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Replacing GB/T529-1999

Rubber, Vulcanized or Thermoplastic - Determination of Tear Strength (Trouser, Angle and Crescent Test Pieces)

(ISO 34-1:2004 Rubber, Vulcanized or Thermoplastic - Determination of Tear
Strength - Part 1: Trouser, Angle and Crescent Test Pieces, MOD)

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Foreword

This Standard is modified in relation to international standard ISO 34-1:2004 "Rubber, Vulcanized or Thermoplastic - Determination of Tear Strength - Part 1: Trouser, Angle and Crescent Test Pieces".

This Standard replaces GB/T 529-1999 "Rubber Vulcanized or Thermoplastic - Determination of Tear Strength (Trouser, Angle and Crescent Test Pieces)".

This Standard is redrafted according to ISO 34-1:2004, with the technical differences and reasons as follows:

In this Standard: If groups of test pieces are being compared, the median thickness of each group shall be within 7.5% of the total median thickness of all the groups (Chapter 9 in this edition). While ISO 34-1:2004 specifies that if groups of test pieces are being compared, the median thickness of each group shall be within 15% of the total median thickness of all the groups. Such specification is based on China's actual conditions.

For convenient application, the following editing revisions are made in this Standard:

- a) "This international standard" was replaced by "this Standard";
- b) The foreword in the international standard was deleted;
- c) The comma "," acting as decimal point was replaced by the decimal point ".".

The major differences of this part from GB/T 529-1999 are as follows:

- "Number of Test" (Chapter 7 in this edition) was added;
- Partial size of die used for cutting angle test pieces was modified: the tolerance $\pm 0.5^\circ$ for angle 90° was added; and the dimension $(27+0.05)$ mm and (28 ± 0.05) mm (Figure 2 in 1999 edition and this edition) were deleted.

Appendix A and B in this Standard are informative.

This Standard was proposed by China Petroleum and Chemical Industry Association.

This Standard shall be under the jurisdiction of the Subcommittee on Physical and Chemical Test Methods for Rubber of National Technical Committee 35 on Rubber and Rubber Products of Standardization Administration of China (SAC/TC 35/SC 2).

Drafting organization of this Standard: Giti Tire (Hualin) Co., Ltd.

Chief drafting staffs of this Standard: Han Lei, and Geng Fumin.

Rubber, Vulcanized or Thermoplastic - Determination of Tear Strength (Trouser, Angle and Crescent Test Pieces)

1 Scope

This Standard specifies three test methods for the determination of the tear strength of vulcanized and thermoplastic rubber, namely:

- Method A, using a trouser test piece;
- Method B, using an angle test piece, with or without a nick of specified depth;
- Method C, using a crescent test piece with a nick.

The value of tear strength obtained depends on the shape of the test piece, speed of stretching, temperature of test and calendaring effect of vulcanized rubber.

Method A: Using a trouser test piece

Using the trouser test piece is preferred because it is not sensitive to the length of the cut, unlike the other two test pieces in which the nick has to be very closely controlled. In addition, the results obtained are more easily related to the fundamental tear properties of the material and are less sensitive to modulus effects (provided that the leg extension is negligible) and the rate of propagation of the tear is directly related to the rate of grip separation. With some rubbers, the propagation of tear is not smooth (knotty tear), and analysis of results may be difficult.

Method B, procedure (a): Using an angle test piece without nick

This test is a combination of tear initiation and propagation. Stress is built up at the point of the angle until it is sufficient to initiate a tear and then further stresses propagate this tear. However it is only possible to measure the overall force required rupturing the test piece, and, therefore, the force cannot be resolved in two components producing initiation and propagation.

Method B, procedure (b): Using an angle test piece with nick

This test measures the force required to propagate a nick already produced in the test piece. The rate of propagation is not directly related to the jaw speed.

Method C: Using a crescent test piece

This test also measures the force required to propagate a nick already produced in the test piece and the rate of propagation is not related to the jaw speed.

Note: A method for the determination of the tear strength of small test pieces of rubber (Delft test pieces) is specified in ISO 34-2.

2 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. For dated reference, the subsequent modification or revisions of these publications do not apply. However, all parties who enter into an agreement according to this Standard are encouraged to study whether the latest edition of these documents is applicable. For undated references, the latest edition of the normative document is applicable to this Standard. For undated references, the latest edition of the normative document is applicable to this Standard.

GB/T 2941 Rubber - General Procedures for Preparing and Conditioning Test Pieces for Physical Test Methods (GB/T2941-2006, ISO 23529:2004, IDT)

GB/T 12833 Rubber and Plastics - Analysis of Multi-peak Traces Obtained in Determinations of Tear Strength and Adhesion Strength (GB/T 12833-2006, ISO 6133:1998, IDT)

GB/T 14838 Rubber and Rubber Products - Determination of Precision for Test Method Standards (GB/T 14838-1993, neq ISO/TR 9272:1986)

ISO 5893 Rubber and Plastics Test Equipment - Tensile, Flexural and Compression Types (Constant Rate of Traverse) - Specification

3 Terms and Definitions

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

3.1

Trouser tear strength

Median force, calculated in accordance with GB/T 12833, required propagating a cut in a specified trouser-shaped test piece by tearing, divided by the thickness of the test piece, the force acting in a direction substantially in the plane of the cut.

3.2

Unnicked angle tear strength

Means shall be provided for clamping the test piece firmly, to fix the nick on a certain position. The cutting tool, consisting of a razor blade or similar blade, shall be clamped in a plane perpendicular to the major axis of the test piece, and positioned so as to introduce the nick in the appropriate place. The blade clamping device shall permit no lateral movement and shall be fitted in guides to enable the blade to be moved across the test piece with its edge remaining perpendicular to the plane of the test piece. Alternatively, the blade may be fixed and the test piece arranged to move in an analogous manner. Means shall be provided for fine adjustment of the depth of the nick to make the nick depth meet relevant requirements. The adjustment of the position of the blade holder and/or clamped test piece shall be determined for each blade by cutting one or two preliminary nicks and measuring these with the aid of a microscope. The blade shall be wetted with water or soap solution prior to nicking.

