METHODS OF TESTING VULCANIZED RUBBER

PART A28. DETERMINATION OF ADHESION OF VULCANIZED RUBBER TO RIGID PLATES IN SHEAR (QUADRUPLE SHEAR TEST)

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THIS BRITISH STANDARD, having been approved by the Rubber Industry Standards Committee, was published under the authority of the Executive Board on 22 July, 1970.

SBN: 580 06271 6

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This standard makes reference to the following British Standard:

BS 1610. Methods for the load verification of testing machines.

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The following BSI references relate to the work on this standard:
Committee references RUC/10 and RUC/10/4
Draft for comment 68/21328

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The Rubber Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government department and scientific and industrial organizations.

British Association of Synthetic Rubber Manufacturers
*British Rubber Manufacturers' Association Ltd.
*Institution of the Rubber Industry
*Ministry of Technology
*Natural Rubber Producers' Research Association
*Rubber and Plastics Research Association of Great Britain
Rubber Growers' Association
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National College of Rubber Technology
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BRITISH STANDARD

METHODS OF TESTING VULCANIZED RUBBER

Part A28. Determination of adhesion of vulcanized rubber to rigid plates in shear (Quadruple shear test)

FOREWORD

This British Standard has been prepared under the authority of the Rubber Standards Industry Committee.

It is based on a document* which is now being considered by Technical Committee 45—Rubber, of the International Organization for Standardization (ISO).

Attention is drawn to the marked similarities between this method and that described in Part A14†.

METHOD

1. SCOPE

This part of this British Standard describes a procedure for determining the strength of bonds of rubber to metal or other rigid plates, where the rubber is assembled between four parallel rigid plates.

It is designed primarily to apply to test pieces prepared in the laboratory under standard conditions such as may be used to provide data for the development and control of rubber mixes and methods of manufacture of bonded shear units.

2. PRINCIPLE OF TEST

The test consists in measuring the force required to cause the rupture of a unit of standard dimensions comprising four parallelepipeds of rubber symmetrically disposed and bonded to four parallel rigid plates, the force being parallel to the bonding surfaces.

* At present Draft ISO Recommendation No. 1747

† BS 903, Part A14, ' Determination of modulus in shear of rubber (bonded quadruple shear test piece).

3. ADHESION FAILURE TERMINOLOGY

(1) R indicates the failure is in the rubber.

(2) RC indicates the failure is at the interface between the rubber and the cover cement.

(3) CP indicates the failure is at the interface between the cover cement and prime cement.

(4) M indicates the failure is at the interface between the rigid plate and the prime cement.

4. APPARATUS

4.1 Testing machine. A tensile testing machine conforming to the requirements of BS 1610*, Grade B, shall be used. It shall be capable of accurately registering the applied forces during the test while maintaining the specified constant rate of separation of the jaws of 50 ± 5 mm per minute.

NOTE. Inertia (pendulum) type dynamometers are apt to give results which differ because of frictional or inertial effects. An inertialess (for example, electronic or optical transducer) type dynamometer gives results which are free from these effects and is therefore to be preferred.

4.2 Fixtures. The fixtures for holding the test pieces in the grips shall be provided with a universal joint to permit accurate centring of the line of action of the applied force.

5. STANDARD TEST PIECE

5.1 Dimensions of test piece. The standard test piece shall consist of four identical parallelepipedic rubber elements 4 ± 0·1 mm thick, $20^{+0}_{-0{\cdot}1}$ mm wide and 25 ± 0·1 mm long, bonded on each of their two largest opposite faces to the mating faces of four rigid plates of the same width and of appropriate lengths to obtain a symmetrical double sandwich arrangement, means being provided at the free external end of each central plate to secure its further assembly to the corresponding holding fixture. The thickness of the rigid plates shall be $5^{+0}_{-0{\cdot}1}$ mm. A typical test piece is shown in Fig. 1.

5.2 Preparation of test piece. The standard test piece shall be prepared as follows.

5.2.1 Rectangular plates of the standard dimensions shall be prepared from the rigid material being investigated.

* BS 1610, 'Methods for the load verification of testing machines'.

5.2.2 The plates shall be prepared and treated in accordance with the adhesion system being investigated.

5.2.3 Unvulcanized rubber blanks shall be cut using a die of such size that a limited amount of flash is obtained on moulding.

5.2.4 The rigid plates and rubber blanks shall then be disposed for vulcanization in the mould. Moulding may be performed in two different ways:

(1) Compression moulding, where individual rubber blanks treated in accordance with the adhesion system used are preassembled in the mould between the rigid plates.

(2) Transfer moulding, where a single rubber blank is transferred into a plurality of cavities through appropriate nozzles.

A suitable type of transfer mould accommodating the elements for six test pieces (24 cavities) is shown in Fig. 2.

