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Rubber threads — Methods of test

Fils élastiques — Méthodes d'essai

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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 2321 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 4, *Products (other than hoses)*.

This third edition cancels and replaces the second edition (ISO 2321:1983), which has been technically revised.

Rubber threads — Methods of test

1 Scope

This International Standard specifies methods of test for determining general physical and mechanical properties of rubber threads, as well as specific mechanical properties of such threads in contact with fabrics. Owing to the comparatively small cross-section and the unusual conditions of service of this material, certain special methods have been developed.

Some of the tests included in this International Standard may not be entirely suitable for threads made from certain synthetic rubbers (e.g. urethane rubber). These tests are intended for natural or synthetic polyisoprene rubbers.

It is pointed out that comparisons may only be made on new rubber threads or on those with identical processing histories. In the interpretation of results from threads which have been subjected to spooling, fabrication or any other process, it should be borne in mind that the previous history is important, and what is known of this and of any relaxation treatments used shall be stated in the test report.

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 37, *Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties*

ISO 105-A02, *Textiles — Tests for colour fastness — Part A02: Grey scale for assessing change in colour*

ISO 105-A03, *Textiles — Tests for colour fastness — Part A03: Grey scale for assessing staining*

ISO 188, *Rubber, vulcanized or thermoplastic — Accelerated ageing and heat resistance tests*

ISO 648, *Laboratory glassware — One-mark pipettes*

ISO 1042, *Laboratory glassware — One-mark volumetric flasks*

ISO 1183-2, *Plastics — Methods for determining the density of non-cellular plastics — Part 2: Density gradient column method*

ISO 23529, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

3 Conditioning of samples or test pieces

The samples or test pieces shall be kept in a relaxed state in one of the standard atmospheres described in ISO 23529, for not less than 16 h before testing. The tests shall be carried out under similar atmospheric conditions. The test piece selected shall be clean, dry and free from any visual defects. Samples or test pieces shall not be allowed to come into contact with copper or manganese or their compounds during conditioning or testing.

4 Count

4.1 Sectional count

The sectional count of a rubber thread is given by the value of its cross-sectional area, expressed in square millimetres.

NOTE The sectional count corresponds to the tex count for a nominal density of 1 Mg/m^3 (= $1 g/cm^3$). The use of the sectional count is recommended.

4.2 Conventional count (size number)

4.2.1 The conventional count of a rubber thread is the number of threads which, when placed side by side, measure 25,4 mm.

The conventional count of a round thread is calculated by dividing 25,4 by the diameter, in millimetres, of the thread.

The conventional count of a square thread is calculated by dividing 25,4 by the length, in millimetres, of one of the sides of the thread.

The conventional count of a rectangular thread is generally quoted as the count of a square thread of equivalent cross-sectional area.

Thus, in the case of a round thread, the number 100 is the conventional count of a thread whose diameter is equal to 0,254 mm; in the case of a square thread, the number 40 is the conventional count of a thread whose sides are equal to 0,635 mm.

4.2.2 It is customary to quote the conventional count of a round thread, followed by the whole even number which is nearest to the actual conventional count of the square thread of equivalent cross-sectional area (count of round thread × 1,13 = actual count of square thread).

EXAMPLE A round thread of count 50 is indicated by 50/56.

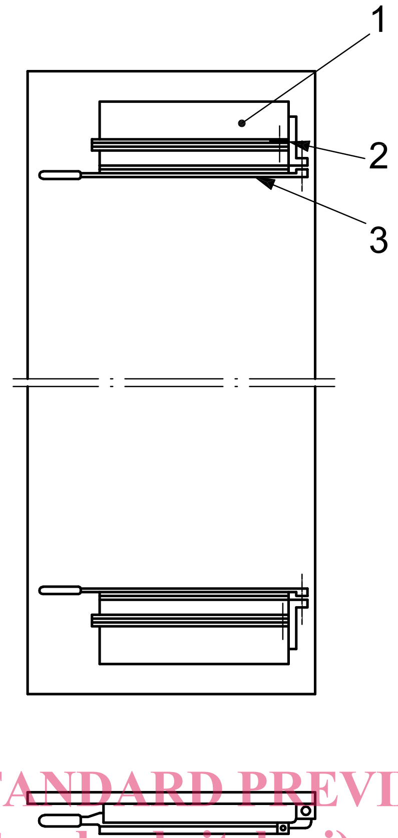
4.2.3 The conventional count of a multi-filament round thread is expressed by stating successively the number of components, the count of the single round thread which would have the same total cross-sectional area as the component threads, and the count of the corresponding square thread.

EXAMPLE The conventional count of a multi-filament round thread made up of three components equal in total cross-sectional area to a round thread of count 32 is indicated by 3/32/36.

4.3 Apparatus

See Figure 1.

The apparatus for cutting the test pieces consists of a rectangular vertical frame at the upper and lower ends of which are mounted two metal plates whose inside edges are parallel and sharp. Two cutting devices (the fixed blade of which consists of the inside edge of the metal plate) and two external clamps are provided. The clamps shall be of a spring-loaded type and the distance between the internal edges of the metal plates shall be 100 mm ± 1 mm.



