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ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION R 1827

DETERMINATION OF MODULUS IN SHEAR
OF VULCANIZED RUBBERS

(BONDED QUADRUPLE SHEAR TEST PIECE)

1st EDITION

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BRIEF HISTORY

The ISO Recommendation R 1827, *Determination of modulus in shear of vulcanized rubbers (Bonded quadruple shear test piece)*, was drawn up by Technical Committee ISO/TC 45, *Rubber*, the Secretariat of which is held by the British Standards Institution (BSI).

Work on this question led to the adoption of Draft ISO Recommendation No. 1827, which was circulated to all the ISO Member Bodies for enquiry in April 1969.

The Draft has been approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Australia	India	Spain
Austria	Iran	Sweden
Brazil	Israel	Switzerland
Canada	Netherlands	Thailand
Ceylon	New Zealand	Turkey
Czechoslovakia	Peru	U.A.R.
France	Poland	United Kingdom
Greece	Portugal	U.S.S.R.
Hungary	South Africa, Rep. of	

No Member Body opposed the approval of the Draft.

This Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided to accept it as an ISO RECOMMENDATION.

DETERMINATION OF MODULUS IN SHEAR OF VULCANIZED RUBBERS

(BONDED QUADRUPLE SHEAR TEST PIECE)

1. SCOPE

This ISO Recommendation describes a procedure for determining the modulus in shear of rubber bonded between four parallel plates.

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

2. PRINCIPLE

The test consists in measuring the forces required to obtain a range of predetermined shear distortions of a unit of standard dimensions comprising four parallelepipeds of rubber symmetrically disposed and bonded to four parallel plates, the forces being parallel to the bonding surfaces and, as a rule, non destructive, i.e. of maximum values appreciably lower than the bond strength.

3. APPARATUS

3.1 *Testing machine*, conforming to the requirements of national standards for verification of testing machines. It should be capable of accurately measuring the deformations and registering the applied forces during the test while maintaining the specified constant rate of separation of the jaws of 25 ± 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.

3.2 *Fixtures*, for holding the test pieces in the grips, provided with a universal joint to permit accurate centering of the line of action of the applied force.

4. TEST PIECE

4.1 Dimensions of test piece

The standard test piece consists of four identical parallelepipedal rubber elements 4 ± 0.1 mm thick, 20 ± 0.1 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 should be $5 \begin{smallmatrix} 0 \\ -0.1 \end{smallmatrix}$ mm. A typical test piece is shown in Figure 1.

4.2 Preparation of test pieces

The standard test piece should be prepared as follows :

- 4.2.1 Rectangular rigid plates of the standard dimensions should be prepared and treated in accordance with a normal adhesion system.
- 4.2.2 Unvulcanized rubber blanks should be cut using a die of such size that a limited amount of flash is obtained on moulding.
- 4.2.3 The rigid plates and rubber blanks should then be disposed for vulcanization in the mould. Moulding may be performed in two different ways :
 - (a) by compression moulding, where individual rubber blanks are preassembled in the mould between the rigid plates;
 - (b) by transfer moulding, where a single rubber blank is transferred into a plurality of cavities through appropriate nozzles.

A suitable type of transfer mould accommodating six test parts (24 cavities) is shown in Figure 2.

- 4.2.4 The vulcanization should be carried out by heating the mould for a definite time at controlled temperature under pressure.
- 4.2.5 At the conclusion of the vulcanization, great care should be taken in removing the test pieces from the mould to avoid subjecting the adhered surfaces to undue stress.

4.3 Number of test pieces

Three test pieces should be tested.

5. TIME LAPSE BETWEEN VULCANIZATION AND TESTING

Unless otherwise specified for technical reasons the following procedures should be used :

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

The maximum time between vulcanization and testing should be 4 weeks, and for evaluations intended to be comparable the test should, as far as possible, be carried out after the same time interval.

6. CONDITIONING OF TEST PIECES

- 6.1 When a test is made at a standard laboratory temperature, the prepared test pieces should be maintained at the conditions of test for at least 16 hours immediately before testing.
- 6.2 When tests are made at higher or lower temperatures, the test pieces should be maintained at the conditions of test 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 immediately tested.

7. TEMPERATURE OF TEST

The test should normally be carried out in a standard atmosphere as specified in clause 3.2 of ISO Recommendation R 471, *Standard atmospheres for the conditioning and testing of rubber test pieces*, that is $20 \pm 2^\circ\text{C}$, $23 \pm 2^\circ\text{C}$ or $27 \pm 2^\circ\text{C}$. When other temperatures are used these should be selected from the following list of preferred temperatures :

– 75, – 55, – 40, – 25, – 10, 0, 40, 50, 70, 85, 100, 125, 150, 175, 200, 225, and 250°C .

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

8. PROCEDURE

After conditioning as described in section 6, immediately mount the test piece in the test machine, taking care to ensure freedom of longitudinal self-alignment with the direction of force application. Carry out at least five successive, steady, non-destructive, loading and release cycles corresponding to the whole range of shear distortions under investigation, prior to actual deformation measurements, in order to reach a stabilized stress-strain behaviour of the rubber to eliminate the so called "Mullins" effect. Zero the force and distortion measuring apparatus while maintaining a slight traction force, for example about 10 N. Immediately apply an increasing traction force at a rate of separation of the jaws of 25 ± 5 mm/min until the maximum shear strain under investigation is reached.

Record the forces corresponding to the predetermined fixed values of deformation or alternatively the deformations at a predetermined fixed force.

9. EXPRESSION OF RESULTS

- 9.1 The shear stress, expressed in newtons per square metre, should be calculated by dividing the applied force by twice the bonded area, that is $20 \times 25 \times 10^{-6} \text{ m}^2$.
- 9.2 The shear strain should be calculated by dividing one half the actual deformation of the test piece by the sheared thickness (both expressed in the same units of length).
- 9.3 The mean apparent shear modulus, expressed in newtons per square metre at any value of the shear strain should be calculated as the ratio of the corresponding shear stress to the shear strain.

10. TEST REPORT

The test report should include the following particulars :

- (a) the results, for all three test pieces, calculated in accordance with section 9, for the apparent shear modulus at various shear strains;
- (b) identification of the rubber mix;
- (c) moulding process (compression, transfer, casting, etc.);
- (d) duration and temperature of vulcanization;
- (e) temperature of test;
- (f) date of vulcanization;
- (g) date of test;
- (h) failure of test part, if any.

