BRITISH STANDARD

BS 903 :
Part A5 : 1993
ISO 2285 : 1988

Physical testing of rubber

Part A5. Method for determination of tension set at normal and high temperatures

UDC [678.4 + .7] : 539.382

BSI STANDARDS

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Plastics and Rubber Standards Policy Committee (PRM/-) to Technical Committee PRM/22, upon which the following bodies were represented:

BP Chemicals Ltd.
British Railways Board
British Rubber Manufacturers' Association Ltd.
GAMBICA (BEAMA Ltd.)
Institution of Mechanical Engineers
Malaysian Rubber Producers' Research Association
Ministry of Defence
RAPRA Technology Ltd.
SATRA Footwear Technology Centre

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Contents

National foreword

This Part of BS 903 has been prepared under the direction of the Plastics and Rubber Standards Policy Committee. It is identical with ISO 2285 : 1988 *Rubber, vulcanized or thermoplastic — Determination of tension set at normal and high temperatures*, published by the International Organization for Standardization (ISO). This edition supersedes BS 903 : Part A5 : 1974, which is withdrawn.

This edition of Part A5 differs from the 1974 edition as follows.

a) Provision is made for the testing of thermoplastic rubbers.

b) Provision is made for testing ring-type test pieces.

Cross-references

International standard	Corresponding British Standard
	BS 903 *Physical testing of rubber*
ISO 471 : 1983	Part A35 : 1985 *Temperatures, humidities and times for conditioning and testing of test pieces* (Identical)
ISO 3383 : 1985	Part A32 : 1988 *General directions for achieving elevated or subnormal temperatures for test purposes* (Identical)
ISO 4661/1 : 1986	Part A36 : 1988 *Preparation of samples and test pieces* (Identical)

The Technical Committee has reviewed the provisions of ISO 1826 : 1981, to which normative reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard. A related British Standard to ISO 1826 is BS 903 *Methods of testing vulcanized rubber Part A19 : 1986 Heat resistance and accelerated ageing tests*.

Additional information. In the UK, the 'standard temperature' (see **4.5**) is 23 °C ± 2 °C.

NOTE. The 'standard temperature' is commonly referred to as the 'standard laboratory temperature'.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

INTERNATIONAL STANDARD ISO 2285 : 1988 (E)

Rubber, vulcanized or thermoplastic — Determination of tension set at normal and high temperatures

1 Scope

This International Standard specifies a method for determining the tension set characteristics of vulcanized or thermoplastic rubbers. The test is intended to measure the ability of rubbers of hardness within the range 30 to 94 International Rubber Hardness Degrees (IRHD) to retain their elastic properties after extension, at a standard temperature, to a specified strain which is maintained for a specified time at the same or at a specified higher temperature and then released at the standard temperature.

NOTE — Three types of test piece are described : strips, strips with enlarged ends and rings. Tests made with different types of test piece do not necessarily give the same value of tension set; neither will tests made at different temperatures necessarily place the materials in the same order of merit.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 471 : 1983, *Rubber — Standard temperatures, humidities and times for the conditioning and testing of test pieces.*

ISO 1826 : 1981, *Rubber, vulcanized — Time-interval between vulcanization and testing — Specification.*

ISO 3383 : 1985, *Rubber — General directions for achieving elevated or subnormal temperatures for test purposes.*

ISO 4661 : 1986, *Rubber, vulcanized — Preparation of samples and test pieces — Part 1 : Physical tests.*

3 Apparatus

3.1 Straining device, consisting of a metal rod or other suitable guide fitted with pairs of holders, one fixed and one movable, for the ends of the test piece. The holders shall be in the form of self-tightening clamps for strip test pieces, in the form of jaws to hold tab ends in a firm position for strip test pieces with enlarged ends, and in the form of flat pulleys of about 5 mm width and 10 mm diameter for ring test pieces.

If so desired, a means of operating the moving holder other than by hand may be provided, for example, a screwed rod, provided that the tolerances on extension speed are met (see 5.1). Suitable stops or graduations may also be provided to avoid over-extension in the initial straining of the test piece.