Key

1 metal plate
2 clamp
3 cutting device

Figure 1 — Apparatus for cutting test pieces

4.4 Procedure

4.4.1 Cutting out the test pieces

Take five strips of thread samples and cut them to a length of approximately 110 mm.

Tear off threads equally from both edges of each strip till there are only ten threads in each strip. If these strips are taken from bobbins or from any other type of presentation in which the strip is under tension, heat-treat them for 30 min in a thermostatically controlled oven at a temperature of 70 °C ± 2 °C. After this heat treatment, condition the strips as specified in Clause 3. For strips taken from other forms of presentation where no tension is applied to the strip, condition as specified in Clause 3.

Suspend each conditioned strip from the upper clamp. When it has settled in the vertical position without stretch, fix it by means of the lower clamp. Cut the strip to the required length with the two cutting devices, using the lower one first.

4.4.2 Weighing the test pieces

Free the cut strips from any loose dusting powder by shaking or brushing them gently and weigh to an accuracy of ± 1 %.

4.5 Expression of results

4.5.1 The sectional count, S, is given by the equation:

$$S = \frac{m}{\rho} \times \frac{1}{1000}$$

where

ρ is the density, expressed in megagrams per cubic metre, of the thread, determined as specified in Clause 7;

m is the mass, in milligrams, of the strip.

4.5.2 The conventional count, C, is given by the following equations:

For round thread

$$C = 22{,}51\sqrt{\frac{\rho}{m}}$$

For square thread

$$C = 25{,}40\sqrt{\frac{\rho}{m}}$$

where

ρ is the density, expressed in megagrams per cubic metre, of the thread, determined as specified in Clause 7;

m is the mass, in milligrams, of the strip.

4.5.3 Express the count of the thread as the median of the values for the five test pieces as indicated in 4.2.3. The maximum and minimum values obtained shall also be stated.

5 Metric yield

5.1 Terms and definitions

For the purposes of this clause, the following terms and definitions apply.

5.1.1
metric yield
unstretched length, in metres, of 1 000 g of thread

5.2 Procedure

Determine the mass of each of five test pieces as specified in 4.4.2.

5.3 Expression of results

5.3.1 The metric yield of rubber thread, expressed in metres per kilogram, is given by the formula:

$$\frac{1000}{m}$$

where m is the mass, in grams, of 1 000 mm of thread.

5.3.2 Express the metric yield of the thread as the median of the values for the five test pieces.

6 Properties of rubber threads

Properties of rubber threads are made up of two kinds: general physical and mechanical properties, and specific mechanical properties of the threads in contact with fabrics. They shall be determined by the test methods specified in Table 1 and Table 2, respectively.

Table 1 — General properties of rubber threads

Physical and mechanical properties	Clause No.
Density	7
Tensile strength, modulus, elongation at break	8
Schwartz value (SV)	9
Elongation under a specified load	10
Stress retention	11
Accelerated-ageing test on rubber threads in a relaxed state	12
Dry-heat resistance test	13

Table 2 — Specific properties of rubber threads

Mechanical properties in contact with fabrics	Clause No.
Ribbons: Degree of adhesion between threads	14
Resistance to copper staining during laundering	15
Effect of washing	16
Resistance to atmospheric fume staining	17

7 Density

7.1 Terms and definitions

For the purposes of this clause, the following terms and definitions apply.

7.1.1
density (of thread)
mass per unit volume of a test piece of thread measured at a standard laboratory temperature and expressed in megagrams per cubic metre

NOTE The standard laboratory temperatures are given in ISO 23529.

7.2 Principle

Test pieces are placed in a suitable mixture of liquids, the density of which is adjusted until the test pieces neither float nor sink; this density is determined.

7.3 Methods

7.3.1 Method A

7.3.1.1 Most of the rubber threads on the market have a density in the range of 0,90 Mg/m^3 to 1,11 Mg/m^3. It is necessary, therefore, to have a series of liquids having densities within this range. Mixtures of ethanol (0,79 Mg/m^3) and ethylene glycol (1,11 Mg/m^3) are suitable.

For threads of greater density, a suitable inorganic salt solution may be used. A solution of sodium chloride is suitable.

7.3.1.2 Before the mixtures are used, it shall be ensured that they are homogeneous and free from air bubbles. They shall be kept in closed containers so as to avoid evaporation. They shall be used at a temperature of 20 °C ± 2 °C.

7.3.1.3 Apparatus

7.3.1.3.1 Glass cylinder, of capacity about 1 000 cm^3.

7.3.1.3.2 Hydrometer or **hydrostatic balance** or **other apparatus** allowing measurement of the density of liquids to an accuracy of at least 0,005 Mg/m^3.

7.3.1.4 Procedure

7.3.1.4.1 Take four test pieces approximately 10 mm long from the sample. Dip each test piece in ethanol and then rub between the fingers to remove dusting powder and any air bubbles from the surface.