5.2.5 During the preparation of the test pieces great care shall be taken to keep the exposed surfaces of the rubber and plates free from dust, moisture and foreign matter. The treated surfaces shall not be touched by hand during assembly.

5.2.6 The vulcanization shall be carried out by heating the mould under pressure for a definite time at a controlled temperature.

5.2.7 At the conclusion of the vulcanization, great care shall be taken in removing the test pieces from the mould to avoid subjecting the adhered surfaces to undue stress.

5.3 Number of test pieces. Five test pieces shall be tested.

5.4 Conditioning of test pieces. Unless otherwise specified for technical reasons the following procedures shall be used.

For all test purposes the minimum time between vulcanization and testing shall be 16 hours.

The maximum time between vulcanization and testing should be 4 weeks.

For evaluations intended to be comparable, the tests should, as far as possible, be carried out after the same time interval.

For tests at 20 ± 2 °C prepared test pieces shall be conditioned immediately before testing for a minimum of 16 hours at a temperature of 20 ± 2 °C (this may be the same 16 hours as that between vulcanization and testing).

If a lower or higher test temperature is used the temperature should be selected from the following preferred temperatures: −75, −55, −40, −25, −10, 0, +40, +50, +70, +85, +100, +125, +150, +175, +200, +225, +250 °C.

The test pieces should be conditioned at the selected temperature for a period of time sufficient to reach temperature equilibrium with the testing environment, or for the period of time required by the specification covering the material or product being tested, and should then be tested immediately.

6. PROCEDURE

Mount the test piece in the test machine, care being taken to ensure freedom of self alignment with the direction of force application. Apply increasing, steady traction forces at the rate of separation of 50 ± 5 mm per minute until the test piece breaks. Record the maximum force applied.

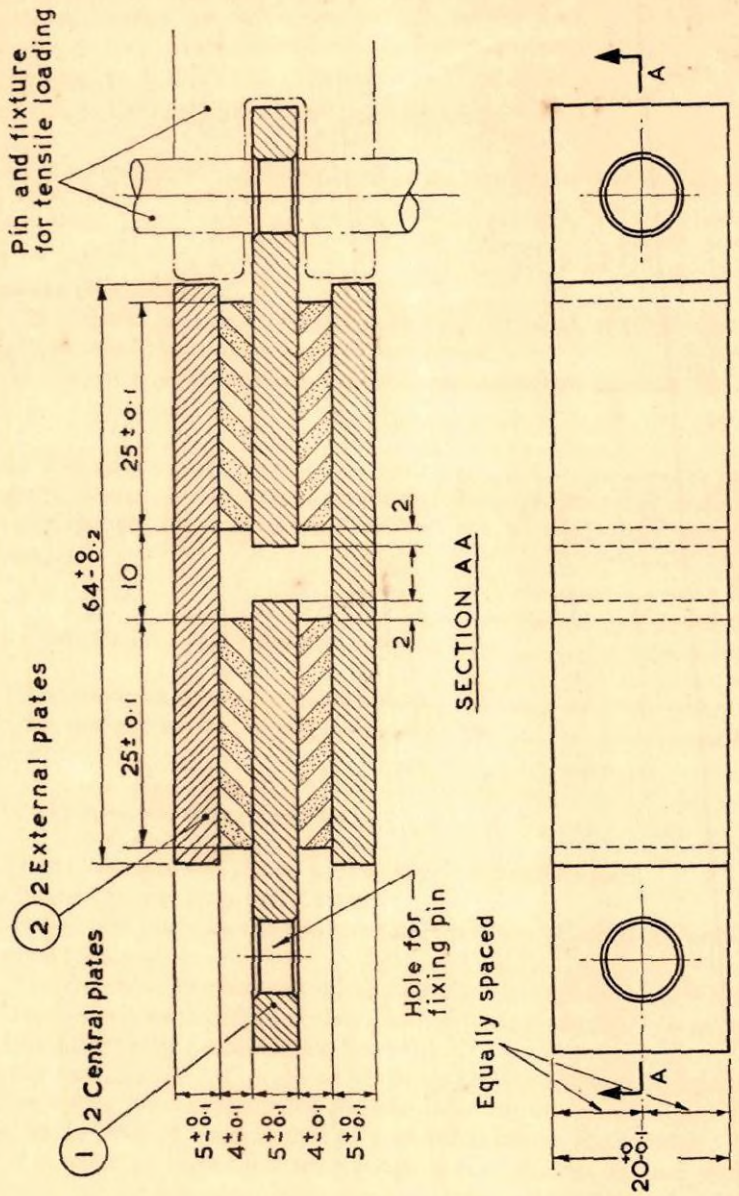
7. EXPRESSION OF RESULTS

The adhesion value, expressed in newtons per square metre, is calculated by dividing the applied force by the total bonded area of one of the double sandwiches on the corresponding central rigid plate, i.e. $2 \times 20 \times 25$ mm^2.

