INTERNATIONAL STANDARD

ISO 34-2

Second edition
2007-07-15

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
ISO 34-2:2007(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword iv
1 Scope 1
2 Normative references 1
3 Principle 1
4 Apparatus 2
5 Test pieces 2
5.1 Shape and dimensions 2
5.2 Measurement of dimensions 2
5.3 Time interval between vulcanization and testing 6
5.4 Number 6
6 Temperature of test 6
7 Procedure 6
8 Expression of results 6
9 Precision 7
10 Test report 7
Annex A (informative) Precision 8

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 34-2 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 2, *Testing and analysis*.

This second edition cancels and replaces the first edition (ISO 34-2:1996), which has been revised principally to update the normative references (ISO 471, ISO 3383 and ISO 4648 have been replaced by ISO 23529). Since ISO 5893 has also been revised, the force-measuring accuracy of the tensile-testing machine has been corrected to class 2. The text concerning precision in Clause 9 has been combined with Annexes A, B and C to give a new Annex A. In addition, the layout of Clause 10, the test report, has been updated.

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 — 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.

CAUTION — Certain procedures specified in this part of ISO 34 may 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 available material is limited, and may be particularly suitable for testing small finished products.

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 5893:2002, *Rubber and plastics test equipment — Tensile, flexural and compression types (constant rate of traverse) — Specification*

ISO/TR 9272, *Rubber and rubber products — Determination of precision for test method standards*

ISO 23529:2004, *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 2 as defined in ISO 5893:2002, and with a rate of traverse of the moving grip of 500 mm/min ± 50 mm/min.

The capacity of the test machine shall be such that the force required to tear the test piece will be not less than 15 % or more than 85 % of that capacity.

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

5.1 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 can 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.

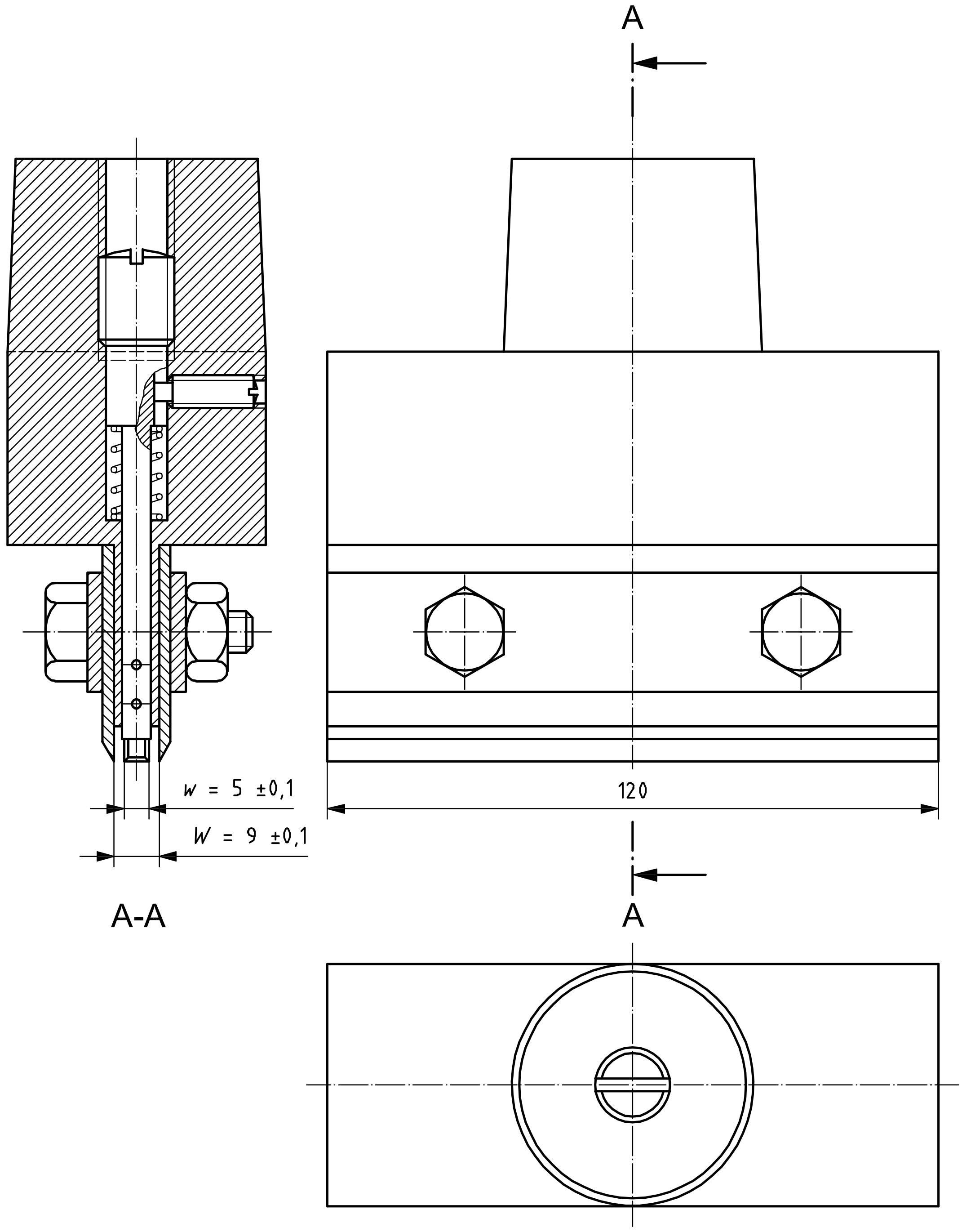
The thickness d of the test pieces shall be 2,0 mm ± 0,2 mm.

