
INTERNATIONAL STANDARD



2307

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Ropes — Determination of certain physical and mechanical properties

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Ref. No. ISO 2307-1972 (E)

Descriptors : rope, dimensions, diameters, linear density, mechanical properties, breaking strength, elongation, tension tests, tests

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FOREWORD

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Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

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

It was approved in November 1971 by the Member Bodies of the following countries :

Austria	India	Spain
Belgium	Iran	Sweden
Czechoslovakia	Ireland	Switzerland
Denmark	Israel	Thailand
Egypt, Arab Rep. of	Japan	Turkey
Finland	New Zealand	United Kingdom
France	Poland	U.S.S.R.
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The Member Body of the following country expressed disapproval of the document on technical grounds :

Netherlands



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Ropes — Determination of certain physical and mechanical properties**AMENDMENT 1**

Amendment 1 to International Standard ISO 2307-1972 was drawn up by Technical Committee ISO/TC 38, *Textiles*, and circulated to the Member Bodies in January 1973.

It has been approved by the Member Bodies of the following countries :

Belgium	Hungary	Romania
Bulgaria	India	South Africa, Rep. of
Canada	Israel	Sweden
Czechoslovakia	Italy	Switzerland
Denmark	Japan	Thailand
Egypt, Arab Rep. of	Netherlands	Turkey
Finland	New Zealand	United Kingdom
France	Norway	
Germany	Poland	

The Member Bodies of the following countries expressed disapproval of the document on technical grounds :

Australia
U.S.A.

Page 6

Delete the first two paragraphs of annex A and substitute the following :

“By agreement between the interested parties, the strength of 3-, 4- and 8-strand ropes made from one material and of one linear density of twisted rope yarns, and having breaking strengths above 25 000 daN can be calculated from the breaking strength of the yarns by the method indicated below, provided that, before determination of the yarn breaking strength, the rope has fulfilled the specified requirements in all other respects.

In order to obtain the rope yarns necessary for the test, a sufficient length of rope must be untwisted, avoiding any rotation of the individual rope components (for example, yarns, strands) about their own axes. A number of yarns equal to half the nominal diameter of the rope in millimetres shall be tested. For 3- and 4-strand ropes 1/5 shall be selected from the centre of the strand. For 8-strand ropes half the yarns shall be selected from S-twist strands and the remainder from Z-twist strands.”

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Add a further column to table 3 under "synthetic fibre ropes" after "3- or 8-strand polypropylene monofilament"

3- or 8-strand polypropylene fibre film ¹⁾
—
—
0.890
0.880
0.875
0.870
0.865
—
0.855
—
0.845
0.840
0.835

Add the following footnote :

"1) These values are only applicable when the fibre film rope yarns have an elongation at break of at least 7 %. The method should not be used when the elongation value is less."

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Ropes — Determination of certain physical and mechanical properties

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies, for ropes of different kinds¹⁾, a method of determining each of the following characteristics :

- net mass per metre;
- lay;
- diameter or circumference²⁾;
- elongation;
- breaking strength.

The first three of these characteristics (net mass per metre, lay and diameter or circumference) are those of rope measured under a specified tension called the reference tension.

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

The breaking strength measured is the maximum load registered (or reached) in the course of the breaking test of 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 testing of the whole section of the rope is not possible, the method described in Annex A can be used, by agreement between the interested parties.

NOTE — Knowledge of the net mass per metre, measured in accordance with this International Standard, makes possible also the calculation of the net length (under reference tension) of a rope by dividing the net mass of the whole rope (without lashings or packing material) by the mass per metre, these two masses having been measured after conditioning in the same way.

1) The particular specifications for each type of rope are the subject of the following ISO Recommendations :

- ISO/R 1140, *Three-strand polyamide multifilament ropes.*
- ISO/R 1141, *Three-strand polyester multifilament ropes.*
- ISO/R 1181, *Three or four-strand manila and sisal ropes.*
- ISO/R 1346, *Three-strand (hawser-laid) and eight-strand (plaited) polypropylene monofilament or film ropes.*
- ISO/R 1969, *Three-strand polyethylene monofilament ropes.*
- ISO/R 1970, *Eight-strand plaited manila and sisal ropes.*

2) For measurement (under tension) of the diameter and the circumference, the methods given here concern the presentation of the rope; the detailed measuring procedure shall be arranged between the interested parties beforehand.

