INTERNATIONAL STANDARD

ISO 34-2

Fourth edition
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Rubber, vulcanized or thermoplastic — Determination of tear strength —

Part 2: Small (Delft) test pieces

Caoutchouc vulcanisé ou thermoplastique — Détermination de la résistance au déchirement —

Partie 2: Petites éprouvettes (éprouvettes de Delft)

Reference number
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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 2, *Testing and analysis*.

This fourth edition cancels and replaces the third edition (ISO 34-2:2011), which has been technically revised. Precision results from an interlaboratory have been updated as Annex A.

ISO 34 consists of the following parts, under the general title *Rubber, vulcanized or thermoplastic — Determination of tear strength*:

— *Part 1: Trouser, angle and crescent test pieces*

— *Part 2: Small (Delft) test pieces*

Rubber, vulcanized or thermoplastic — Determination of tear strength —

Part 2: Small (Delft) test pieces

WARNING 1 — Persons using this part of ISO 34 should be familiar with normal laboratory practice. This part of ISO 34 does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

WARNING 2 — Certain procedures specified in this part of ISO 34 might involve the use or generation of substances, or the generation of waste, that could constitute a local environmental hazard. Reference should be made to appropriate documentation on safe handling and disposal after use.

1 Scope

This part of ISO 34 specifies a method for the determination of the tear strength of small test pieces (Delft test pieces) of vulcanized or thermoplastic rubber.

NOTE The method does not necessarily give results agreeing with those given by the method described in ISO 34-1, which uses trouser, angle and crescent test pieces. It is used in preference to ISO 34-1 when the amount of material available is limited, and might be particularly suitable for testing small finished products.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5893, *Rubber and plastics test equipment — Tensile, flexural and compression types (constant rate of traverse) — Specification*

ISO 18899:2013, *Rubber — Guide to the calibration of test equipment*

ISO 23529:2010, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

3 Principle

The force required to tear across the width of a small test piece containing a slit in the centre is measured.

4 Apparatus

4.1 Tensile-testing machine, complying with the requirements of ISO 5893, capable of measuring force with an accuracy corresponding to class 1 as defined in ISO 5893, and with a rate of traverse of the moving grip of 500 mm/min ± 50 mm/min.

4.2 Die, for cutting out the test piece. The construction of the die and the knife which cuts the slit are shown in Figure 1 and Figure 2.

4.3 Micrometer gauge, complying with the requirements of ISO 23529 and having a circular foot approximately 6 mm in diameter which exerts a pressure of 22 kPa ± 5 kPa.

4.4 Travelling microscope, giving at least 10× magnification, fitted with a graticule graduated at 0,01 mm intervals.

5 Calibration

The requirements for calibration of the test apparatus are given in Annex B.

6 Test pieces

6.1 Shape and dimensions

The test pieces shall be rectangular and shall conform to the dimensions shown in Figure 3 and Table 1.

The test pieces shall be cut from a sheet by punching with the die (4.2), using a single blow of a mallet or (preferably) a single stroke of a press. The rubber may be wetted with water or a soap solution, and shall be supported on a sheet of slightly yielding material (for example leather, rubber belting or cardboard) on a flat, rigid surface.

The tear strength is particularly susceptible to grain effects in the rubber. Normally, all test pieces are prepared with the grain at right angles to their length, but, in cases where grain effects are significant and are to be evaluated, two sets of test pieces shall be cut from the sheet, one at right angles to the grain and the other parallel to the grain.