5.2 Measurement of dimensions

5.2.1 Measurement of thickness

Measure the thickness of the test piece by method A of ISO 23529:2004. 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.

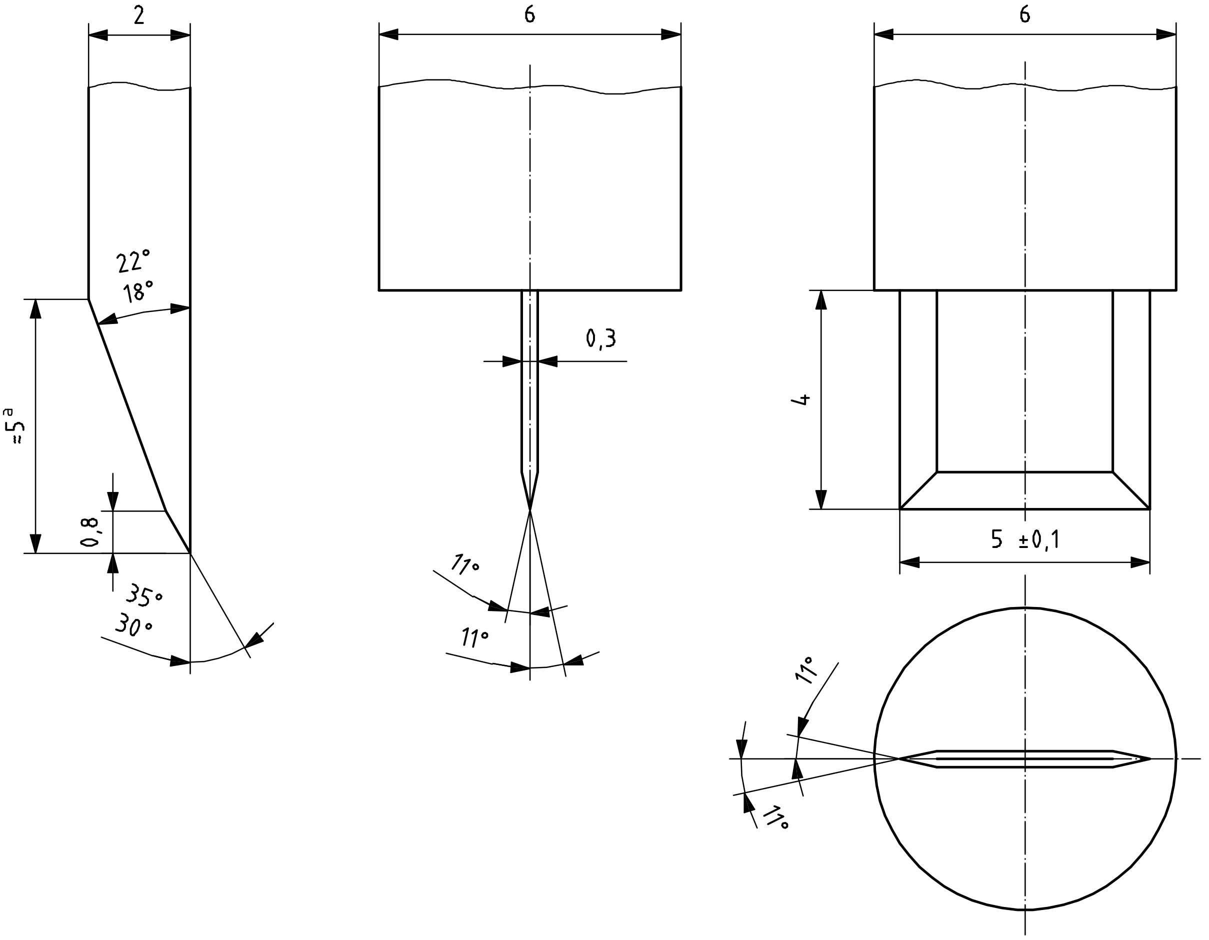
Dimensions in millimetres



$b_3 = W - w$ (second method)

Figure 1 — Die for Delft test pieces

Dimensions in millimetres

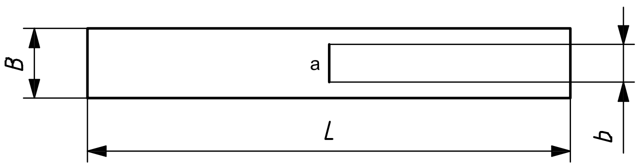


a) Enlarged detail of blade for cutting out test piece

b) Enlarged detail of small blade for cutting slit

a Cutting edge.

Figure 2 — Details of Delft test piece die cutting edges



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

5.2.2 Measurement of the total width outside the slit

5.2.2.1 General

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

Two methods of measurement can be used. The first method is theoretically more exact, but is difficult to use in practice. The second method, which is in common use, is simpler but can give different results. Unless otherwise specified, use the second method.

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

5.2.2.2 First method: Measurement by travelling microscope

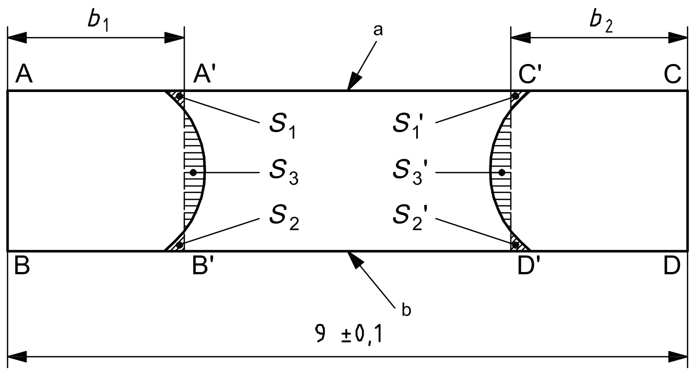
Variations occur in the length of the slit and in the total width of the test piece when the same die is used to prepare test pieces from rubber of different hardnesses. Moreover, the slit might not be uniform throughout its depth, but might be wider at one surface. Take one test piece which has been 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



$b_3 = b_1 + b_2$ (first method)

a Top.

b Bottom.

Figure 4 — Section through slit in Delft test piece

5.2.2.3 Second (simpler) method: 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 the following equation:

$$b_3 = W - w$$

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.

5.3 Time interval between vulcanization and testing

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

5.4 Number

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

6 Temperature of test

The test is normally carried out at a standard laboratory temperature of 23 °C ± 2 °C or 27 °C ± 2 °C, 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.

7 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.

8 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 by the equation

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

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 5.2);

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.

9 Precision

See Annex A.

10 Test report

The test report shall include the following particulars:

a) all details necessary for identification of the sample tested;

b) a reference to this part of ISO 34 (i.e. ISO 34-2:2007);

c) the test details:

   1) the temperature of test,

   2) the direction of the grain in the test piece,

   3) the date of vulcanization, if known,

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

   5) the number of test pieces tested,

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

d) the tear strength, calculated in accordance with Clause 8;

e) the date of the test.