2 REFERENCES

ISO/R 1142, *Sampling and conditioning of ropes for testing.*

ISO/R 1968, *Ropes and cordage — Vocabulary.*

3 PRINCIPLE

3.1 Calculation of the net mass per metre by dividing the total mass of the conditioned test piece by its length under reference tension.

3.2 Measurement of the lay and diameter (or circumference) at the time of application of reference tension.

3.3 Measurement of breaking strength by increasing the tension to breaking point.

3.4 Measurement of elongation (if required) under a tension equal to 75 % of the minimum specified rope breaking load, if necessary using another test piece (see Annex B).

4 APPARATUS

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

4.2 **Tensile testing machine** of appropriate capacity, allowing a constant rate of traverse of the moving element as prescribed in 6.4.1 and in Annex A, and measurement of breaking load to an accuracy of 1 %.

The following different types of grips can be used :

- wedge grips;
- bollards to take eye-spliced test pieces;
- pulley type grips ("cors de chasse").

5 SAMPLING, SELECTION OF TEST PIECES, AND THEIR CONDITIONING

Sampling, selection of test pieces, and their conditioning prior to testing shall be carried out in accordance with the specifications of ISO/R 1142.

To obtain accuracy of measurement, it is recommended that the ends of the test pieces be whipped before separating them from the rest of the coil, and that the cut be made as close as possible to the whipped ends.

Except when otherwise agreed by the interested parties, the test pieces shall be of a sufficient length to give, after mounting on the testing machine, effective lengths, as defined in 6.2 (Figures 1, 2 and 3), at least equal to those listed in Table 1.

TABLE 1 - Effective lengths

Type of rope	Type of testing machine	Minimum effective length, L_u necessary for testing
		mm
Man-made fibre ropes, diameter (in millimetres) or reference number ≤ 10	All kinds	400
Man-made fibre ropes, diameter (in millimetres) or reference number > 10	Wedge grip or cors de chasse machine	600
	Other kinds	1 800
Natural fibre ropes	All kinds	1 800

6 PROCEDURE

6.1 Initial measurements

The test piece of appropriate length having been laid out by hand on a flat surface, measure its length to $\pm 0.5\%$ before splicing or unstranding for fixing on the testing machine. This length, in metres, is designated as L_o .

Make two marks on the test piece, spaced symmetrically about its mid-point and at least 0.50 m apart. The distance between these marks is designated D_o .

NOTE - In the case of man-made fibre ropes of small diameter, for which a minimum effective length of 400 mm is specified in Table 1, the requirements of this clause can be met by making two marks at least 0.50 m apart on a specimen of rope laid out on a flat surface by hand.

Determine the mass of the test piece to the nearest 1.0%. This mass, expressed in grams, is designated as m_o .

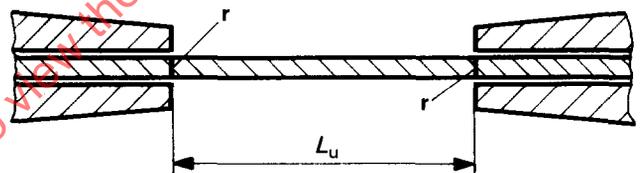
6.2 Mounting of the test piece on the testing machine

6.2.1 Fix the ends of the test piece between the wedge grips, or on the cors de chasse, or by its eye splices on the bollards, according to the type of grips used, in such a way as to obtain the effective length, L_u , of test piece specified in Table 1.

The effective length, L_u , shall be measured under zero tension, the test piece being simply held straight for each of the three principal types of grips.

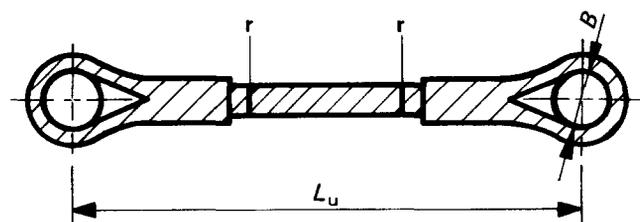
The separation of strands by untwisting or unplaiting the ends of the test piece in the case when the testing is carried out as indicated by Figures 1 and 3, shall not be done before testing.