8. TEST REPORT

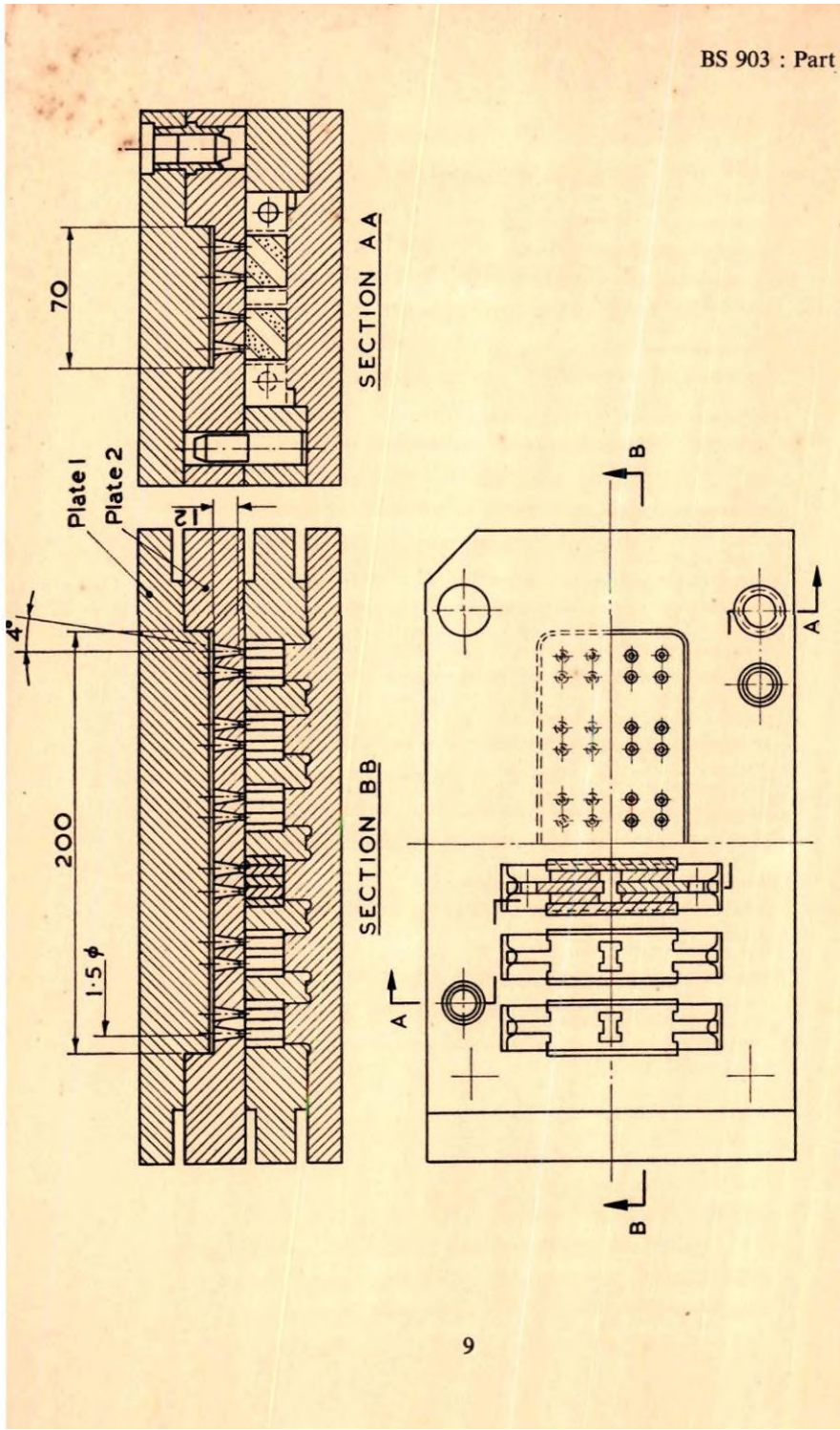
The test report should state:

(1) The result, calculated in accordance with Clause 7, for adhesion value. All five sets of test results shall be stated.
(2) A description of the type of failure in accordance with Clause 3.
(3) Identification of the rubber mix.
(4) Nature of the rigid plates.
(5) A description of the method of securing adhesion.
(6) Moulding process.
(7) Time and temperature of vulcanization.
(8) Date of vulcanization.
(9) Date of test.
(10) Temperature of test, if other than 20 ± 2 °C.



All dimensions are in millimetres

Fig. 1. Typical test piece



All dimensions are in millimetres

Fig. 2. Suitable transfer mould

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