7.3.1.4.2 Take a suitable liquid mixture (see 7.3.1.1) and thoroughly homogenize it, taking care not to introduce any air bubbles. Place one of the test pieces in the liquid. Adjust the density of the liquid by addition of the appropriate component, mixing thoroughly after each addition. Continue this adjustment until the test piece neither sinks nor floats.

7.3.1.4.3 Test the other three test pieces in the mixture; at least two of these three test pieces shall reach equilibrium within a period of 3 min to 10 min.

7.3.1.4.4 Determine the density of the liquid mixture to the nearest 0,005 Mg/m^3.

7.3.2 Method B

Determine the density of the test pieces in accordance with ISO 1183-2.

8 Tensile strength, modulus and elongation at break

8.1 Terms and definitions

For the purposes of this clause, the following terms and definitions apply.

8.1.1
tensile strength
stress at which the thread breaks when it is stretched under specified conditions, the value being expressed in megapascals[1)], based on the initial cross-sectional area

8.1.2
modulus at 300 % and 500 %
stress, measured in megapascals[1)], calculated with respect to the original cross-sectional area, at 300 % and 500 % elongation

8.1.3
elongation at break
increase in length of the thread at break when it is stretched under the specified conditions, expressed as the percentage increase in the original length

EXAMPLE A test piece 30 mm in length which increases in length to 210 mm at break is said to give an elongation at break of 600 %.

8.2 Apparatus

8.2.1 Loop-forming machine.

8.2.2 Tensile-testing machine, as described in ISO 37, with O-ring grips.

8.3 Procedure

8.3.1 Test piece preparation

The thread test piece is allowed to relax at room temperature for 60 min to ensure that all stresses in the thread have been released. It is then weighed and the average diameter of the thread calculated.

Using a loop-forming machine, the rubber thread is made into a loop and the ends tied securely. The diameter of the loop is dependent on the distance between the two cylinders of the tensile-testing machine (see 8.3.2). Usually, these are set 100 mm apart. The total number of loops for each test piece is dependent on the count of the thread and the load capacity of the tensile tester. The more loops, the greater the total cross-sectional area and hence the greater the force which will be needed to stretch the test piece to breaking point.

8.3.2 The test piece is looped over the two cylinders of the tensile tester. The loop diameter shall be such that it fits exactly over the two cylinders without stretching.

The tensile tester is then run to stretch the test piece to breaking point. The machine is set to read the modulus at 300 % and 500 %, the tensile strength and the elongation at break. Depending on the complexity of the machine, usually the cross-sectional area of the loop is entered into the machine and the modulus and tensile strength are then automatically calculated and printed out on a printer or displayed on a computer screen. The elongation at break, calculated as the percentage stretch relative to the original length (100 mm), is automatically displayed by the tensile tester on completion of the test.

Test five test pieces.

1) 1 MPa = 1N/mm^2

8.4 Expression of results

Modulus at 300 % (in mN/mm^2) = F_{300}/A

Modulus at 500 % (in mN/mm^2) = F_{500}/A

Tensile strength (in mN/mm^2) = F_B/A

Elongation at break (in %) = $\frac{L_B - L_0}{L_0} \times 100$

where

F_{300} is the force, in millinewtons, necessary to stretch the test piece to 300 %;

F_{500} is the force, in millinewtons, necessary to stretch the test piece to 500 %;

F_B is the force, in millinewtons, necessary to stretch the test piece to the break point;

A is the total cross-sectional area, in square millimetres, of the test piece.

L_B is the length at break of the test piece;

L_0 is the original length of the test piece.

Express the tensile strength, modulus and elongation at break of the thread as the median of the values for the five test pieces. The maximum and minimum values shall also be quoted. In addition, the test report shall indicate the type of apparatus used and the procedure followed.

9 Schwartz value (SV)

9.1 Terms and definitions

For the purposes of this clause, the following terms and definitions apply.

9.1.1
Schwartz value
average of the stresses, in megapascals, calculated with respect to the original cross-sectional area at a specified elongation measured on extension and retraction of a previously massaged (mechanically conditioned) thread

NOTE 1 It is denoted by the abbreviated term SV_n^c, where c is the massaging elongation (the elongation to which the test piece is stretched during mechanical conditioning) and n the elongation at which the readings are taken. Both c and n are expressed as percentages of the initial length as multiples of 100 and, unless otherwise specified, are chosen so that

$c = n + 100$

NOTE 2 The preferred values of n are 300 % and 500 %, depending on the type of thread under test.

9.1.2
Schwartz hysteresis ratio
ratio of the loads at a specified elongation measured on extension and retraction, after massaging (mechanical conditioning)

NOTE 1 It is denoted by the abbreviated term SHR_n^c, where c is the massaging elongation (the elongation to which the test piece is stretched during mechanical conditioning) and n the elongation at which readings are taken. Both c and n are expressed as percentages of the initial length as multiples of 100 and, unless otherwise specified, are chosen so that

$c = n + 100$

NOTE 2 The preferred values of n are 300 % and 500 %, depending on the type of thread under test.