NOTE - Nevertheless, in the case of cors de chasse, ropes of diameter above 12 mm can be untwisted or unplaited beyond point "d" on the circumference of the pulleys for the purpose of fixing the ends on the cors de chasse.



The limiting marks "r" of the test piece shall be positioned in line with the grips.

FIGURE 1 - Test piece mounted between wedge grips

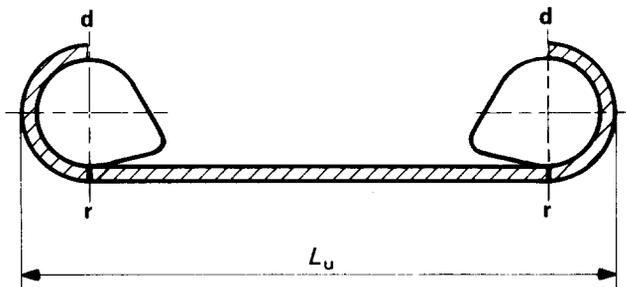


The limiting marks "r" shall be 150 mm from the last turn of the splice.

FIGURE 2 - Eye-spliced test piece between two bollards

Eyes shall have an internal length of between 250 and 300 mm when measured closed and splices shall be made to the manufacturer's discretion. In the case of man-made fibre ropes it is recommended that the end of the splices be tapered to finish.

The bollard diameter (B) shall be at least 100 mm for ropes of a nominal diameter of 40 mm or less, and 150 mm for ropes with a nominal diameter above 40 mm.



The limiting marks "r" shall be positioned where the rope leaves the cor de chasse.

FIGURE 3 – Test piece mounted on pulleys ("cors de chasse")

6.2.2 With the test piece mounted on the testing machine apply the marks "r" limiting the portion of the test piece within which the rope is normally expected to break during the course of the breaking test.

6.3 Measurement of diameter (or circumference), lay and new distance between marks

Apply to the test piece the reference tension specified in Table 2 for the type of rope concerned, then while the test piece is under tension carry out the following measurements.

6.3.1 Diameter and circumference of the rope

The nominal diameter and the nominal circumference are approximate values. Checking of these characteristics is only possible if a previous agreement on the method of measuring values and tolerances has taken place between the interested parties at the time of ordering.

6.3.2 Length of lay¹⁾ of cabled or plaited ropes

Measure the length of *n* complete turns of the same strand, or, in the case of plaited rope, the length between *n* successive points of plaiting. This length, expressed in metres, is designated as *d*.

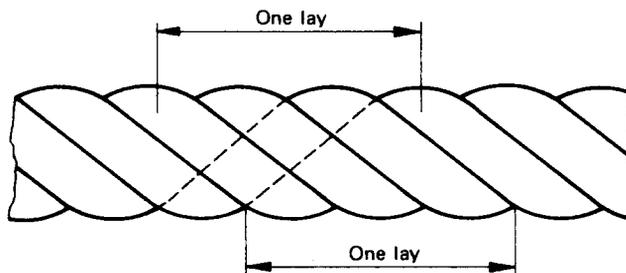


FIGURE 4 – Lay of cabled rope

TABLE 2 – Load to be applied to ropes for the measurement of net mass per metre, lay, diameter (or circumference) and, if necessary, net length

Nominal diameter (or reference number)	Nominal circumference	Reference tension for			
		natural fibre ropes		man-made fibre ropes	
mm	in	daN (Tolerance ± 5%)	kgf (approx.)	daN (Tolerance ± 5%)	kgf (approx.)
4	1/2				2
5	5/8			2.9	3
6	3/4			3.9	4
7	7/8			5.9	6
8	1	11	11	7.8	8
9	1 1/8			9.8	10
10	1 1/4	14	14	13	13
11	1 3/8			15	15
12	1 1/2	20	20	18	18
13	1 5/8			21	21
14	1 3/4	29	30	24	25
16	2	39	40	29	30
18	2 1/4	49	50	39	40
20	2 1/2	69	70	49	50
22	2 3/4	78	80	59	60
24	3	88	90	69	70
26	3 1/4	108	110	83	85
28	3 1/2	118	120	93	95
30	3 3/4	137	140	108	110
32	4	157	160	118	120
36	4 1/2	196	200	147	150
40	5	235	240	176	180
44	5 1/2	285	290	210	215
48	6	330	340	240	250
52	6 1/2	390	400	290	295
56	7	440	450	330	335
60	7 1/2	500	510	380	385
64	8	570	580	420	430
68	8 1/2	630	640	—	—
72	9	700	710	530	540
76	9 1/2	750	770	—	—
80	10	820	840	650	660
88	11	980	1 000	770	785
96	12	1 080	1 100	910	925

