

वस्त्रादि — अपतटीय स्टेशन के रखरखाव
के लिए रेशों से बनी रस्सियाँ
भाग 4 पॉलीएरिलेट

**Textiles — Fibre Ropes for
Offshore Station Keeping
Part 4 Polyarylate**

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भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुर शाह ज़फर मार्ग, नई दिल्ली - 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI - 110002

www.bis.gov.in www.standardsbis.in

NATIONAL FOREWORD

This Indian Standard which is identical to ISO 18692-4 : 2023 'Textiles — Fibre ropes for offshore stationkeeping — Part 4: Polyarylate' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on recommendation of the Cordage Sectional Committee and approval of the Textiles Division Council.

The text of ISO standard has been approved as suitable for publication as Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

- a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'; and
- b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to the following International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their respective places are given below along with its degree of equivalence for the editions` indicated.

<i>International Standard</i>	<i>Corresponding Indian Standard</i>	<i>Degree of Equivalence</i>
ISO 1968 Textiles — Fibre ropes and cordage — Vocabulary	IS 3871 : 2013/ISO 1968 : 2004 Fibre ropes and cordage — Vocabulary (<i>third revision</i>)	Identical
ISO 18692-1 : 2018 Fibre ropes for offshore station keeping — Part 1: General specification	IS 17929 (Part 1) : 2022/ISO 18692-1 : 2018 Fibre ropes for offshore station keeping: Part 1 General specification	Identical

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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Indian Standard

TEXTILES — FIBRE ROPES FOR OFFSHORE STATION
 KEEPING

PART 4 POLYARYLATE

1 Scope

This document specifies main characteristics and test methods of polyarylate fibre ropes used for offshore stationkeeping.

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 1968, *Fibre ropes and cordage — Vocabulary*

ISO 18692-1:2018, *Fibre ropes for offshore stationkeeping — Part 1: General specification*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1968, ISO 18692-1 and the following apply.

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/>

3.1

polyarylate

high-modulus fibre made from thermotropic liquid crystal aromatic polyester and produced by melt spinning

Note 1 to entry: An example of polyarylate chemical structure shows in [Figure 1](#).

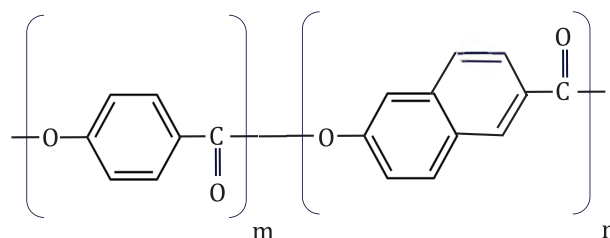


Figure 1 — Polyarylate chemical structure

3.2

axial compression fatigue

failure mode for fibre rope such as polyarylate under low tension or compression

4 Materials

The fibre used in the core of the rope shall be polyarylate fibre, with an average tenacity of not less than 1,8 N/tex, and qualified and tested in accordance with [Annex A](#).

Rope cover material and other materials employed in rope assembly shall be in accordance with ISO 18692-1.

5 Requirements — Rope properties

5.1 Minimum breaking strength

The minimum breaking strength (MBS) of the rope (spliced), when tested according to ISO 18692-1, shall conform to [Table 1](#).

Table 1 — Minimum breaking strength (MBS)

Reference number (RN) ^a	Minimum breaking strength kN
80	2 500
90	3 100
100	3 900
106	4 400
112	5 000
118	5 600
125	6 300
132	7 000
140	7 800
150	8 700
160	10 000
170	11 200
180	12 500
190	14 000
200	15 500
212	17 500
224	19 500

^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 minimum tenacity of the polyarylate rope core shall be 0,90 N/tex, measured according to ISO 18692-1. All samples tested shall comply with this minimum value.

5.3 Axial compression fatigue properties

The rope shall have demonstrated a residual strength not less than 95 % of MBS, following the axial compression fatigue test method in [Annex B](#) and additional information in [Annex C](#).

5.4 Torque properties

Torque-neutral rope or torque-matched rope shall be defined according to ISO 18692-1.

5.5 Cyclic loading performance

The rope shall have demonstrated performance under cycling loading following the requirements of ISO 18692-1.

5.6 Particle ingress protection

Unless otherwise specified, the rope shall be constructed with a protection of the core against the ingress of particles in accordance with ISO 18692-1.

6 Requirements — Rope layout and construction

Rope layout and construction shall be in accordance with ISO 18692-1.

7 Rope testing

7.1 Type test

7.1.1 General

Type tests shall be performed in accordance with ISO 18692-1 and the specific requirements of this clause.