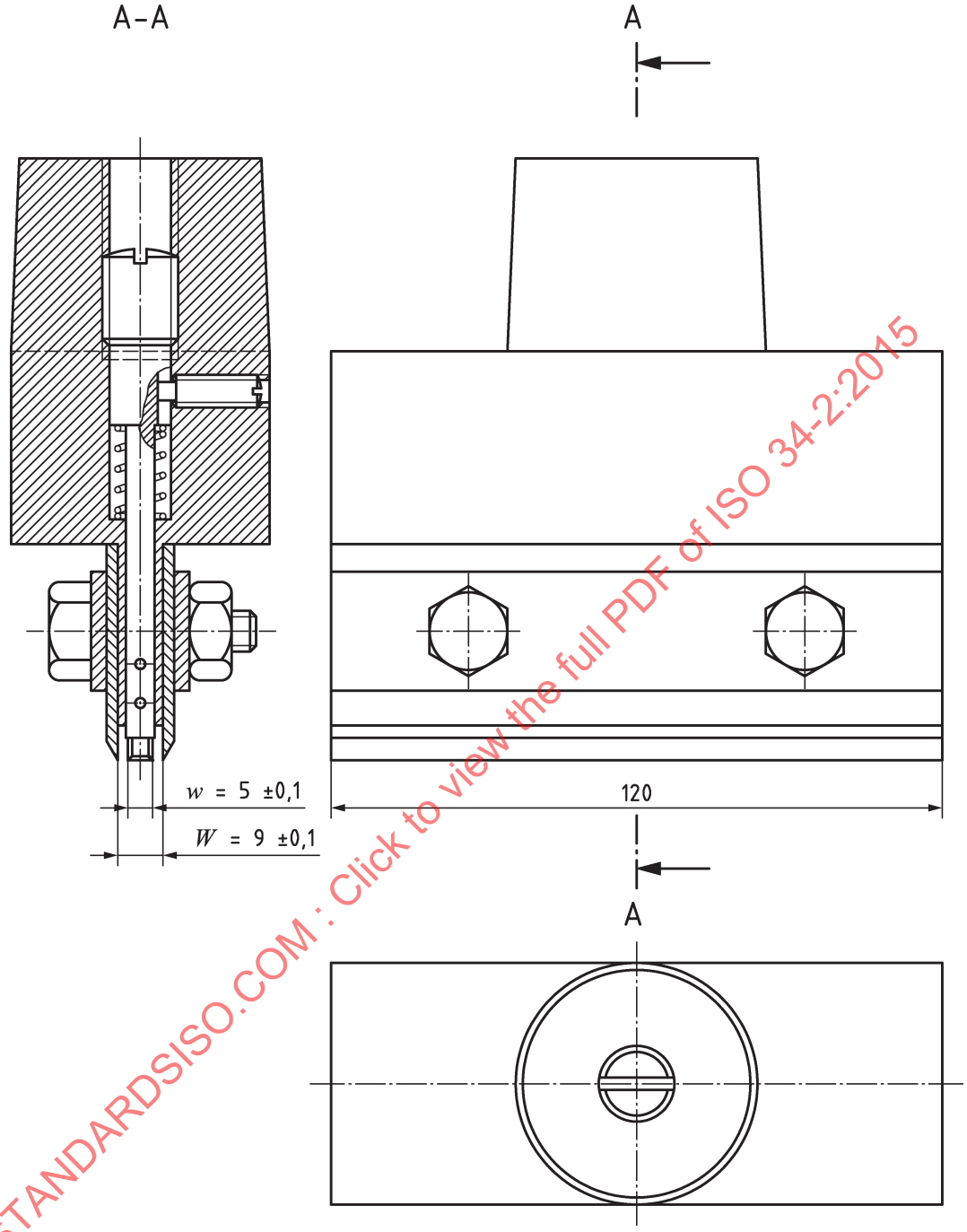
The thickness *d* of the test pieces shall be 2,0 mm ± 0,2 mm.

6.2 Measurement of dimensions

6.2.1 Measurement of thickness

Measure the thickness of the test piece by ISO 23529:2010, method A. Take at least three gauge readings in the region of the slit. If an even number of readings is taken, use the average of the two median values as the result. If an odd number of readings is taken, use the median value. No reading shall deviate by more than 2 % from the value used. When the test results are to be used for comparative purposes, the thickness of any test piece shall not vary by more than 10 % from the mean thickness of all the test pieces.

