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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION

R 37

DETERMINATION OF TENSILE STRESS-STRAIN PROPERTIES OF VULCANIZED RUBBERS

2nd EDITION

September 1968

This second edition supersedes the first edition

Printed in Switzerland

Also issued in French and Russian. Copies to be obtained through the national standards organizations.

BRIEF HISTORY

The ISO Recommendation R 37, *Determination of tensile stress-strain properties of vulcanized natural and synthetic rubbers,* 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 by the Technical Committee began in 1948 and led, in 1953, to the adoption of a Draft ISO Recommendation.

In August 1954, this Draft ISO Recommendation (No. 53) was circulated to all the ISO Member Bodies for enquiry. It was approved by 23 Member Bodies. One Member Body (the U.S.A.) opposed the approval of the Draft.

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council which decided, in March 1957, to accept it as an ISO RECOMMENDATION

BRIEF HISTORY RELATING TO THE 2nd EDITION

Work for the revision of ISO Recommendation R 37-1957 was subsequently started and, in 1962, a draft proposal was adopted by the Members of Technical Committee ISO/TC 45 as a Draft ISO Revision.

In November 1963, this Draft ISO Revision (No. 634) was circulated to all the ISO Member Bodies for enquiry. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Argentina	Germany	Poland
Australia	Hungary	Spain
Austria	India	Sweden
Brazil	Israel	Switzerland
Canada	Italy	United Kingdom
Chile	Korea, Rep. of	U.S.A.
Colombia	Morocco	U.S.S.R.
Czechoslovakia	Netherlands	Yugoslavia
France	New Zealand	

One Member Body opposed the approval of the Draft :

Japan

The Draft ISO Revision was then submitted by correspondence to the ISO Council which decided, in September 1968, to accept it.

The title of ISO Recommendation R 37-1957 is amended as follows : *Determination of tensile stress-strain properties of vulcanized rubbers.*

This edition (2nd edition) supersedes the first edition of ISO Recommendation R 37-1957.

ISO Recommendation R 37 September 1968

DETERMINATION OF TENSILE STRESS-STRAIN PROPERTIES OF VULCANIZED RUBBERS

1. SCOPE

This ISO Recommendation describes a method for the determination of tensile stress-strain properties of vulcanized rubbers.

2. PRINCIPLE OF METHOD

Standard test pieces, either in the shape of rings or dumb-bells, as described below, are stretched to breakage in a tension-testing machine capable of a substantially constant rate of traverse of the moving grip or pulley.

NOTES

1. Test pieces in the shape of rings and dumb-bells do not necessarily give the same values for the stress-strain properties. This is due mainly to the fact that in stretched rings the stress is not uniform over the cross-section. A second factor is the existence of grain, which may cause dumb-bells to give different values according as their length is parallel or perpendicular to the grain.

2. Rings give lower, sometimes much lower, tensile strength values than dumb-bells, the latter being much nearer to the true tensile strength of the rubber. The estimation of true tensile strength from ring data involves extrapolation of the stress-strain curve.*

3. APPARATUS

The tensile test machine should be capable of a substantially constant rate of traverse of the moving grip or pulley. This rate should be 500 ± 50 mm/min.

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

4. TEST PIECE

4.1 Dimensions of test piece

The test piece should be either in the shape of a ring or a dumb-bell, as described below.

(*a*) *Ring test piece*

Rings should be nominally of internal diameter 44.6 mm and external diameter 52.6 mm, the radial width nowhere deviating by more than ± 0.2 mm from the mean width. The thickness should be preferably between 4 and 6 mm. In any one ring the thickness should nowhere deviate by more than ± 0.2 mm from the mean thickness.

* See W.H. Reece, *Transactions of the Institution of the Rubber Industry*, 1935, 11, 312, and J.R. Scott, *Journal of Rubber Research* 1949, 18, 30.

(*b*) *Dumb-bell test piece*

The shape of test piece should be determined by the die dimensioned as given in the Figure and the Table below.

Gauge marks should be provided and not be more than 25 mm apart for a Type 1 test piece and not more than 20 mm apart for a Type 2 test piece. They are equidistant from the ends of the central parallel-sided part of the test piece. A Type 1 test piece should be used whenever practicable.