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 ^d	3
Axial compression fatigue ^a	1
Torque properties ^b	1
Linear density	1
Cyclic loading endurance ^c	1
^a See 7.1.4 .	
^b See ISO 18692-1:2018, 7.1.4	
^c See ISO 18692-1:2018, 7.1.6	
^d See ISO 18692-1:2018, 7.1.3	

7.1.3 Breaking strength, core tenacity, and stiffness tests

The number of samples from [Table 2](#) shall be tested, and each sample shall be capable of meeting the requirements of [5.1](#) and of [5.2](#).

NOTE The measurements of the dynamic stiffness at end of bedding-in — and, when required, those of the quasi-static stiffness and the dynamic stiffness at several mean load level — are performed for design purposes only. There are no acceptance criteria on these parameters.

7.1.4 Axial compression fatigue properties test

One sample shall be tested for axial compression fatigue properties.

There is no need to perform this test when data are available from the previous qualification test of another rope with the same design, material and method of manufacture of rope core, and a size not less than reference number 90.

7.1.5 Torque properties tests

Where applicable, torque properties tests shall be performed according to the procedure specified in ISO 18692-1:2018, 7.1.4 and Annex B.

7.1.6 Linear density test

The linear density shall be calculated from the measured mass and elongation according to the method defined in ISO 18692-1:2018, 7.1.5 and Annex B.

7.1.7 Cyclic loading endurance test

The cyclic loading endurance test shall be performed according to the procedure specified in ISO 18692-1.

The residual strength of the rope shall be not less than 80 % of the MBS.

7.1.8 Protective cover thickness

The thickness of the protective cover shall be verified. See ISO 18692-1:2018, 7.1.7.

7.1.9 Particle ingress protection

See [5.6](#) and ISO 18692-1:2018, Annex B.

7.2 Testing of current production

Testing of current production shall be in accordance with ISO 18692-1:2018, 7.2.

8 Report

The report shall be in accordance with ISO 18692-1.

9 Certification

Certification shall be in accordance with ISO 18692-1.

10 Marking, labelling, and packaging

The marking, labelling, and packaging shall be in accordance with ISO 18692-1.

Annex A **(normative)**

Fibre qualification and testing

A.1 General

Fibre qualification and testing shall be in accordance with ISO 18692-1:2018, Annex A, and the following requirements.

A.2 Fibre testing — Hydrolysis properties of polyarylate fibres

The material shall have a residual strength of at least 90 % of its nominal value (new fibre), after immersion for two weeks in 80 °C water (alternatively 20 weeks at 60 °C).

NOTE The water for this test can be either natural or artificial seawater (e.g. ASTM D 1141).

Testing may be performed on fibres or small cords (braided or twisted).

Accelerated test based on a factor 1 000 in time over 60 °C increase of temperature, e.g. see ISO 9080, to simulate the conditions of a mooring line (20 years in seawater at 4 °C to 20 °C). Test duration may be adjusted if this can be documented by suitable test data.

Annex B (normative)

Axial compression fatigue properties test

B.1 General

This annex specifies a testing method for axial compression fatigue properties test of polyarylate ropes for offshore station keeping.

B.2 Testing conditions

B.2.1 Rope samples

The axial compression fatigue tests shall be performed on one sample of the full-size rope. Terminations of samples shall be identical to those used in supplied ropes.

Termination fittings shall be provided, with the same type of material and the same profile and dimensions (radius, groove shape) as the thimbles for the supplied rope.

B.2.2 Ambient conditions

The axial compression fatigue test shall be performed under ambient conditions similar to those described for cyclic loading endurance test (see ISO 18692-1:2018, B.2.2).

B.2.3 Testing machine and measurement

The testing machine and the measurement system shall be in accordance with the provisions of ISO 18692-1:2018, B.2.3 and B.2.4. The machine shall be capable of accurately controlling the trough load at 1 % of MBS.

B.3 Testing

B.3.1 Test procedure

The axial compression fatigue test shall be performed according to the steps below:

- a) sample shall be soaked for at least 4 h in fresh water;
- b) test piece shall be installed in the test machine;
- c) load of 2 % of MBS shall be applied;
- d) extensometer shall be installed in a section of the rope undisturbed by the termination;
- e) tension of 50 % of the rope MBS shall be applied at a rate of 10 % MBS/min and held for 30 min;
- f) tension shall be reduced to 20 % of the rope MBS, at a rate of 10 % MBS/min;
- g) cycling tension between 10 % and 30 % of the rope MBS shall be applied 300 times at a frequency between 0,03 Hz and 0,1 Hz;
- h) cycling tension between 1 % and 20 % of the rope MBS shall be applied 2 000 times at a frequency between 0,03 Hz and 0,1 Hz;

- i) unload the sample and pull the rope to failure at a loading rate of approximately 20 % of MBS/min.