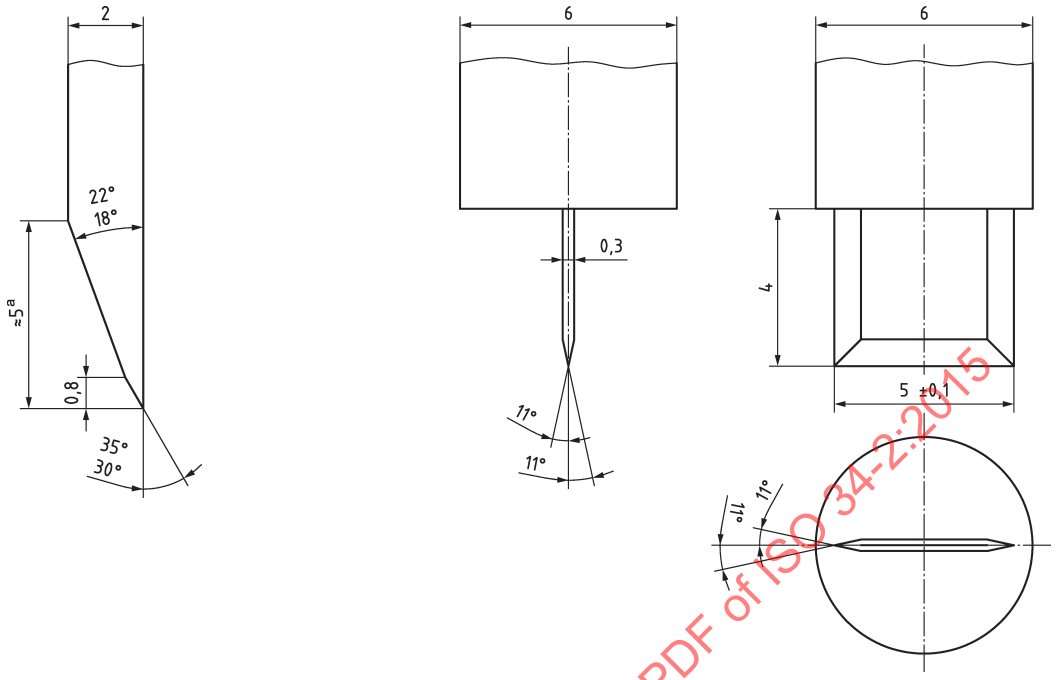
Dimensions in millimetres



NOTE $b_3 = W - w$ (method 2)

Figure 1 — Die for Delft test pieces

Dimensions in millimetres

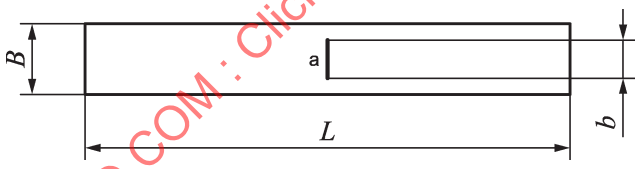


a) Enlarged detail of blade for cutting out test piece

b) Enlarged detail of small blade for cutting slit

NOTE Cutting edge.

Figure 2 — Details of Delft test piece die cutting edges



Key

a Slit to be symmetrical with the width.

Figure 3 — Test piece

Table 1 — Dimensions of test piece

Dimension		Value mm
L	Length	60
B	Width	9,0 ± 0,1
b	Slit length	5,0 ± 0,1

6.2.2 Measurement of the total width outside the slit

6.2.2.1 General

The total width outside the slit b_3 corresponds to the rubber to be torn.

Two methods of measurement may be used. Method 1 is theoretically more exact, but is difficult to use in practice. Method 2, which is in common use, is simpler but can give different results. Unless otherwise specified, use method 2.

Results obtained using test pieces measured by different methods shall not be compared.

6.2.2.2 Method 1: Measurement by travelling microscope

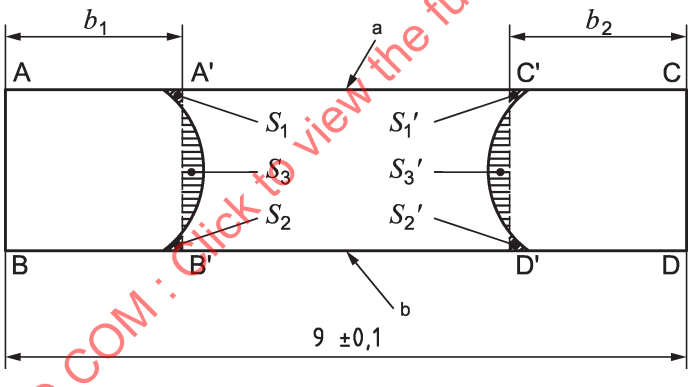
Variations occur in the length of the slit and in the total width of the test piece when the same die is used to prepare test pieces from rubber of different hardnesses. Moreover, the slit might not be uniform throughout its depth, but might be wider at one surface. Take one test piece which has been cut out with the die, therefore, and use it to measure the width to be torn by cutting the test piece through with a sharp razor blade in the plane of the slit and measuring the cut surfaces (width on either side of the slit) with a travelling microscope. The ends of the slit are curved as shown in Figure 4, and an attempt shall be made to allow for this curvature when measuring the width on either side of the slit, as follows.

Take as the width on the left-hand side b_1, which is the distance from the line AB to an imaginary line A′B′ which is situated so that the total area $S_1 + S_2 = S_3$.

Similarly, on the right-hand side, imagine a line C′D′ situated so that the total area $S_1' + S_2' = S_3'$ and b_2 is the width.

