INTERNATIONAL STANDARD

ISO 18692

First edition
2007-03-01

Fibre ropes for offshore stationkeeping — Polyester

Cordages en fibres pour le maintien en position des structures marines — Polyester

Reference number
ISO 18692:2007(E)

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Published in Switzerland

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 18692 was prepared by Technical Committee ISO/TC 38, *Textiles*.

Fibre ropes for offshore stationkeeping — Polyester

1 Scope

This International Standard specifies the main characteristics and test methods of new polyester fibre ropes used for offshore stationkeeping.

2 Normative references

The following referenced documents are indispensable for the application 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 1968, *Fibre ropes and cordage — Vocabulary*

ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

ASTM D 885, *Standard test methods for tire cords, tire cord fabrics, and industrial filament yarns made from manufactured organic-base fibers*

CORDAGE INSTITUTE CI 1503, *Test method for yarn-on-yarn abrasion*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1968 and the following apply.

3.1
breaking strength
BS
maximum force applied in straight tension to a rope, which causes it to rupture

3.2
core
central part which is the load-bearing part of the rope

3.3
cover
braided cover or other protective layer, which is placed over the rope core

NOTE The cover has no significant contribution to the rope strength.

3.4
dynamic stiffness
ratio of rope load to strain variations between the lower (trough) and upper (peak) stresses imposed during testing, normalized by the rope minimum breaking strength

See B.3.6.2.

3.5
marine finish
process and substance used on a fibre or yarn to improve the yarn-on-yarn abrasion performance of the product in a marine environment

3.6
marine grade fibre
fibre intended for use in a marine environment, that is provided with marine finish, and that has demonstrated performance in this respect

3.7
material certificate
document prepared by the manufacturer and the fibre producer certifying the type and grade of fibre material, the properties of the fibre, and that the material used in rope production is that which is specified in the rope design specification

3.8
minimum breaking strength
MBS
specified minimum value that the breaking strength of a rope shall achieve when tested following the procedure in this International Standard

NOTE In this International Standard, the specified MBS is that of a terminated rope.

3.9
prototype rope
rope fully complying with the rope design specification made for the purpose of testing either before an order is placed or before regular rope production begins for an order

3.10
qualified rope
rope already certified by the manufacturer as complying with the requirements laid down in this International Standard, including all the relevant prototype testing

3.11
recognized classification society
RCS
classification society being a member of the International Association of Classification Societies (IACS), with recognized and relevant competence and experience in fibre rope mooring, and with established rules/guidelines for related classification/certification activities

3.12
rope construction
manner in which the fibres, yarns and strands are assembled together in making the rope

NOTE In some rope constructions, rope core is made of sub-ropes, i.e. laid or braided ropes, that are assembled together by laying, braiding, or in parallel.

3.13
rope design specification
document which completely describes the design of the rope, including the numbers and arrangements of strands, the strand pitch, the material chemical composition and the manufacturing method

3.14
rope manufacturing specification
document which completely describes the process of making the rope, including instructions for each step of the manufacturing process

3.15
rope production report
document which completely describes the rope product, including rope design, termination design, and assembly length, and which includes the material certificates, material test results and the various checklists

3.16
rope termination
method (e.g. splice, potted socket, wedged socket) by which the rope is attached to the assembly interface

3.17
termination specification
document which completely describes the design of the termination and the process of making that termination, including materials and steps for making or assembling the termination

3.18
torque
moment that produces or tends to produce a twisting or a rotating motion around rope axis, i.e. the tendency of a rope to rotate due to a change in tension

4 Materials

4.1 Rope core material

4.1.1 Fibre tenacity

The fibre used in the core of the rope shall be high tenacity polyester fibre, with an average tenacity not less than 0,78 N/tex and in accordance with Annex A.

4.1.2 Marine grade

The polyester fibres used in the core shall be marine grade fibres.

The yarn-on-yarn abrasion performance shall be verified by tests on wet yarn, in accordance with Annex A, and it shall meet the requirements of A.4.2.1.4.

4.2 Rope cover material

When polyester yarn is used in the protective cover, its minimum tenacity shall be 0,73 N/tex and in accordance with Annex A.

4.3 Other materials

Other materials employed in rope assembly shall be identified in the rope design/manufacturing specification.

For each material, the following shall be specified, as applicable:

a) base material;

b) size (linear density, mass per unit area, …);

c) relevant strength properties (tenacity, hardness, …).

5 Requirements — Rope properties

5.1 Minimum breaking strength

The minimum breaking strength of the rope, when tested according to Clause 7 and Annex B, shall conform to Table 1.

Table 1 — Minimum breaking strength (MBS)

Reference number [a]	Minimum breaking strength kN
106	3 140
118	3 920
132	4 900
150	6 180
160	6 960
170	7 850
180	8 830
190	9 810
200	11 000
212	12 300
224	13 700
236	15 700
250	17 700
265	19 600

[a] The reference number corresponds to the approximate outer diameter of the rope, in millimetres (mm). Actual diameters may vary for a given reference number.