Note: A suitable apparatus for nicking tear test pieces has been described in detail in the literature [4].

To check that the depth of the nick is within the specified limits (see 6.4), any suitable means may be used, for example an optical projection apparatus. A convenient arrangement is a microscope giving at least $\times 10$ magnification fitted with a travelling stage suitably illuminated. The eyepiece is fitted with a graticule or crosswire by which to record the travel of the stage and test piece through a distance equal to the depth of the nick. The travel of the stage is calibrated with a stage micrometer. Alternatively, a travelling microscope may be used.

The apparatus shall have an accuracy of measurement of 0.05 mm.

5.3 Testing machine

The machine shall conform to the requirements of ISO 5893, to an accuracy corresponding to grade B.

It shall be capable of registering the applied forces within during the test while maintaining the specified constant rate of separation of the jaws of (100 ± 10) mm/min for the trouser test piece and (500 ± 50) mm/min for the angle and crescent test pieces. A low-inertia machine having autographic force-recording facilities is essential when using the trouser test piece.

Note: Inertia (pendulum) type dynamometers are apt to give results which differ from each other because of frictional and inertial effects.

A low-inertia (for example electronic- or optical-transducer) type dynamometer gives results which are free from these effects and is therefore to be preferred.

5.4 Grips

The direction of tear propagation will be parallel to the length of the test piece for the trouser test piece and perpendicular for angle and crescent test pieces.

6.4 Each test piece shall be cut or nicked to a depth as given below by the apparatus specified in 5.2.

Method A (trouser test piece) — Cut of depth (40 ± 5) mm made at the centre of the width of the test piece in the direction indicated in Figure 1. It is important that the last 1 mm (approximately) of the cut is made with a razor blade or a sharp knife.

Method B, procedure (b) (angle test piece) — Nick of depth (1.0 ± 0.2) mm at the apex of the internal angle of the test piece (see Figure 2).

Method C (crescent test piece) — Nick of depth (1.0 ± 0.2) mm at the centre of the concave inner edge of the test piece (see Figure 3).

Test pieces may be nicked, measured and then tested immediately, but if not tested immediately they shall be kept at $(23\pm 2)^{\circ}\text{C}$ or $(27\pm 2)^{\circ}\text{C}$, as the case may be, until tested. The period between nicking of the test piece and testing shall not exceed 24h.

The cut or nick shall be made after any ageing treatment has been carried out.

7 Number of Test

At least five test pieces per sample shall be tested and, where possible, five from each of the directions referred to in 6.3.

8 Temperature of Test

The test is normally carried out at a standard laboratory temperature of $(23\pm 2)^{\circ}\text{C}$ or $(27\pm 2)^{\circ}\text{C}$, as specified in GB/T 2941. When other temperatures are required, these shall be selected from GB/T 2941.

If the test is to be carried out at a temperature other than a standard laboratory temperature, the test piece shall be conditioned for a period sufficient to reach substantial temperature equilibrium at the test temperature, immediately prior to testing. This period shall be kept as short as possible in order to avoid ageing the rubber (see GB/T 2941).

The same temperature shall be used throughout any one test or series of tests intended to be comparable.

9 Procedure

Measure the thickness of the test piece in the region in which tearing is expected to occur, in accordance with GB/T 2941. No measurement on any one test piece shall

11.2.2 A total of 25 laboratories conducted tests for method B and method C, while 22 laboratories conducted tests on the trouser test pieces. For all test pieces, tests were conducted on each of two “test days” one week apart. A test result (as used for the analysis) consists of the median value of five individual tear tests. The precision evaluated is a Type 1 precision; no mixing or curing of compounds was done in the participating laboratories.

11.3 Precision results

The precision results for all tests are given in Table 1. See Appendix A for guidance on using precision results.

The symbols used in Table 1 are as follows:

- r — The repeatability, measurement units;
- (r) — The repeatability, as percentage of material average;
- R — The reproducibility, measurement units;
- (R) — The reproducibility, as percentage of material average.

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

12 Test Report

The test report shall include the following particulars:

- a) The name or serial number of this Standard;
- b) All details necessary for identification of the sample;
- c) The type of test piece used;
- d) The median and range of values of tear strength, in kilonewtons per metre, calculated e) in accordance with Chapter 10, for each direction, plus all the individual results;
- e) The median thickness of each test piece;
- f) The direction of the applied force relative to the grain in the rubber;
- g) The temperature of test;
- h) For method B, whether the test piece was nicked or unnicked;

Appendix A (Informative) Guidance for Using Precision Results

A.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.

A.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.3 With these r and (r) values, the following general repeatability statements may be used to make decisions.

A.3.1 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.

A.3.2 For a percentage difference between two test (value) averages: The percentage difference $[x_1 - x_2] / [(x_1 + x_2) / 2] \times 100$ 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.

A.4 With these R and (R) values, the following general reproducibility statements may be used to make decisions.

A.4.1 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.

A.4.2 For a percentage difference $[x_1 - x_2] / [(x_1 + x_2) / 2] \times 100$ between two test (value) averages: The percentage difference 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.

Appendix B
(Informative)
Formulations for Compounds A, B and C Used in ITP

Material	Value in parts by mass		
	A	B	C
Natural rubber	32	-	83
SBR1500	68	100	17
N550 Carbon black	66	—	-
N339 Carbon black	—	35	—
N234 Carbon black	—	—	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

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