INTERNATIONAL STANDARD

ISO 2307

Second edition
1990-09-15

Ropes — Determination of certain physical and mechanical properties

Cordages — Détermination de certaines caractéristiques physiques et mécaniques

Reference number
ISO 2307:1990(E)

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.

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.

International Standard ISO 2307 was prepared by Technical Committee ISO/TC 38, *Textiles*.

This second edition cancels and replaces the first edition (ISO 2307:1972) and ISO 1142:1973, of which it constitutes a technical revision.

Annexes A, B and C form an integral part of this International Standard. Annex D is for information only.

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland
Printed in Switzerland

Ropes — Determination of certain physical and mechanical properties

1 Scope

1.1 This International Standard specifies, for ropes of different kinds, a method of determining each of the following characteristics:

— net mass per metre;

— lay;

— elongation;

— tensile strength.

1.2 The first two characteristics (net mass per metre and lay) are measured with the rope under a specified tension called the reference tension.

NOTE 1 Knowledge of the net mass per metre, measured in accordance with this International Standard, also makes it possible to calculate the net length (under reference tension) of a rope by dividing the total net mass of the rope (without lashings or packing material) by the mass per metre, both of these masses being measured after the same conditioning.

1.3 The third characteristic (elongation) corresponds to the measured increase in length of the rope when the tension to which it is subjected is increased from an initial value (reference tension) to a value equal to 75 % of the minimum specified breaking strength of the rope.

1.4 The fourth characteristic (tensile strength) is the maximum load registered (or reached) during a breaking test on the test piece, carried out on a tensile testing machine with constant rate of traverse of the moving element. The breaking strength values given in the tables of rope specifications are only valid when this type of testing machine is used. When it is not possible to test the whole section of rope, the method described in annex B can be used, subject to agreement between the parties involved.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 139:1973, *Textiles — Standard atmospheres for conditioning and testing*.

3 Principle

3.1 Calculation of the net mass per metre

The net mass per metre is obtained by measurement of the mass and length, under a reference tension, of a conditioned test piece.

3.2 Measurement of the lay

This measurement is taken at the time of application of the reference tension.

3.3 Measurement of the elongation of the rope

This measurement is taken by comparing the lengths of a section of the test piece which has been subjected successively to

— the reference tension;

— a tension equal to 75 % of the minimum specified breaking load for the rope.

3.4 Measurement of breaking strength

This measurement is carried out by increasing the previous tension to breaking point.

4 Apparatus

4.1 Tensile testing machine, accommodating the assumed breaking strength of the rope, which allows a constant rate of traverse of the moving element as stipulated in 8.4 and measurement of breaking load to an accuracy of 1 %.

Different types of tensile testing machine may be used: a machine with wedge grips, pulley-type grips ("cors de chasse"), or bollards to take eye-spliced test pieces. In the last case, the diameter of the bollards passing through the eye-spliced test pieces shall be at least double the diameter of the rope to be tested.

In the case of the cors de chasse tensile testing machine, the diameter of the pulleys or catches holding down the test pieces shall be at least equal to 10 times that of the rope being tested.

4.2 Balance, of the appropriate capacity, allowing measurement of mass to an accuracy of 1 %.

5 Sampling

5.1 Composition of the batch to be sampled

Samples shall be taken from a homogeneous batch, i.e. consisting of ropes of the same size and same dimensions and which have been subject to the same series of manufacturing operations and the same checking procedure.

5.2 Selecting the samples

Unless otherwise agreed between the parties, take at random from the batch the number of samples S obtained from the following equation:

$$S = 0{,}4\sqrt{N}$$

where N is the number of coils making up the batch.

Where the calculated value of S is not a whole number, the number obtained shall be rounded to the nearest whole number, for example 27,5 and 30,35 shall be rounded to 28 and 30, respectively. Where $S < 1$, take one sample length.

6 Test pieces

6.1 Length

The test piece shall be of adequate length to give an effective length (see 8.2) at least equal to the one given in table 1, when mounted on the tensile testing machine.

Table 1 — Effective lengths

Type of rope	Type of testing machine	Minimum effective length L_u necessary for testing mm
Man-made fibre ropes, reference number ⩽ 10	All types	400
Man-made fibre ropes, reference number > 10	Wedge grip or cors de chasse machines	600
	Other types	1 800
Natural fibre ropes	All types	2 000

6.2 Number of test pieces

Take a test piece from each sample.

6.3 Taking the test pieces

Take the test piece either from one end of the samples, or from the body of the samples if these are intended to be cut. Take all necessary steps to prevent unlaying. If necessary, remove slightly unlaid ends.

7 Conditioning

In general the test is carried out when the test piece has been lying for some time on a flat surface in the ambient atmosphere.

In the event of dispute, leave the test piece for at least 48 h in an atmosphere specified in ISO 139.