Straining devices shall be so designed that, when used at high temperatures in an oven, they can be placed with the reference lengths of the test pieces perpendicular to the direction of air flow; they shall also be of minimal mass in order to avoid excessive lag in the attainment of temperature equilibrium after introduction into an oven.

Multiple unit straining devices may be used, provided that the foregoing requirements are met.

3.2 Oven (if the test is to be carried out at a temperature above the standard temperature), conforming to the requirements of ISO 3383.

3.3 Measuring device, suitable for measuring length to the nearest 0,1 mm.

For strip test pieces, a bench marker shall be provided to mark the length used for measurement, hereinafter called the reference length.

For strip test pieces with enlarged ends, the length of the narrow portion shall be used as the reference length.

For ring test pieces, the reference length may alternatively be the inner diameter of the ring, in which case a graduated cone, allowing measurements to be made to the nearest 0,1 mm, may be used. If measurements are made on a straight reference length, a rigid channel, 3,5 mm deep and 20 mm wide for large ring test pieces, and 1,75 mm deep and 10 mm wide for small ring test pieces, shall be provided for straightening portions of such test pieces during marking and measuring of the reference length.

4 Test piece

4.1 Preparation

Test pieces shall be prepared in general accordance with ISO 4661-1.

4.1.1 Strip test piece

Strips between 2 and 10 mm wide shall be cut with a sharp die from a flat sheet 2 mm ± 0,2 mm thick of the material under test. A width of 6 mm is preferred. The sheets may be prepared by moulding or from finished articles by cutting and buffing.

Strip test pieces may have wider ends for easier clamping outside the reference length, for example dumb-bells.

The length of any given strip depends on the selected reference length and the type of straining device.

4.1.2 Strip test piece with enlarged ends

Test pieces of the shape shown in figure 1 shall be cut with a sharp die from a flat sheet 2 mm ± 0,2 mm thick of the material under test. The length of the narrow section (reference length) shall be between 25 and 50 mm. The sheets may be prepared by moulding or from finished articles by cutting and buffing.

Dimensions in millimetres

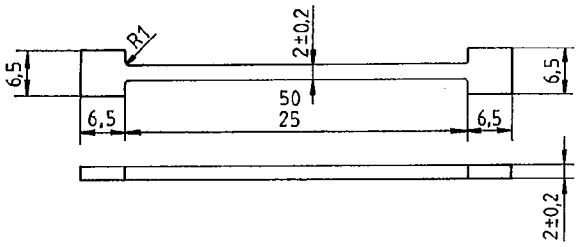

Figure 1 — Test piece with enlarged ends

4.1.3 Ring test piece

Ring test pieces shall be cut from a flat sheet by means of a pair of concentric circular dies or rotating cutters. The separation of the two cutting edges of such dies or cutters shall not differ from the average value by more than 0,05 mm. The sheets may be prepared by moulding or from finished articles by cutting and buffing.

The following two sizes of ring test piece may be used:

large ring test piece :

thickness : 4 mm ± 0,2 mm

outer diameter : 52,6 mm ± 0,2 mm

inner diameter : 44,6 mm ± 0,2 mm

small ring test piece :

thickness : 2 mm ± 0,2 mm

outer diameter : 33,5 mm ± 0,2 mm

inner diameter : 29,5 mm ± 0,2 mm

4.2 Marking

A reference length shall be marked on strip test pieces using a suitable bench marker and ink which does not affect the material and which withstands the temperature of test. The reference length shall be between 25 and 50 mm. The preferred length of strip test pieces and strip test pieces with enlarged ends is 50 mm. Ring test pieces shall be straightened by means of the rigid channel (see 3.3) and the reference length, preferably 40 mm for large ring test pieces and 25 mm for small ring test pieces, shall be marked on one of the straightened sides.

4.3 Number of test pieces

For each test, three test pieces shall be used.

4.4 Time-interval between vulcanization and testing

4.4.1 The time-interval between vulcanization and testing shall be in accordance with ISO 1826.

4.4.2 Samples and test pieces shall be protected from light as completely as possible during the interval between vulcanization and testing.

4.5 Conditioning

Prepared test pieces shall be conditioned immediately before testing for a minimum period of 3 h at one of the standard temperatures defined in ISO 471, the same temperature being used throughout any one test or series of tests intended to be comparable.