The total width b_3 outside the slit (i.e. the rubber to be torn) is then $b_1 + b_2$.

Dimensions in millimetres



Key

a Top

b Bottom

NOTE $b_3 = b_1 + b_2$ (method 1).

Figure 4 — Section through slit in Delft test piece

6.2.2.3 Method 2 (simpler): Measurement from the dimensions of the die used to cut the test piece

Calculate b_3 from the dimensions of the die (see Figure 1), using Formula (1):

$$b_3 = W - w \tag{1}$$

where

W is the measured distance between the cutting edges of the die;

w is the measured width of the blade for cutting the slit.

6.3 Time interval between vulcanization and testing

The time between vulcanization and testing shall be in accordance with ISO 23529.

6.4 Number

At least three and preferably six test pieces shall be tested.

7 Temperature of test

The test is normally carried out at a standard laboratory temperature as specified in ISO 23529.

If the test is to be carried out at a temperature other than a standard laboratory temperature, condition the test piece, immediately prior to testing, for a period sufficient for it to reach substantial temperature equilibrium at the test temperature. Keep this period as short as possible in order to avoid ageing the rubber (see ISO 23529).

Use the same temperature throughout any one test, as well as any series of tests intended to be comparable.

8 Procedure

Mount the test piece in the testing machine so that the free length between the points of contact of the grips on the test piece is 30 mm, i.e. so that each grip is 15 mm from the slit. Stretch the test piece in the machine. Do not interrupt the stretching before the test piece has torn completely through. Note the maximum force reached during tearing.

9 Expression of results

The tearing force depends on the thickness of the test piece and the width of the rubber torn, and the result is therefore expressed as the force necessary to tear a test piece of standard width and thickness. This value, the tear strength F_0, in newtons, is given in Formula (2):

$$F_0 = \frac{8F}{b_3 d} \tag{2}$$

where

8 is the product of the nominal values of b_3 (4 mm) and d (2 mm);

F is the force, in newtons, required to tear the test piece;

b_3 is the actual width, in millimetres, of the rubber torn in the test piece (see 6.2);

d is the actual thickness, in millimetres, of the test piece.

Arrange the results in order of increasing value and take as the result the average of the two median values if the number of test pieces is even, or the median value if the number of test pieces is odd. If only three test pieces are tested, give the individual results.

10 Precision

See Annex A.

11 Test report

The test report shall include at least the following information:

a) full description of the sample and its origin;

b) a reference number of this part of ISO 34, i.e. ISO 34-2:2015;

c) test details:

   1) number of test pieces tested,

   2) median thickness of each test piece, calculated in accordance with 6.2.1,

   3) total width of each test piece outside the slit,

   4) method of measurement of the total width outside the slit,

   5) time and temperature of conditioning prior to the test,

   6) temperature at which the test was carried out,

   7) direction of the grain in the test pieces relative to that of the applied force,

   8) any special tearing behaviour of the test pieces noted during the test,

   9) details of any procedures not specified in this part of ISO 34;

d) test results, expressed in accordance with Clause 9;

e) date of the test.

Annex A
(informative)

Precision results from an interlaboratory test programme

A.1 General

The precision calculations to provide repeatability and reproducibility values were performed in accordance with ISO/TR 9272 the guidance document for ISO/TC 45 test methods. Precision concepts and nomenclature are also given in ISO/TR 9272.

A.2 Precision results from the ITP

A.2.1 Programme details

The two ITP were organized and conducted by France in 1989 and 2011. For the ITP held in 1989, prepared test pieces were supplied and each participating laboratory carried out the following operations: thickness measurement, measurement of the total width outside the slit (methods 1 and 2) and, finally, tear strength measurement.

For each set of measurements, two types of test piece were used:

— direction 1 test pieces, cut with the mill grain at 90° to the direction of elongation;

— direction 2 test pieces, cut with the mill grain parallel to the direction of elongation.

For the ITP held in 2011, the prepared test pieces were supplied and each participating laboratory carried out the following operations: test piece nicking (if required), thickness measuring and tear strength measurement.

A total of four compounds were used in the test. The samples were designated as Compounds A, B, C and E. For the details of the compounding of the materials and their vulcanization, see Table A.1.

