may differ from its reference number.

5.2.3 Typical types

5.2.3.1 The core rope structure of the fibre rope is composed of a single braided structure or a parallel multi-bundle structure. The particle-resistant isolating layer is evenly covered between the core rope

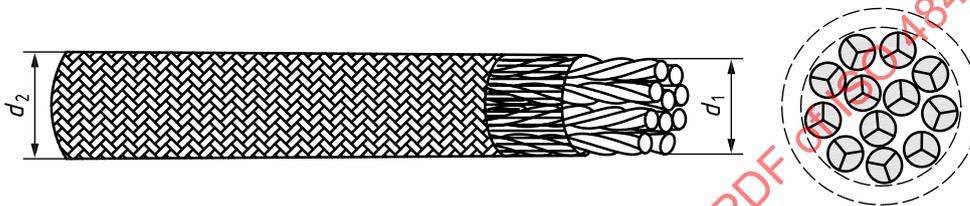
and the protective layer. The protective layer shall be wrapped outside the particle-resistant isolating layer. See [Figure 2](#) and [Figure 3](#) for the typical structure diagram.



Key

- d_1 diameter of rope core
- d_2 diameter of fibre rope consisting of a core rope, a particle-resistant isolating layer and a sheath

Figure 2 — Type A fibre rope



Key

- d_1 diameter of rope core
- d_2 diameter of fibre rope consisting of a core rope, a particle-resistant isolating layer and a sheath

Figure 3 — Type B fibre rope

5.2.3.2 The protective layer is used to protect the rope from mechanical damage during operation and use. The thickness of the protective layer shall be not less than 7,0 mm. The protective layer shall have at least one S-shaped and one Z-shaped coloured strand cross-woven to identify whether it is twisted.

5.2.3.3 Thimbles shall be installed at both ends of the fibre rope. The type of thimbles should be according to [Annex C](#). The thimble shall match the fibre rope and the shackle shall match the thimble.

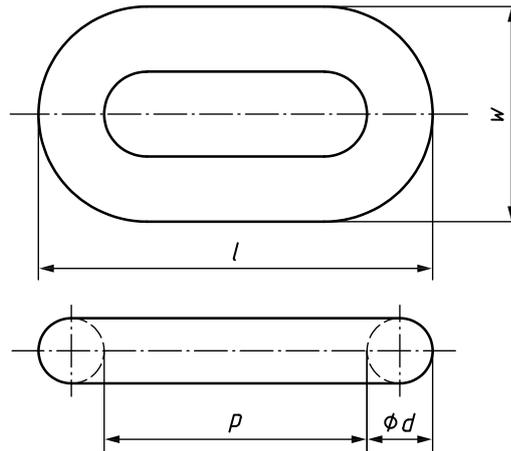
5.3 Mooring chains

5.3.1 Mooring chains performances

The material grade and performance of the mooring chains shall meet the requirements of ISO 20438:2017, Clauses 4 and 5. The breaking load of the mooring chains shall meet the requirements in of ISO 20438:2017, Table 2.

5.3.2 Typical types

The mooring chains shall be selected in accordance with the structural types and dimensions of studless chains specified in of ISO 20438:2017, Clause 6. The typical structure for studless chains is shown in [Figure 4](#).