5.2 Minimum core tenacity

The rope minimum core tenacity shall be 0,47 N/tex, measured according to Annex B.

All samples tested shall comply with this minimum value.

5.3 Dynamic stiffness at end of bedding-in

The dynamic stiffness at the end of the bedding-in sequence, obtained at the time of the prototype testing in step 8 of the rope test procedure in B.3.1, shall be between 18 and 28.

NOTE A different range may be specified by the purchaser.

5.4 Torque properties

5.4.1 Torque-neutral rope

A rope is considered torque-neutral if it has a torque factor, Q, of less than 0,005.

$$Q = \frac{T}{d \cdot F}$$

where

Q is the torque factor;

d is the rope diameter, expressed in millimetres (mm);

F is the force applied to the rope, expressed in kilonewtons (kN);

T is the torque generated by the rope, expressed in newton metres (N·m).

The test method to demonstrate torque-neutral behaviour is defined in B.6.1.

Parallel construction ropes having braided sub-ropes or an equal number of left lay and right lay twisted sub-ropes which are all identical in every respect except for twist direction are inherently torque-neutral (see also 6.2). These constructions need not have their torque generation verified.

5.4.2 Torque-matched rope

A rope is considered torque-matched if its torsional characteristic over the design load range is essentially the same as that of the wire rope to which it is to be connected.

When tested as described in B.6.2, the angular rotation in the wire rope element shall not exceed 5° per rope lay.

5.5 Cyclic loading performance

The rope shall have demonstrated performance under cycling loading following the requirements of 7.1.6 and B.5.

5.6 Particle ingress protection

If specified, the rope shall be constructed with a protection of the core against the ingress of particles having a size greater than 20 µm (microns) or as agreed between involved parties. Testing of the protection shall be performed in accordance with B.7. The tests shall be performed on one rope size within the range of Table 1.

6 Requirements — Rope layout and construction

6.1 General

The typical section of a rope shall comprise a rope core, providing intended strength and stiffness, and a cover.

6.2 Type of construction

The rope shall be of one of the following types of construction:

— torque-neutral construction (type TF);

— torque-matched construction (type TM).

The type of rope shall be specified by the purchaser.

NOTE Torque-neutral ropes are intended for use in mooring systems together with chain or torque-neutral spiral strand wire ropes. Torque-matched ropes are intended for use in mooring systems together with six-strand wire ropes or other non torque-neutral wire ropes. Typical constructions are illustrated in Figures E.1 and E.2.

6.3 Rope core

6.3.1 The total number of yarns in the rope shall be at least the number specified in the rope design specification.

6.3.2 Splices are not allowed in the rope core nor in sub-ropes, except for those at the end terminations.

Strands shall be uninterrupted over the length of the rope, with no splice or strand interchange.

NOTE Yarns may be joined if necessary.

6.4 Protective cover

6.4.1 A protective cover shall be provided around the rope core to protect the rope core from mechanical damages (mainly abrasion) during handling and in service.

The protection shall be water-permeable.

6.4.2 A polyester braided protective cover shall have a minimum thickness of 7,0 mm.

Strand interchanges, i.e. the overlapping continuation of an interrupted strand with another identical strand following the same path, are permitted if they are properly staggered.

6.4.3 If an alternative protective cover is used, it shall demonstrate a level of protection equal to that of a polyester braided cover.

6.4.4 A braided cover shall include coloured strands forming a pattern so that rope twist during installation or in service can be identified. There shall be a minimum of one 'S' coloured strand and one 'Z' coloured strand to form a cross on the rope.

An alternative protective cover shall be fitted with an axial stripe of contrasting colour, or other means to identify rope twist during installation or in service.

6.5 Terminations

The terminations shall be made of an eye splice plus abrasion protection materials.

NOTE There may be other terminations provided that they do not jeopardize the rope performance.

The dimensions and arrangement of the eye shall match the diameter and groove shape of the thimble (or other interface piece) to be used for end connections, and shall be the same as for the rope prototype testing.

In the splice area, the integrity and the continuity of rope cover and particle-ingress protection, if fitted, shall be preserved or restored.

The eye and the splice area shall be further covered by an abrasion protection coating such as polyurethane.

Each termination shall be made according to the manufacturing practice as described in the termination specification.

6.6 Length of rope

The standardized bedded-in lengths of the rope sections shall be multiples of one hundred metres (100 m), calculated in accordance with 7.2.2, under 20 % of MBS, unless otherwise agreed on the purchase order or contract.

The calculated length of supplied rope shall be within ± 1 % of the specified length.

For each supplied rope, the actual length at the reeling tension or during manufacture shall be reported as an indicative value.

The length of short sections intended as inserts shall be mutually agreed between the purchaser and the manufacturer.

