International Standard 5600

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Rubber — Determination of adhesion to rigid materials using conical shaped parts

Caoutchouc — Détermination de l'adhérence aux matériaux rigides au moyen de pièces coniques

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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.

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. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 5600 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*.

This second edition cancels and replaces the first edition (ISO 5600-1979), of which it constitutes a minor revision.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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Rubber — Determination of adhesion to rigid materials using conical shaped parts

1 Scope and field of application

1.1 This International Standard specifies a method for the determination of the static vulcanized adhesion strength of rubber compounds to rigid materials. The test piece is composed of two conical ends of the rigid material, joined by a cylinder of rubber.

1.2 The adhesion is obtained by a bonding system which may include not only the rigid material and the rubber compound, but other elements such as thin alloy coatings or chemical treatments of rigid parts and either a single cement or both primer and cover cements. The bonding system for preparing the test pieces should be adequately specified by the user but provision is made in this International Standard for the evaluation of different types of failure related to a complex adhesive system.

1.3 The method is designed primarily to apply to test pieces prepared in the laboratory under standard conditions in order to provide data for development and control of bonding systems and their components, such as cements or special rubber compounds, and of methods of manufacture. While intended to be applied where the rubber is bonded to supporting rigid pieces, it may not cover such cases where the support, although of high modulus material, has a low rigidity due to small transverse dimensions, as in the case of rubber bonded to metal wires, cords or thin sheets.

2 References

ISO 471, *Rubber — Standard temperatures, humidities and times for the conditioning and testing of test pieces.*

ISO 1826, *Rubber, vulcanized — Time interval between vulcanization and testing — Specification.*

ISO 4648, *Rubber, vulcanized — Determination of dimensions of test pieces and products for test purposes.*

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

3 Principle

3.1 The test consists in measuring the force required to cause the rupture of a test piece of standard dimensions, comprising a cylindrical rubber bonded to two conical and rigid parts.

3.2 The particular geometry of the test piece produces in most cases an interfacial failure between rubber and conical parts, because of a stress concentration at the tip of the cones.

4 Apparatus

4.1 Tensile testing machine, complying with the requirements of ISO 5893, capable of measuring force with an accuracy corresponding to grade B as defined in ISO 5893, and with a rate of traverse of the moving grip of 50 ± 5 mm/min.

NOTE — Inertia (pendulum) type dynamimeters are apt to give results which differ because of inertial effects. A low-inertia type dynamometer (for example, using electronic or optical transducer) gives results which are free from this effect, and is therefore to be preferred.

4.2 Fixtures, for holding the test pieces in the testing machine, which permit accurate centring of the applied load during the test.

5 Test piece

5.1 Form and dimensions

The standard test piece (see the figure) is formed by two cylindrical rigid parts terminated by opposite conical ends, and a cylinder of rubber bonded to the conical ends.

The determination of dimensions of the test piece shall be in accordance with ISO 4648.

The diameter of this cylinder and of the cylindrical portion of the rigid parts shall be 25 ± 0,5 mm. The distance between the tips of the conical ends shall be 12 ± 1 mm; the half-angle of the cone vertex shall be 45° ± 1° and the tip shall be rounded to a radius not greater than 0,8 mm.

The cylindrical portion of each rigid part shall be not less than 5 mm in length and shall be terminated so as to match with the holding jaws (4.2) of the testing machine (4.1).

Dimensions in millimetres

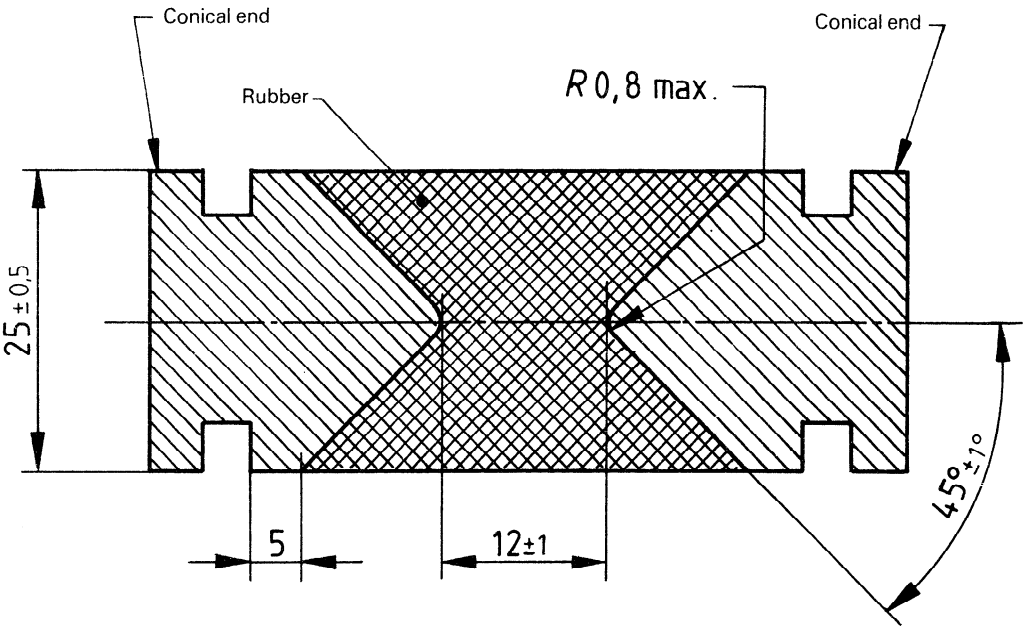

Figure — Standard test piece

5.2 Materials

The materials used shall conform to the specifications for the bonding system to be investigated.