Annex A
(informative)

Precision

A.1 General

The calculations to determine the repeatability and reproducibility were performed in accordance with ISO/TR 9272. Consult this for precision concepts and nomenclature. In addition to the precision data itself, this annex gives guidance on the use of repeatability and reproducibility results.

A.2 Precision details

A.2.1 An interlaboratory test programme (ITP) was organized in 1989 by the Laboratoire de Recherches et de Contrôle du Caoutchouc et des Plastiques (LRCCP).

Test pieces prepared by LRCCP from cured sheets of three compounds A, B and C (the same as were used for the ITP for ISO 34-1) were sent out to all participating laboratories. Details of these compounds are outlined in Table A.1.

Table A.1 — Formulations for compounds A, B and C used in the ITP

Values in parts by mass

Compound	A	B	C
Natural rubber	32	—	83
SBR 1500	68	100	17
Carbon black			
Type N550	66	—	—
Type N339	—	35	—
Type N234	—	—	37
Aromatic oil	16	—	—
Stearic acid	1	1	2,5
Antiozonant	3	—	2,8
Zinc oxide	12	3	3
Sulfur	3,2	1,75	1,3
Accelerator	2,0	1	1,5
Hydrocarbon resin	—	—	3,5

In each laboratory, the following operations were carried out on each of the two testing days a week apart: 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.

Five laboratories participated in the testing of test pieces whose width outside the slit was measured using method 1, seven in the testing of test pieces whose width outside the slit was measured using method 2.

A.2.2 The precision determined is a type 1 precision; no mixing or curing of the test compounds was done in the participating laboratories.

A.3 Precision results

The precision results for all tests are given in Table A.2. See A.4 for guidance on using precision results. For comments, see A.5.

The symbols used in Table A.2 are as follows:

r = repeatability, in measurement units;

(r) = repeatability, as a percentage of the average for the material;

R = reproducibility, in measurement units;

(R) = reproducibility, as a percentage of the average for the material.

Pooled (r) and (R) values are calculated on the basis of pooled r and R and overall material average values.

A.4 Guidance for using precision results

A.4.1 The general procedure for using precision results is as follows, with the symbol $|x_1 - x_2|$ designating a positive difference in any two measurement values (i.e. without regard to sign).

A.4.2 Enter the appropriate precision table (for whatever test parameter is being considered) at an average value (of the measured parameter) nearest to the "test" data average under consideration. This line will give the applicable, r, (r), R or (R) for use in the decision process.

A.4.3 With these r and (r), values, the following general repeatability statements may be used to make decisions.

a) For an absolute difference: The difference $|x_1 - x_2|$ between two test (value) averages, found on nominally identical material samples under normal and correct operation of the test procedure, will exceed the tabulated repeatability r on average not more than once in twenty cases.

b) For a percentage difference between two test (value) averages: The percentage difference

$$\left[|x_1 - x_2| \Big/ \frac{1}{2}(x_1 + x_2)\right] \times 100$$

between two test values, found on nominally identical material samples under normal and correct operation of the test procedure, will exceed the tabulated repeatability r on average not more than once in twenty cases.

Table A.2 — Precision results for "Delft" tear strength

Tear strength values in newtons

Material	Average	Within-laboratory		Between-laboratory	
		r	(*r*)	*R*	(*R*)
Width outside slit measured using method 1					
Direction 1 (mill grain perpendicular)					
Compound A	36,7	4,37	11,9	12,9	35,1
Compound B	32,0	5,62	17,6	11,2	34,9
Compound C	129,8	38,9	30,0	62,5	48,2
Pooled values	66,2	22,8	34,5	37,4	56,6
Direction 2 (mill grain perpendicular)					
Compound A	36,8	1,68	4,57	9,96	27,1
Compound B	31,4	3,99	12,7	6,96	22,2
Compound C	132,1	25,8	19,5	44,5	33,7
Pooled values	66,8	15,6	23,4	24,3	36,3
Width outside slit measured using method 2					
Direction 1 (mill grain perpendicular)					
Compound A	40,0	4,73	11,8	17,2	43,2
Compound B	37,4	2,37	6,23	19,0	50,8
Compound C	157,0	38,5	24,5	67,7	43,2
Pooled values	78,1	23,6	30,2	37,2	47,7
Direction 2 (mill grain perpendicular)					
Compound A	40,4	6,73	16,7	12,3	30,7
Compound B	37,2	3,69	9,94	17,0	45,6
Compound C	163,9	24,0	14,6	80,6	49,2
Pooled values	82,5	14,5	17,6	50,7	61,4