Adequate extra length shall be manufactured in order to prepare the samples for testing, which are considered to be part of the delivery.

7 Rope testing

7.1 Prototype testing

7.1.1 General

Prototype tests demonstrate that ropes certified by the manufacturer as complying with the requirements laid down in this International Standard possess the properties specified in this International Standard. The purpose of these tests is to verify the design, material and method of manufacture of each size of finished rope, including protective cover and terminations.

All ropes to be prototype tested shall comply with all the other requirements laid down in this International Standard. The tests specified below shall be carried out on a prototype rope for each size of rope, unless otherwise noted in this Clause 7.

Any change in the design, material, method of manufacture, including protective cover and terminations, which may lead to a modification of the properties as defined in Clause 5 shall require that the prototype tests specified in this International Standard be carried out on the modified rope.

7.1.2 Sampling

The number of rope samples to be tested is given in Table 2.

Table 2 — Number of samples for testing

Test	Number of samples
Breaking strength, core tenacity and stiffness	3
Torque properties	1 [a]
Linear density	1
Cyclic loading endurance	1 [b]

[a] See 7.1.4.

[b] See 7.1.6.

7.1.3 Breaking strength, core tenacity and stiffness tests

7.1.3.1 Three samples shall be tested according to the procedure specified in Annex B, and each shall be capable of meeting the requirements of 5.1 (minimum breaking strength), of 5.2 (minimum core tenacity) and of 5.3 (dynamic stiffness at end of bedding-in).

7.1.3.2 The rope core tenacity and dynamic stiffness at end of bedding-in shall be calculated according to the methods defined in B.3.

7.1.3.3 Measurement of the static stiffness and of the dynamic stiffness at other load levels shall be performed within the same tests.

These measurements are, however, not required when results are available for another qualified rope of the same design, material and method of manufacture, with a reference number of not less than 150.

NOTE 1 These measurements are performed for design purposes only. There are no acceptance criteria on these parameters.

NOTE 2 These measurements can be also performed on a separate rope sample (see B.3.5).

7.1.4 Torque properties tests

Where applicable, torque properties tests shall be performed according to the procedure specified in B.6. These tests are, however, not required when results are available for another qualified rope of the same design, material, method of manufacture and termination, with a reference number of not less than 150.

7.1.5 Linear density test

The linear density shall be calculated from the measured weight and elongation according to the method defined in B.4.

7.1.6 Cyclic loading endurance test

7.1.6.1 One sample shall be tested for cyclic loading. However, cyclic loading endurance tests performed with two different sizes of qualified ropes having the same design, material and method of manufacture including protective cover and terminations, are enough to qualify all sizes with an MBS between 50 % of the MBS of the smaller rope and 200 % of the other. The test for cyclic loading is not required if such data is available.

7.1.6.2 The cyclic loading endurance test shall be performed according to the procedure specified in B.5.

A load range shall be selected by the manufacturer, and the rope shall withstand, without breaking, at least the number of cycles for that load range, as given in Figure B.2.

NOTE The value of the breaking force shows the rope residual strength and it is only for information.

7.1.7 Protective cover thickness

The thickness of the protective cover shall be verified.

The thickness of a braided cover shall be measured as twice the thickness of cover strands under the maximum braiding tension.

7.2 Testing of current production

7.2.1 Sampling and testing

When the ropes are already certified by the manufacturer as complying with the requirements laid down in this International Standard, the rope tests, including breaking strength and core tenacity, as well as protective cover thickness verification, shall be performed on one sample taken from the manufacturing process for each type and size of rope.

7.2.2 Length measurement

The bedded-in length of each supplied rope section (other than short sections) shall be calculated from the linear density, ρ_l, by the following formula:

$$L = \frac{(m_T - m_S) \cdot 1000}{\rho_{l,20}}$$

where

L is the length of the rope in metres (m);

m_T is the mass of the total rope length in kilograms (kg);

m_S is the mass of the materials used to form the eyes and the splices in kilograms (kg);

$\rho_{l,20}$ is the linear density of the rope, in ktex, obtained from the prototype test, in accordance with 7.1.5.

The length of short rope sections (i.e. sections of less than 20 m) shall be measured at a load of 2 % of MBS as the length between the centres of termination fittings (i.e. same as L_u on Figure B.1).

8 Report

8.1 Prototype rope

A complete and detailed report of the prototype rope manufacturing shall be supplied, including the fibre manufacturer, the fibre type and finish and all rope characteristics that may influence the mechanical properties, like design, material specifications, method of manufacture, including protective cover and terminations, with sketches or pictures.

A complete and detailed report of type tests, with sketches or pictures of the test set-up, shall also be provided.

8.2 Current production

The manufacturing report of supplied ropes shall be provided. A complete and detailed report of rope tests with sketches and pictures of the test set-up shall also be provided.