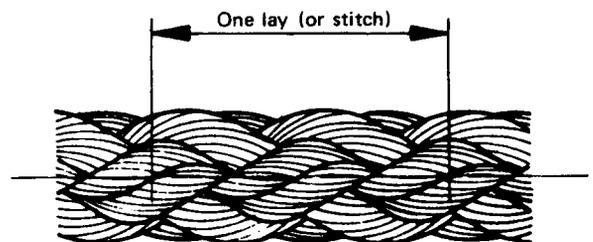


FIGURE 5 – Lay of plaited rope

6.3.3 New distance between marks

Measure the new distance between the marks made on the test piece at the time of initial measurement (see 6.1). This distance is designated as *D_p*.

1) The lay of a rope is defined in ISO/R 1968.

In the case of specimens of man-made fibre ropes of small diameter having a minimum effective length of 400 mm, the value of D_p can be obtained by placing on a specimen of rope laid out on a surface the initial marks specified in 6.1, at a distance of at least 0.50 m, and by applying the appropriate tension by means of weights over a pulley.

6.4 Measurement of elongation and breaking strength

Increase tension by means of the moving element of the testing machine until breakage of the rope occurs.

6.4.1 Speed of testing

The rate of traverse of the moving element of the testing machine shall be constant, and shall be, in millimetres per minute, within the limits of 6 to 10 % of the numerical value of the effective length of the test piece expressed in millimetres. For all man-made fibre ropes, the rate of traverse of the moving element shall not exceed 250 mm/min.

6.4.2 Elongation

When elongation values are required, a special test piece shall be used and the method for obtaining the plot of load/elongation shall be that given in Annex B.

NOTES

1 If the method recommended in Annex B is not required, the load/elongation values recorded during tensile testing can be used.

2 By previous agreement between the interested parties, a measurement of elongation can also be made by stopping, for as short a time as possible, the action of the moving element when the tensile load has reached 75 % of the minimum specified rope breaking load.

6.4.3 Breakage

It is important to determine the location of the break on the test piece on completion of the test, in order to establish whether or not the test results represent the true strength of the rope. Damage to the test piece caused by holding devices can seriously affect the results of the test, and in consequence the marks shall have been made on the sample before the application of the load, as indicated in 6.2.

Breakage should occur between the two marks on the test piece.

If breakage takes place beyond these marks and below the specified breaking strength, the test piece shall be considered to be conforming to tensile strength specifications if the load recorded is not less than 90 % of the specified breaking strength. If not, the test shall be discarded and a new test carried out.

It is not permitted to report, as a test result, a breaking strength having a value other than the value actually recorded during testing.

7 EXPRESSION OF RESULTS

7.1 Net mass per metre (or linear density)

The net mass per metre, m , is given by the formula

$$m = \frac{m_o}{L}$$

where

m_o is the mass;

L is the length, in metres, of the test piece under reference tension, calculated by the formula

$$L = \frac{D_p \times L_o}{D_o}$$

D_o being the initial distance between marks measured in accordance with 6.1;

D_p being the distance between these marks measured under reference tension in accordance with 6.3;

L_o being the initial total length of the test piece, in metres, measured in accordance with 6.1.

Take the average value of net mass per metre for all of the test pieces submitted to the test; express the result in grams per metre or in kilotex.

NOTE — If the approximate length of a coil or rope under reference tension is required, calculate this by dividing the net mass of the rope by the net mass per metre.

7.2 Diameter (or circumference)

Take the arithmetical average of the measured diameters (or circumferences) for all the test pieces submitted to the test; express the result in millimetres.

7.3 Lay

The length of lay is equal to

$$\frac{d}{n}$$

where d is the length of n complete turns of the same strand, or, in the case of plaited ropes, the length between n successive points of plaiting (see 6.3.2).

Take the average of the measured lay for all the test pieces submitted to the test; express the result in millimetres.