B.3.2 Recorded data

The following data shall be recorded:

- type and length of the sample, linear density, and MBS;
- applied cyclic tension load;
- residual strength and as % of MBS.

Annex C (informative)

Additional information and guidance — Axial compression fatigue properties

C.1 Axial compression fatigue of polyarylate fibres

The main characteristics of polyarylate fibre that make it attractive for mooring applications are its high strength, high modulus, and low creep properties. However, compared with PET fibres, polyarylate fibre is more susceptible to damage from axial compression fatigue. In a rope, this effect will appear when subjected to tension-tension cycles at the low loads.

Care should be taken to properly design and test polyarylate ropes for axial compression fatigue performance in order to ensure endurance of the rope in station keeping use.

C.2 Technical considerations

C.2.1 To avoid failures due to improper design of a rope, it is important to understand and distinguish the factors that play a role in causing compression fatigue. Compression fatigue should be separated in the following effects.

- a) Tension-tension fatigue due to cycling at low loads.

Cycling at low loads in general gives more damage to materials than cycling the same range at a higher load. The cause of this fatigue effect is partly from the fact that these fibres are less abrasion resistant.

During the low load cycling, the movement in a rope is relatively high, causing abrasion.

- b) Compression of filaments due to length differences, e.g. in the splice area.

Data on polyarylate fibres indicate that, when filaments are compressed for more than a 0,5 % strain, a weak spot will be created, which is generally referred to as a kink-band. When the fibre is subjected to 0,5 % or less compressive strain, studies have shown that no strength loss is found, even after several hundred thousand of cycles. Especially when filaments are locked into their position, this effect will appear. This affects the splice area (and ropes with large length differences within the rope, also causing low strength efficiency).

C.2.2 The risk from the axial compression fatigue can be minimized by the following methods.

- a) Improve rope design to minimize local compression, especially in the splice areas.
b) Establish proper rope minimum tension criteria and analysis procedure.
c) Conduct rope axial compression fatigue test to demonstrate adequate resistance to failure.

Bibliography

- [1] ISO 139, *Textiles — Standard atmospheres for conditioning and testing*
- [2] ISO 2060, *Textiles — Yarn from packages — Determination of linear density (mass per unit length) by the skein method*
- [3] ISO 9080, *Plastics piping and ducting systems — Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation*
- [4] ASTM D 1141, *Standard Practice for the Preparation of Substitute Ocean Water*
- [5] ASTM D 7269, *Test Methods for Tensile Testing of Aramid Yarns*
- [6] MCKENNA H.A., HEARLE J.W.S., O'HEAR N., *Handbook of fibre rope technology*. Woodhead Publishing, Cambridge, England, 2004, pp. 366.
- [7] ASSAYAG M.I., CASTRO G. Minami, K., Assayag, S., *Campos Basin: A Real Scale Lab for Deepwater Technology Development*, OTC 8492, 1997
- [8] CHI C.H., LUNDHILD E.M., VESELIS T., HUNTLEY M.B. *Enabling ultra-deepwater mooring with aramid fiber rope technology*, OTC 20074, 2009
- [9] SAITO H., INABA S., NAKAHASI M., KATAYAMA T., KIMPARA I. "Residual Strength of Organic Mono-Filaments After Compressive Loading." Proceedings 18th International Conference on Composite Materials, ICCM-18, Jeju, Korea, August 21-26, 2011

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BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002

Telephones: 2323 0131, 2323 3375, 2323 9402

Website: www.bis.gov.in

Regional Offices:

Central : 601/A, Konnectus Tower -1, 6th Floor,
DMRC Building, Bhavbhuti Marg, New
Delhi 110002

Telephones

{ 2323 7617

Eastern : 8th Floor, Plot No 7/7 & 7/8, CP Block, Sector V,
Salt Lake, Kolkata, West Bengal 700091

{ 2367 0012
{ 2320 9474

Northern : Plot No. 4-A, Sector 27-B, Madhya Marg,
Chandigarh 160019

{ 265 9930

Southern : C.I.T. Campus, IV Cross Road, Taramani, Chennai 600113

{ 2254 1442
{ 2254 1216

Western : 5th Floor/MTNL CETTM, Technology Street, Hiranandani Gardens, Powai
Mumbai 400076

{ 25700030
{ 25702715

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