A.4.4 With these R and (R) values, the following general reproducibility statements may be used to make decisions.

a) For an absolute difference: The absolute difference $|x_1 - x_2|$ between two independently measured test (value) averages, found in two laboratories using normal and correct test procedures on nominally identical material samples, will exceed the tabulated reproducibility R not more than once in twenty cases.

b) For a percentage difference between two test (value) averages: The percentage difference

$$\left[|x_1 - x_2| \Big/ \frac{1}{2}(x_1 + x_2) \right] \times 100$$

between two independently measured test (value) averages, found in two laboratories using normal and correct test procedures on nominally identical material samples, will exceed the tabulated reproducibility (R) not more than once in twenty cases.

A.5 Comments on precision results

The values of r and R in Table A.2 are roughly proportional to the magnitude of the “Delft” tear strength; the values of (r) and (R) however, which are equivalent to a coefficient of variation, do not change appreciably, while the tear strength increases by a factor of approximately four. There appears to be no consistent difference in the influence of the two methods for measuring the width outside the slit, i.e. method 1 and method 2, except with parallel mill grain testing. Here, the reproducibility (R) is almost two times higher for method 2.

Parallel-grain test pieces appear to be more precise (i.e. give a lower r and R) for method 1, in both within-laboratory and between-laboratory testing. For method 2, there appears to be a similar advantage with parallel-grain test pieces for within-laboratory testing, i.e. lower r and (r), but the opposite is found for between-laboratory testing.

Method 2 gives higher average tear values than method 1. The grain direction has no significant influence on the magnitude of the tear strength.

Table A.3 lists the results obtained in a previous ITP conducted in 1987 for ISO 34-1. The ISO 34-2 ITP made use of the same three compound formulations as the ISO 34-1 programme. Thus a comparison of the precision of the two ISO test methods is possible. This is done in Table A.3.

Expressed on a relative basis since the measurement units are different in the two test methods, the precision obtained with the Delft test piece is, overall, better than that obtained with the trouser test piece. This superiority can be seen for both (r) and (R) with only some minor exceptions. This is perhaps not surprising since the Delft test piece is effectively a tensile test piece with a very large “flaw”.

Table A.3 — Comparison of ISO 34-1 and ISO 34-2

Tear strength values in newtons

Material	ISO 34-1			ISO 34-2		
	Average	(r)	(R)	Average	(r)	(R)
Trouser test piece (mill grain perpendicular)						
Compound A	3,68	24,7	35,0	36,7	11,9	35,1
Compound B	7,67	25,5	30,8	32,0	17,6	34,9
Compound C	22,8	38,0	60,7	129,8	30,0	48,2
Trouser test piece (mill grain parallel)						
Compound A	4,81	48,3	54,3	36,8	4,57	27,1
Compound B	8,34	35,0	35,0	31,4	12,7	22,2
Compound C	27,3	42,5	49,6	132,1	19,5	33,7
Die B (angle) test piece with notch (mill grain perpendicular)						
Compound A	13,2	29,4	35,7	36,7	11,9	35,1
Compound B	14,7	40,8	40,8	32,0	17,6	34,9
Compound C	62,1	49,6	60,9	129,8	30,0	48,2
Die C (crescent) test piece with notch (mill grain perpendicular)						
Compound A	29,9	22,8	103,7	36,7	11,9	35,1
Compound B	31,1	15,1	94,6	32,0	17,6	34,9
Compound C	124,0	23,5	38,0	129,8	30,0	48,2
NOTE 1 For both sets of tests (ISO 34-1 and ISO 34-2), the comparison is made on a common mill grain basis (either perpendicular or parallel).						
NOTE 2 The results for 34-2 were obtained using test pieces in which the width outside the slit was measured by method 1.						

ICS 83.060
Price based on 11 pages