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

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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 5600 was developed by Technical Committee ISO/TC 45, *Rubber and rubber products*, and was circulated to the member bodies in February 1977.

It has been approved by the member bodies of the following countries :

Austria	Italy	Sweden
Belgium	Mexico	Switzerland
Bulgaria	Netherlands	Turkey
Canada	Poland	United Kingdom
Czechoslovakia	Romania	U.S.A.
Germany, F.R.	South Africa, Rep. of	U.S.S.R.
India	Spain	Yugoslavia
Ireland	Sri Lanka	

The member body of the following country expressed disapproval of the document on technical grounds :

France

Printed in Switzerland

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 measuring 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 PRINCIPLE

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

2.2 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.

3 APPARATUS

3.1 Testing machine, capable of recording within 2 % the maximum force obtained during the test, and of maintaining the specified constant rate of separation of the jaws.

NOTE — Inertia (pendulum) type dynamometers 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.

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

4 TEST PIECE

4.1 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 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 12,0 ± 1 mm; the half-angle of the cone vertex shall be 45 ± 1° and the tip shall not be rounded to a radius 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 (3.2) of the testing machine (3.1).

Dimensions in millimetres

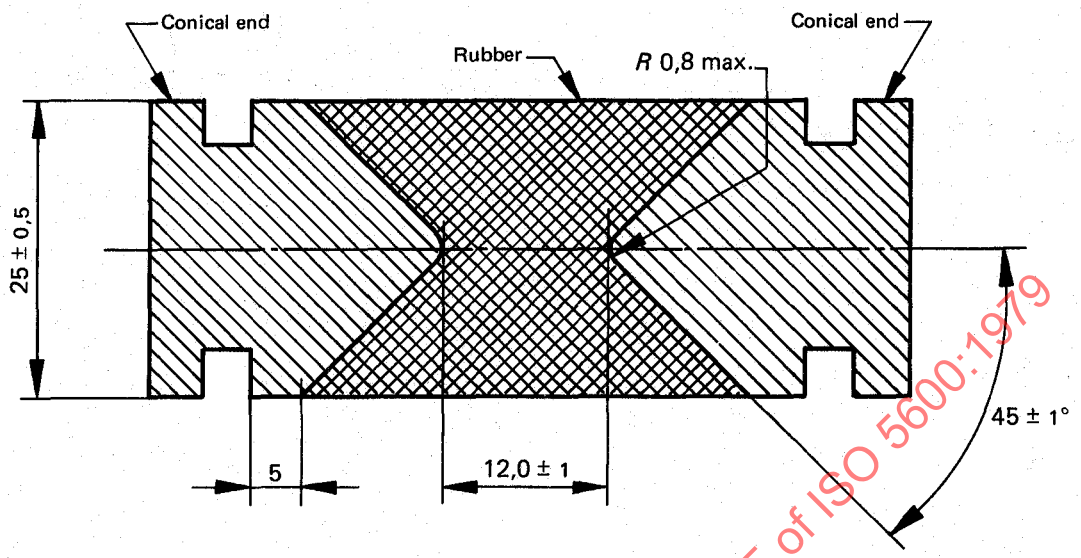

FIGURE — **Standard test piece**

4.2 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.

4.3 Preparation

4.3.1 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.

4.3.2 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.

4.3.3 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.

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

4.3.5 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.

4.4 Number of test pieces

Prepare and test a minimum of three test pieces.

4.5 Conditioning of test pieces

4.5.1 Condition the test pieces 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.

4.5.2 The time between vulcanization and testing shall not exceed 6 days.

5 PROCEDURE

5.1 Mount the test piece in the jaws (3.2) of the testing machine (3.1). Take extreme care in centring and adjusting the test piece so that the tension is symmetrically distributed in the cross-section during the test.

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

Record and note the maximum force.

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

6 EXPRESSION OF RESULTS

6.1 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.

6.2 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 area 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.

7 TEST REPORT

The test report shall include the following particulars :

a) a reference to this International Standard;

b) 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;

c) the dates of test piece preparation and testing;

d) the standard laboratory temperature used;

e) the type of dynamometer used;

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

g) the types of failure for each test piece, expressed as in 6.2.

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

8 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 number	Compound designation	Cure temperature °C	Cure time minutes	Substrate treatment	Date of preparation	Date of test	Adhesion newtons	Type of break, % R	RC	CP	M	Laboratory temperature °C	Testing equipment	Adhesive system	Comments