5 Procedure

5.1 Measure the unstrained reference length to the nearest 0,1 mm at the standard temperature. Place the ends of strip test pieces (4.1.1) into the clamps, or tab ends of test pieces with enlarged ends (4.1.2) into the jaws, or fit ring test pieces (4.1.3) over the pulley rims of the straining device (3.1). Extend the test pieces to the required strain at a speed between 2 and 10 mm/s.

With ring test pieces, rotate the pulleys slightly by hand to equalize the strain in the two halves of the ring, ensuring that the reference length remains centralized between the pulleys.

5.2 Between 10 and 20 min after the specified strain has been reached, measure the strained reference length to the nearest 0,1 mm. When the inner diameter of ring test pieces is used as

the reference length, it may be calculated from the diameter of the pulleys and the distance between them, measured to the nearest 0,1 mm. If the strain, calculated as specified in 6.1, does not conform to the appropriate standard value, taking account of tolerances, discard the test piece and prepare and test a replacement test piece with a modified applied strain.

5.3 For tests at other than standard temperatures, place the strained test pieces in the oven (3.2), operating at the test temperature, between 20 and 30 min after the specified strain has been reached; at the end of the test period, remove the test pieces from the oven and allow to cool in the strained condition for 30 to 35 min.

5.4 After the appropriate duration of straining (see 6.2), release the strain at a speed of 2 to 10 mm/s, remove the test pieces from the clamps or pulleys and lay free on a wooden surface. After $30 \, ^{+3}_{0}$ min, measure the reference length to the nearest 0,1 mm, using the rigid channel to straighten ring test pieces if required.

6 Strain, duration of test and temperature of test

6.1 Strain

The percentage strain, calculated by the formula

$$100 \times \frac{l_s - l_0}{l_0}$$

where

l_0 is the original unstrained reference length and

l_s is the strained reference length,

shall be one of the following values :

(25 ± 2,5) %

(50 ± 5) %

(100 ± 10) %

(200 ± 10) %

(300 ± 10) %

The strain value should be selected in accordance with the final application. For normal use, it is recommended that elongations higher than one-third of the breaking elongation at the test temperature should not be used. The value (100 ± 10) % is preferred unless the above considerations dictate otherwise.

NOTE — If a yield point exists, results are only valid calculated at strain values below the yield point.

6.2 Duration of test

The strained test pieces shall be exposed for $24 \, ^{0}_{-2}$ h or, alternatively, if a longer test period is required, for $72 \, ^{0}_{-2}$ h or $168 \, ^{0}_{-2}$ h, the period commencing 30 min after the original straining has been effected.

6.3 Temperature of test

The test pieces shall be exposed in a strained condition at one of the following temperatures :

standard temperature
70 °C ± 1 °C
85 °C ± 1 °C
100 °C ± 1 °C
125 °C ± 2 °C
150 °C ± 2 °C

If no temperature is specified in the relevant product specification, 70 °C ± 1 °C shall be preferred.

For special cases, higher standard temperatures may be used.

7 Expression of results

Calculate the tension set, as a percentage of initial strain, using the formula

$$100 \times \frac{l_1 - l_0}{l_s - l_0}$$

where

l_0 is the original unstrained reference length;

l_s is the strained reference length;

l_1 is the reference length after recovery.

The mean value of the results for the three test pieces shall be calculated. The individual values of the three test pieces shall agree within 10 % of the mean value. If they do not, the test shall be repeated using three further test pieces and the median of the six results shall be calculated and quoted in the test report.

8 Test report

The test report shall include the following particulars :

a) a reference to this International Standard;

b) the full description of the sample and any relevant facts about its pre-test history;

c) the preparation of the test pieces, for example whether moulded or cut;

d) the curing conditions applied to the test pieces, if known;

e) the duration and temperature of conditioning of the test pieces prior to testing;

f) the type and dimensions of test pieces;

g) the number of test pieces tested;

h) the strain applied;

i) the duration and temperature of the test;

j) any non-standardized procedures adopted;

k) the mean or median value of the tension set, in per cent, for the test pieces tested;

l) the date of the test.

List of references

See national foreword.

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