If no specification is given for the material for the rigid parts, they shall be made from low carbon steel bar and their conical ends shall be grit-blasted.

5.3 Preparation

5.3.1 Clean the surface of the conical ends or treat in accordance with the adhesion system under investigation and, if so specified, coat with primer and/or cover cement.

Spread the adhesive coating over the conical area only.

5.3.2 During the preparation of the test piece, take great care when handling the materials to keep the bonding surfaces of the rubber and rigid parts free from dust, moisture and foreign matter. Do not touch the treated conical surfaces by hand during assembly.

5.3.3 Vulcanize the test pieces in a suitable transfer mould, properly insulated, provided with heaters and compression devices. Place the rigid parts and the rubber compound in the preheated mould for vulcanization. Use sufficient unvulcanized compound to fill the pot and provide some excess after filling the mould cavities.

NOTE — The mould design should take account of the fact that machining the rigid parts for re-use will gradually reduce their size.

5.3.4 Carry out the vulcanization under the specified conditions of time, temperature and pressure.

5.3.5 At the conclusion of the cure, take great care when removing the test pieces from the mould to avoid subjecting the bonded surfaces to undue stress before the test pieces have cooled.

5.4 Number of test pieces

Prepare and test a minimum of three test pieces.

5.5 Conditioning of test pieces

5.5.1 Condition the test pieces in accordance with the requirements of ISO 471 for at least 16 h at a standard laboratory temperature immediately before test. The standard laboratory temperature is (23 ± 2 °C or 27 ± 2 °C), the same temperature being used throughout any one test or series of tests intended to be comparable.

5.5.2 The time-interval between vulcanization and testing shall be in accordance with the requirements of ISO 1826.

6 Procedure

6.1 Mount the test piece in the fixtures (4.2) of the tensile testing machine (4.1). Take extreme care in centring and adjusting the test piece so that the tension is symmetrically distributed in the cross-section during the test.

6.2 Apply the tension by separating the jaws at a constant rate of 50 ± 5 mm/min until the test piece breaks. Record the maximum force.

6.3 Recover the broken test pieces and examine the failure surfaces.

7 Expression of results

7.1 Adhesion value

Express the adhesion value, in newtons, required to produce failure. In cases where the failure is in the rubber bulk, the adhesion value is recognized as being higher than that recorded.

7.2 Type of adhesion failure

Express the type of adhesion failure, as determined by examination of broken test pieces, by one or more of the following symbols:

R failure in the rubber bulk;

RC failure at the rubber/cover cement interface;

CP failure at the cover cement/primer cement interface;

M failure at the metal/primer cement interface.

Each symbol shall be followed by the percentage of the conical surface involved in that type of failure, estimated to the nearest 5 %.

NOTE — The estimated percentage of the various types of failure may be expressed as in the following examples:

R — 50, RC — 50 means that roughly 50 % of the showed failure in the rubber and the other 50 % showed failure at the rubber/cover cement interface.

R — 25, RC — 25, M — 50 means three types of failure present, with the M indicating 50 % failure at the metal/primer cement interface.

8 Test report

The test report shall include the following information:

a) a reference to this International Standard;

b) the adhesion values for each test piece, in newtons;

c) a description of the types of failure for each test piece, expressed in accordance with 7.2;

d) a description of the adhesion system used, including materials, treatments and rubber cure. If the materials are of undisclosed composition, sufficient references shall be given to identify them;

e) date of vulcanization;

f) date of test;

g) time and temperature of vulcanization;

h) temperature of test;

i) the type of dynamometer used;

j) any unusual features noted during the determination;

k) any operation not included in this International Standard or in the International Standards to which reference is made, or regarded as optional.

NOTE — Shown below is an example of a chart for reporting adhesion test results.

9 Salvaging of bonded metal parts

Bonded metal parts may be salvaged by the usual burning or chemical stripping techniques. Mechanical or chemical surface treatments may be used to re-establish a clean bonding surface.

The sharpness of the conical tip may be reduced during salvaging; this affects reproducibility of the test results, and care must be taken to re-establish the sharpness of the cone to a radius of 0,8 mm or less.

Example of form for reporting adhesion test results															ISO 5600
Sample No.	Compound designation	Cure temperature °C	Cure time min	Substrate treatment	Dates of		Adhesion N	Type of break, %				Laboratory temperature °C	Testing equipment	Adhesive system	Comments
					vulcanization	test		R	RC	CP	M				

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