**Key**

- w width
- l length
- p pitch length
- d nominal diameter

Figure 4 — Typical studless chain structure

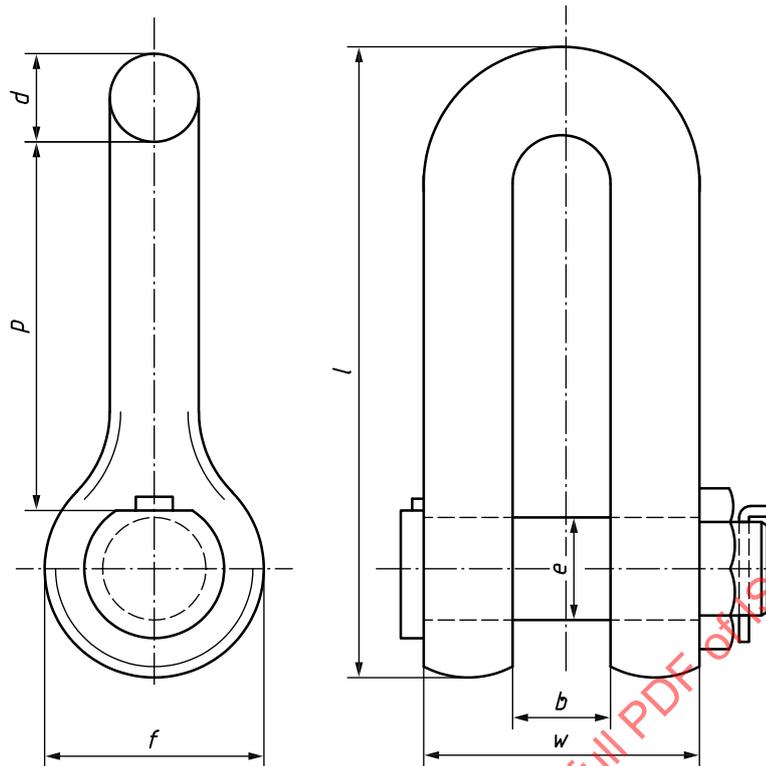
5.4 Shackles

5.4.1 Shackles performances

The material grade and performance of the shackle shall meet the requirements of ISO 20438:2017, Clauses 4 and 5.

5.4.2 Typical types

The shackle shall be connected to the mooring chain by a chain link of a suitable dimension. At the same time, the shackle shall match the dimension of the anchor and the fibre rope end loop. The shackle structure refers to the D-type shackle structure in ISO 20438:2017, Clause 6. The typical shackle structure for studless chains is illustrated in [Figure 5](#).



Key

- d* nominal diameter
- p* pitch length
- f* head width
- b* inner width

- l* length
- e* pin diameter
- w* width

Figure 5 — Typical shackle structure

6 Test

6.1 Make the 1:1 size template of the shackle to check the compatibility of the shackle with the fibre rope loop and chain link.

6.2 The template of the shackle shall meet the reliable connection of various components and the interchangeability of various components between different combinations of rigging of the same specification.

6.3 The test method of each component of the combined rigging shall be in accordance with the rules and corresponding standards of the classification society.

6.4 The minimum breaking strength test of the fibre rope, the minimum tenacity test of the core rope and the anti-particle penetration test shall be tested in accordance with ISO 18692-3. The creep properties of the fibre ropes shall be verified in accordance with the test method in ISO 18692-3.

6.5 The mechanical performance test and load test method of mooring chain and shackle can refer to the corresponding rules of classification society and should meet the performance requirements of ISO 20438:2017, Tables 1 and 2.

7 Marking and documents delivered

7.1 Marking

The combined rigging shall include the permanent marks with the following requirements.

- a) The fibre ropes of the rigging shall be clamped at the rope core with a continuous marking tape which includes the name of the manufacturer, rope specifications, minimum breaking strength requirements and the date of manufacture.
- b) The termination thimbles shall include the name of the manufacturer and bore size.
- c) The shackles shall include the name of the manufacturer and material grade code.
- d) The mooring chains shall include the name of manufacturer, as well as the grade code and the nominal diameter of the mooring chains.

7.2 Technical documents

The combined rigging shall be supplied with the following documents:

- a) test report and warranty of the combined rigging;
- b) dimensional inspection report of each component of the combined rigging;
- c) material report of each component of the combined rigging;
- d) certificate of qualification of the combined rigging, whose serial number is noted in all other certificates.

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Annex A (normative)

Ratio of fibre rope and mooring chain

The ratio of fibre rope and mooring chain is shown in [Table A.1](#).

Table A.1 — Ratio of fibre rope and mooring chain

Reference of fibre rope ^a	Diameter of mooring chain ^b <i>d</i> (mm)				
	R3 ^d	R3S ^d	R4 ^d	R4S ^d	R5 ^d
63	55	52	50	47	46
71	63	60	56	54	52
80	71	67	64	60	58
90	81	76	72	68	66
100	90	86	81	76	74
106	97	92	87	81	81
112	105	97	92	87	84
118	111	105	100	93	90
125	117	111	105	100	95
132	c	117	111	105	102
140	-	-	120	111	110
150	-	-	-	120	117
160	-	-	-	-	127
170	-	-	-	-	135
180	c	-	-	-	142

^a The reference number refers to the diameter of the core rope of the fibre rope. The actual diameter of the fibre rope can be different from its reference number.

^b This reference table does not consider the size of the mooring chain under corrosion and wear. In the actual design, the diameter of the mooring chain and shackle should be increased by referring to the wear amount in [Table B.1](#). The design requires a corrosion margin design with a life span of 10 years.

^c When the mooring chain shall be greater than 120, other auxiliary designs shall be considered to increase the overall buoyancy of the rigging.

^d R3 to R5 is the grade of chain steel refers to ISO 20438:2017.