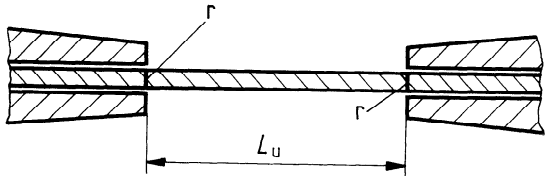
8 Procedure

8.1 Initial measurements

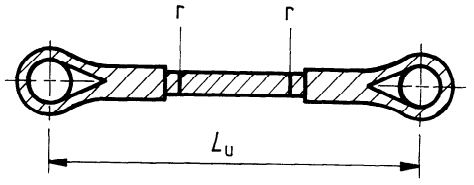
Lay the test piece out straight without noticeable tension on a flat surface. Measure its length. Let L_0 be this length, expressed in metres to the nearest 1 %.

Make two marks on the test piece, spaced symmetrically with regard to its mid-point, and at a distance apart l_0 which is greater than 0,5 m.[1)]

Determine the mass of the test piece. Let m be this mass, expressed in grams to the nearest 0,5 %.

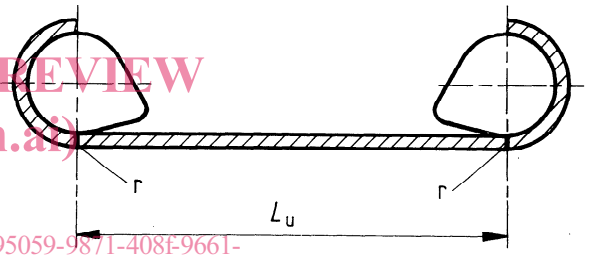


a) **Wedge grip testing machine**



NOTE 2 The marks r are situated 150 mm from the last turn of the splice.

b) **Testing machines with bollards for eye splices**



NOTE 3 The distance r r, in millimetres, is three times the lay.

c) **Cors de chasse testing machine**

r = limiting marks for the standard test;

L_u = effective length measured with no tension, the test piece simply being held straight.

Figure 1 — Effective length L_u for each of the three main types of tensile testing machine

8.2 Mounting the test piece on the testing machine

Fix the ends of the test piece between the wedge grips or on the cors de chasse or by its eye splices, depending on the type of testing machine used, in order to obtain the effective length of test piece specified in 6.1.

In the case of a test on splices, the eyes shall have an internal length of between 250 mm and 300 mm when closed; their production is left to the manufacturer's discretion. In the case of man-made fibre ropes, it is recommended that the ends of the splices be tapered to finish.

Marks r limiting the section of the test piece in which rupture is considered as normal shall be positioned as shown in figure 1.

8.3 Measurement of lay, diameter and gauge length

Apply the reference tension specified for the type of rope being tested[2)] to the test piece and measure

- the length between n complete turns of the same strand or, in the case of plaited rope, the distance between n successive plait points. Let l_1 be this length, expressed in metres.
- the distance between the two marks. Let l_2 be this distance, expressed in metres to the nearest 0,5 %.

8.4 Measurement of the elongation of the rope

Increase the tension again by moving the moving element of the testing machine at a constant rate, selected in such a way that the rate of traverse per minute has a value of between 6 % and 10 % of the effective length of the test piece. For all man-made

1) In the case of man-made fibre ropes with a reference number of $\leqslant 10$ which have a test piece of effective length such that two marks cannot be made at a distance apart $l_0 \geqslant 0{,}5$ m and the distance l_2 between these marks cannot be measured as indicated in 8.3, the value l_0 may be obtained by placing 2 marks at least 0,5 m apart on a sample of rope laid out on a flat surface with no noticeable tension; the value l_2 is obtained by applying the appropriate tension by means of weights and a pulley.

2) See annex A which gives the reference tension to be applied for each type of rope.

fibre ropes, the rate of traverse of the moving element shall not exceed 250 mm/min.

When the tensile force reaches 75 % of the minimum breaking force, measure the distance between the marks (the stoppage necessary for measurement shall be as brief as possible). Let l_3 be this distance, expressed in metres to the nearest 0,5 %.

By previous agreement between the purchaser and supplier, a force-elongation curve, recorded during the tensile tests up to 75 % of the minimum breaking force of the rope, may be supplied.

It may be requested that the elongation be determined on a particular test piece. In this case, the procedure given in annex C shall be followed to obtain the force-elongation coordinates.

8.5 Measurement of the breaking force

Continue to increase the tension, at the same rate, until a strand breaks.

Note the breaking force and the place on the test piece where the break occurred.

If the breakage occurs outside the limits defined by the marks, start the test again on another test piece, unless the force registered at the time of breaking is not less than 90 % of the minimum specified breaking force.

9 Expression and interpretation of results

For the net mass per metre, lay and elongation (see 9.1 to 9.3), the numerical result of a test is the arithmetic mean of the individual values obtained on each test piece in the batch. As far as the tensile strength is concerned (see 9.4), the result is expressed by giving the breaking force for each of the test pieces in the batch, without calculating the mean value.