7.4 Elongation (see also Annex B)

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

$$A = \frac{D_a - D_p}{D_p} \times 100$$

where

D_a is the distance between marks under a tension equal to 75 % of the minimum specified breaking strength;

D_p is the distance between marks measured under reference tension.

7.5 Breaking strength

Express the result in decanewtons (daN) for each test piece, without taking the average, indicating whether the break occurred between the marks.

8 TEST REPORT

The test report shall include the following particulars :

- a) the results obtained;
- b) reference to this International Standard;

c) the particular testing conditions (conditioning of the test pieces, type of testing machine used, procedure used for the determination of elongation, and use of the method described in Annex A if relevant);

d) the individual values used in the calculation of results;

e) any operational details not given in this International Standard, as well as any incidents which may have affected the results.

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ANNEX A

SPECIAL PROCEDURE FOR DETERMINATION OF HIGH BREAKING STRENGTHS

By agreement between the interested parties, the strength of 3-, 4- and 8-strand ropes having breaking strengths above 25 000 daN can be calculated from the breaking strength of the yarns by the method indicated below, provided that, before determination of the breaking strength, the rope has fulfilled the specified requirements in all other respects.

In order to obtain the rope yarns necessary for the test, a sufficient length of rope must be untwisted, avoiding any rotation of the individual rope components (e.g. yarns, strands) about their own axes. At least 15 rope yarns from 3- or 4-strand ropes shall be tested, of which 3 shall be selected from the centre of the strands. In the case of 8-strand plaited rope, at least 8 yarns in the two directions of twist S and Z must be tested (i.e. a total of at least 16 yarns).

The rope yarns selected shall have a length sufficient to provide a minimum effective length L_u of 400 mm.

The specimens shall be mounted in turn on the testing machine. In the course of this process, necessary

precautions must be taken to avoid the untwisting of the yarns 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 specimen.

The average of the results thus obtained shall be used to determine the breaking strength, F_c , of the rope from which the rope yarns were taken, using the following formula :

$$F_c = F_v \times n \times r$$

where

F_v is the average strength of the yarns, in decanewtons;

n is the number of yarns in the rope;

r is the realization factor (see Table 3).

TABLE 3 — Realization factors

Nominal diameter or reference number	Circumference (nominal)	Realization factor for					
		manila and sisal ropes			synthetic fibre ropes		
mm	in	3-strand	4-strand	8-strand	3-strand polyamide	3-strand polyester	3- or 8-strand polypropylene monofilament
40	5	—	—	—	0.709 5	—	—
44	5 1/2	—	—	—	0.702 2	0.570 5	—
48	6	—	—	—	0.695 8	0.565 5	0.871 9
52	6 1/2	—	—	—	0.690 0	0.561 0	0.864 6
56	7	—	—	—	0.685 0	0.557 2	0.858 3
60	7 1/2	0.592	0.533	—	0.680 8	0.553 6	0.853 1
64	8	0.589	0.530	0.610	0.677 0	0.550 2	0.848 3
68	8 1/2	0.585	0.527	0.606	—	—	—
72	9	0.582	0.524	0.603	0.670 0	0.544 6	0.839 5
76	9 1/2	0.579	0.521	0.600	—	—	—
80	10	0.577	0.519	0.598	0.665 0	0.540 0	0.833 2
88	11	0.574	0.517	0.595	0.661 3	0.536 7	0.828 6
96	12	0.572	0.515	0.593	0.657 8	0.533 3	0.824 2

If the breaking strength has been calculated, mention shall be made of this fact in the test report, in commercial documents, and in dealings with the purchaser.

ANNEX B

DETERMINATION OF LOAD/ELONGATION CO-ORDINATES

The special test piece for load/elongation measurements shall be mounted on the testing machine, and loaded ten times to 50 % of the specified minimum breaking strength. The rate of loading and unloading shall be that defined in 6.4 and the time for which each load is maintained or completely removed shall be as short as possible.

After the complete release of the tenth load, a period of 1 h shall be allowed for the test piece to relax, after which the

appropriate reference tension specified in Table 2 shall be applied to it.

While the test piece is under this tension, a convenient distance shall be marked out on the rope. The co-ordinated load/elongation measurements up to 75 % of the breaking strength shall then be taken.

At no point during this test shall the sample be disturbed or taken out of the testing machine.

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