Table A.1 — Compounding

Ingredient	Number of parts by mass			
	Compound A	Compound B	Compound C	Compound E
Natural rubber	32	—	83	—
Smoked sheet	—	—	—	83
SBR 1500	68	100	17	—
SBR 1502	—	—	—	17
Carbon black	—	—	—	—
Type N 550	66	—	—	—
Type N 339	—	35	—	—
Type N 234	—	—	37	—
Type N 330	—	—	—	—
Type N 347	—	—	—	37
Aromatic oil	16	—	—	—
Stearic acid	1	1	2,5	1

Table A.1 *(continued)*

Ingredient	Number of parts by mass			
	Compound A	Compound B	Compound C	Compound E
Antiozonant	3	—	2,8	2
Zinc oxide	12	3	3	3
Sulfur	3,2	1,75	1,3	1,3
Accelerator	2	1	1,5	1,5
Hydrocarbon resin	—	—	3,5	—

The number of laboratories on which precision data for each property is based is given in the tables of precision results (Tables A.2 to A.5). The number of participating laboratories as noted in these tables is the final number after identifying certain laboratory values as outliers. For the ITP held in 1989, only the total number of laboratories is known.

For both ITP, testing was conducted over a period of two sequential weeks. On a specified day in each of these four weeks, five (5) individual measurements were performed on the materials. The test result of each week is the median of the five individual measurements. All analysis was conducted on the basis of these test results.

A.2.2 Precision results

The precision results are listed in Tables A.2 to A.5.

The precision results as determined by this ITP should not be applied to acceptance or rejection testing for any group of materials or products without documentation that the results of this precision evaluation actually apply to the products or materials tested.

Explanation of symbols for Tables A.2, A.3, A.4, and A.5:

s_r = within-laboratory standard deviation (in measurement units);

r = repeatability (in measurement units);

(r) = repeatability (in percent of mean level);

s_R = between-laboratory standard deviation (for total between-laboratory variation in measurement units);

R = reproducibility (in measurement units);

(R) = reproducibility (in percent of mean level).

Table A.2 — Precision data for "Delft" tear strength — Width outside the slit measured using method 1 — Direction 1 (mill grain perpendicular)

Tear strength values in kN/m

Compound	Mean level	s_r	r	(r)	s_R	R	(R)	No. of laboratories[a]
A (1989)	36,7		4,37	11,9		12,9	35,1	
B (1989)	32,0		5,62	17,6		11,2	34,9	
C (1989)	129,8		38,9	30,0		62,5	48,2	
Average[b]			16,30	19,8		28,9	39,4	

[a] Number of laboratories after outliers deleted (total number of laboratories in ITP: 12).

[b] Simple averages calculated.

Table A.3 — Precision data for "Delft" tear strength — Width outside the slit measured using method 1 — Direction 2 (mill grain parallel)

Tear strength values in kN/m

Compound	Mean level	s_r	r	(r)	s_R	R	(R)	No. of laboratories[a]
A (1989)	36,8		1,68	4,57		9,96	27,1	
B (1989)	31,4		3,99	12,7		6,96	22,2	
C (1989)	132,1		25,8	19,5		44,5	33,7	
Average[b]			10,49	12,3		20,5	27,7	

[a] Number of laboratories after outliers deleted (total number of laboratories in ITP: 12 for the ITP held in 1989).

[b] Simple averages calculated.

Table A.4 — Precision data for "Delft" tear strength — Width outside the slit measured using method 2 — Direction 1 (mill grain perpendicular)

Tear strength values in kN/m

Compound	Mean level	s_r	r	(r)	s_R	R	(R)	No. of laboratories[a]
A (1989)	40,0		4,73	11,8		17,2	43,2	
B (1989)	37,4		2,37	6,23		19,0	50,8	
C (1989)	157,0		38,5	24,5		67,7	43,2	
E (2011)	167,6	9,79	27,7	16,5	11,3	31,9	19,0	8
Average[b]			18,3	14,8		34,0	39,1	

[a] Number of laboratories after outliers deleted (total number of laboratories in ITP: 12 for the ITP held in 1989, 8 for the ITP held in 2011).

[b] Simple averages calculated.

Table A.5 — Precision data for "Delft" tear strength — Width outside the slit measured using method 2 — Direction 2 (mill grain parallel)

Tear strength values in kN/m

Compound	Mean level	s_r	r	(r)	s_R	R	(R)	No. of laboratories[a]
A (1989)	40,4		6,73	16,7		12,3	30,7	
B (1989)	37,2		3,69	9,94		17,0	45,6	
C (1989)	163,9		24,0	14,6		80,6	49,2	
Average[b]			11,5	13,7		36,6	41,8	

[a] Number of laboratories after outliers deleted (total number of laboratories in ITP: 12 for the ITP held in 1989).

[b] Simple averages calculated.