The individual values are obtained as follows:

9.1 Linear density ρ_l (net mass per metre)

The linear density (net mass, in grams, per metre), expressed in kilotex, is given by the equation:

$$\rho_l = \frac{m}{L_1}$$

where

m is the mass, in grams, of the test piece;

L_1 is the length, in metres, of the test piece under the reference tension, given by the equation:

$$L_1 = \frac{l_2 \times L_0}{l_0}$$

l_0 being the initial gauge length, measured as described in 8.1;

l_2 being the gauge length under the reference tension, measured as in 8.3;

L_0 being the initial length in metres, measured as in 8.1 .

9.2 Lay

The lay p, expressed in metres, is given by the equation:

$$p = \frac{l_1}{n}$$

where l_1 is the length of n complete turns of the same strand or, in the case of plaited ropes, the length between n successive plait points (see 8.3).

9.3 Elongation

The value of the elongation A, expressed as a percentage, is given by the equation:

$$A = \frac{(l_3 - l_2)100}{l_2}$$

where

l_2 is the gauge length under the reference tension;

l_3 is the gauge length for a tensile force equal to 75 % of the specified minimum breaking force.

9.4 Tensile strength

Express the breaking force in newtons or multiples or submultiples thereof, indicating whether breakage took place inside the marks or not.

Any test piece which breaks outside the marks is considered to comply with the tensile strength specifications if the force recorded on breakage is not less than 90 % of the minimum specified breaking strength; in such a case, it is not, however, permitted to report as the test result a breaking force with a value other than the value recorded during the test.

10 Test report

The test report shall contain the following information:

a) a reference to this International Standard;

b) the results obtained, expressed in accordance with clause 9;

c) the individual values which were used to calculate the results [except for tensile strength values, which will already have been given in item b)];

d) the particular test conditions (conditioning of the test pieces, type of tensile testing machine used, procedure used for determining elongation, use of the procedures described in annexes B and C, where applicable);

e) details of procedure not stipulated in the method, and incidents which are likely to have affected the results.

Annex A
(normative)

Reference tension to be applied to ropes when measuring linear density and lay

Reference number	Reference tension to be applied to the ropes		Reference number	Reference tension to be applied to the ropes	
	Nominal value daN	Tolerance		Nominal value daN	Tolerance
4	2		48	290	
6	4		52	340	
8	8		56	390	
10	12		60	440	
12	18		64	500	
14	24		72	650	
16	32		80	800	
18	40		88	950	
20	50	±5 %	96	1 100	±5 %
22	60		104	1 300	
24	70		112	1 500	
26	85		120	1 800	
28	100		128	2 000	
30	115		136	2 300	
32	130		144	2 600	
36	160		152	2 900	
40	200		160	3 800	
44	240				

Annex B
(normative)

Special procedure for determination of high breaking strengths

By agreement between the parties involved, the strength of three-, four- and eight-strand ropes, having breaking strengths above 30 000 daN, and made of a single material and of yarns with the same linear density, may be calculated on the basis of the breaking force of the yarns by the method indicated below, on condition that, before determining the breaking force of the yarns, the rope fulfils the specified conditions in all other respects.

In order to obtain the rope yarns necessary for the test, untwist a sufficient length of rope, avoiding any rotation of the individual rope components (yarns, strands) about their own axes. A number of yarns equal to half the number giving the nominal diameter of the rope in millimetres shall be subjected to the test. In the case of three- or four-strand ropes, 15 yarns shall be tested, of which three shall be selected from the centre of the strands. In the case of eight-strand plaited rope, at least 8 yarns in the two directions of twist S and Z shall be tested (i.e. a total of at least 16 yarns).

The yarns selected shall be of adequate length to provide a minimum effective length L_u of at least 400 mm for natural fibres and 250 mm for man-made fibres.

The yarns selected shall be mounted in turn on the testing machine. During this process, the necessary steps shall be taken to prevent the yarns untwisting before testing.

The rate of traverse of the moving element, in millimetres per minute, in the breaking test for yarns shall be numerically equal to the length in millimetres of the test piece tested.

The mean of the results thus obtained shall be used to determine the breaking strength of the rope (F_c) from which the yarns were taken, by applying the equation:

$$F_c = F_y \cdot n \cdot r$$

where

F_y is the mean strength of the yarns, in decanewtons;

n is the number of yarns in the rope;

r is the realization factor (see table B.1).

Table B.1 — Realization factors, r

Reference number	Realization factors for polyester	polyamide	polypropylene	manila (abaca) or sisal
44	—	0,68	—	—
48	0,51	0,68	0,82	—
52	0,51	0,68	0,82	—
56	0,50	0,68	0,82	—
60	0,49	0,68	0,82	—
64	0,48	0,67	0,81	—
72	0,48	0,67	0,81	0,58
80	0,48	0,66	0,80	0,58
88	0,48	0,66	0,80	0,57
96	0,47	0,65	0,80	0,57
104	0,47	0,65	0,80	—
112	0,46	0,64	0,79	—
120	0,46	0,64	0,79	—
128	0,46	0,63	0,78	—
136	0,46	0,63	0,78	—
144	0,46	0,62	0,78	—