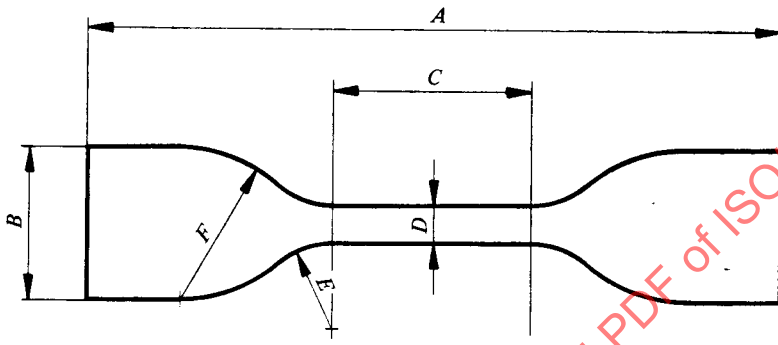

FIGURE – **Die**

TABLE – **Dimensions of test piece**

Dimension		Type 1	Type 2
		mm	mm
A	Overall length (minimum)	115	75
B	Width of ends	25 ± 1	12.5 ± 1.0
C	Length of narrow parallel portion	33 ± 2	25 ± 1
D	Width of narrow parallel portion *	$6.0^{+0.4}_{-0.0}$	4.0 ± 0.1
E	Small radius	14 ± 1	8.0 ± 0.5
F	Large radius	25 ± 2	12.5 ± 1.0
	Thickness, maximum	3	2.5

* The variation within any one die should not exceed 0.05 mm

4.2 Measurement of test pieces

(*a*) *Ring test pieces*

Thickness should be measured by a micrometer gauge the foot of which exerts a pressure of 0.2 bar on the rubber. The width should be measured in the same way, but using a gauge with curved feet to fit the curvature of the ring.

For precise work, the cross-section of the ring should be calculated from its mass, density and mean circumference; for the ring specified in clause 4.1 (*a*) the circumference is

$$\pi \times 48.6 \text{ mm} = 152 \text{ mm}$$

(*b*) *Dumb-bell test pieces*

Thickness should be measured by a gauge as described in clause 4.2 (*a*).

The width of the test portion should be assumed to be equal to the width between the cutting edges of the narrow central part of the die. For this purpose the width of this part of the die should be measured to the nearest 0.05 mm.

4.3 Number of test pieces

Test at least three test pieces.

4.4 Conditioning of test pieces

The test pieces should be conditioned at the test temperature for not less than 16 hours immediately before testing.

5. TEMPERATURE OF TEST

Tests should be carried out at a standard laboratory temperature. The standard laboratory temperature should be 20 ± 2 °C, 23 ± 2 °C or 27 ± 2 °C, the same temperature being used throughout one test or series of tests intended to be comparable.

6. PROCEDURE

Fit the rings over two rotatable pulleys, 25 mm in diameter, at least one of which, preferably the moving pulley, is automatically rotated by the machine to equalize the strain in the ring while it is being stretched. Hold the dumb-bells at their widened ends in grips that tighten automatically as the tension increases and exert a uniform pressure across the width of the test piece.

Place the dumb-bell test piece centrally in the grip.

Means should be provided for obtaining the following measurements without stopping the machine :

(*a*) the force on the test piece;

(*b*) the elongation of the test piece, as shown by either the distance between the gauge marks on the dumb-bell, or the distance between the pulleys in tests on rings.

7. EXPRESSION OF RESULTS

The tensile strength is calculated using the formula :

(*a*) for rings $\frac{F}{2A}$ bar

(*b*) for dumb-bells $\frac{F}{A}$ bar

where

F is the breaking force, expressed in deci-newtons,

A is the initial cross-sectional area, expressed in square millimetres.

The elongation at break is calculated using the formula :

(*a*) for rings $\frac{I - I_o}{I_o} \times 100\ \%$

(*b*) for dumb-bells $\frac{L - L_o}{L_o} \times 100\ \%$

where

I is the internal circumference, expressed in millimetres, at break,

I_o is the initial internal circumference, expressed in millimetres,

L is the length, expressed in millimetres, between gauge marks at break,

L_o is the initial length, expressed in millimetres, between gauge marks.

The modulus is calculated using the formula :

(*a*) for rings $\frac{f}{2A}$ bar

(*b*) for dumb-bells $\frac{f}{A}$ bar

where

f is the force, expressed in deci-newtons, at the required elongation,

A is the initial cross-sectional area, expressed in square millimetres.

The elongation at constant stress is calculated using the formula :

(*a*) for rings $\frac{C - C_o}{C_o} \times 100\ \%$

(*b*) for dumb-bells $\frac{l - L_o}{L_o} \times 100\ \%$

where

C is the mean circumference, expressed in millimetres, at the required stress,

C_o is the initial mean circumference, expressed in millimetres,

l is the length, expressed in millimetres, between gauge marks at the required stress,

L_o is the initial length, expressed in millimetres, between gauge marks.

For tensile strength, elongation at break, modulus or elongation at constant stress, the result reported should be the middle value if an odd number of test pieces is used, or the average of the middle two values if an even number of test pieces is used, the various results being arranged in order of increasing values.