

Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties

ICS 83.060

National foreword

This British Standard is the UK implementation of ISO 37:2005, incorporating corrigendum January 2008. It supersedes BS 903 Part A2:1995 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PRI/22, Physical testing of rubber.

A list of organizations represented on this committee can be obtained on request to its secretary.

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 3 October 2005

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ISBN 978 0 580 61838 3

Amendments/corrigenda issued since publication

Date	Comments
30 June 2008	Implementation of ISO corrigendum January 2008. Subclause 12.3 replaced

INTERNATIONAL STANDARD

ISO
37

Fourth edition
2005-07-15

Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties

*Caoutchouc vulcanisé ou thermoplastique — Détermination des
caractéristiques de contrainte-déformation en traction*



Reference number
ISO 37:2005(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 37 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 2, *Testing and analysis*.

This fourth edition cancels and replaces the third edition (ISO 37:1994).

The major changes incorporated in this revision are as follows:

- The addition of a new dumb-bell test piece designated type 1A.
- The addition of a new annex, Annex B, with precision data on type 1, type 2 and type 1A test pieces.
- The addition of a new annex, Annex C, with an analysis of the dependence of the precision data on dumb-bell test piece shape.

Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties

1 Scope

This International Standard describes a method for the determination of the tensile stress-strain properties of vulcanized and thermoplastic rubbers.

The properties which can be determined are tensile strength, elongation at break, stress at a given elongation, elongation at a given stress, stress at yield and elongation at yield. The measurement of stress and strain at yield applies only to some thermoplastic rubbers and certain other compounds.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5893, *Rubber and plastics test equipment — Tensile, flexural and compression types (constant rate of traverse) — Specification*

ISO 23529:2004, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

tensile stress

S

stress applied so as to extend the test piece

NOTE It is calculated as the applied force per unit area of the original cross-section of the test length.

3.2

elongation

E

tensile strain, expressed as a percentage of the test length, produced in the test piece by a tensile stress

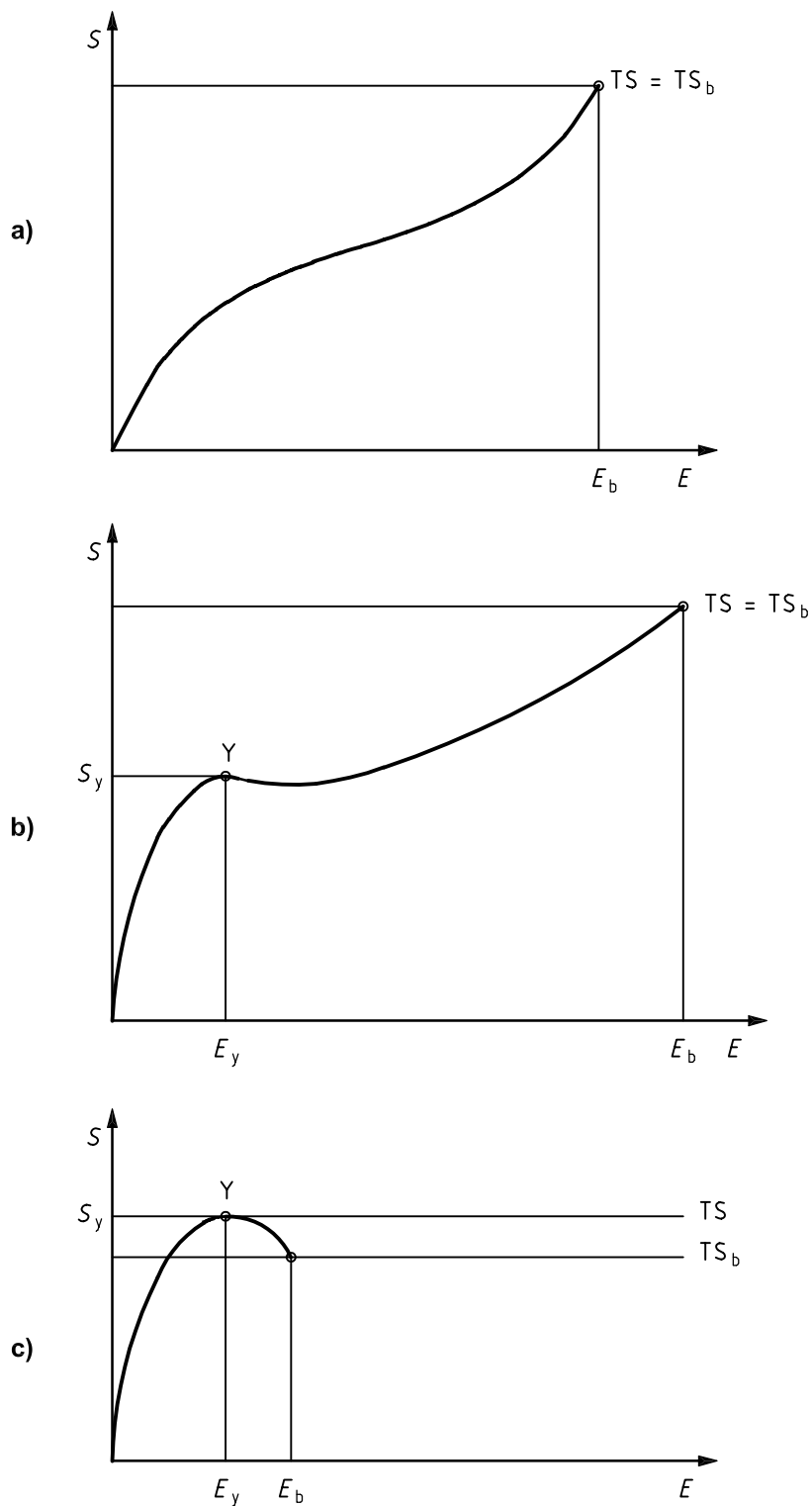
3.3

tensile strength

TS

maximum tensile stress recorded in extending the test piece to breaking point

NOTE See Figures 1a) to 1c).

**Key**

E	elongation	S_y	stress at yield
E_b	elongation at break	TS	tensile strength
E_y	elongation at yield	TS_b	tensile strength at break
S	stress	Y	yield point

Figure 1 — Illustration of tensile terms

3.4**tensile strength at break** **TS_b**

tensile stress recorded at the moment of rupture

NOTE 1 See Figures 1a) to 1c).

NOTE 2 The values of TS and TS_b may be different if, after yield at S_y , the elongation continues and is accompanied by a drop in stress, resulting in TS_b being lower than TS [see Figure 1c)].**3.5****elongation at break** **E_b**

tensile strain in the test length at breaking point

NOTE See Figures 1a) to 1c).

3.6**elongation at a given stress** **E_s**

tensile strain in the test length when the test piece is subjected to a given tensile stress

3.7**stress at a given elongation** **S_e**

tensile stress in the test length required to produce a given elongation

NOTE In the rubber industry, this definition is widely identified with the term “modulus”, and care should be taken to avoid confusion with the other use of “modulus” to denote the slope of the stress-strain curve at a given elongation.

3.8**tensile stress at yield** **S_y**

tensile stress at the first point on the stress-strain curve where some further increase in strain occurs without any increase in stress

NOTE This may correspond to either a point of inflection [see Figure 1b)] or to a maximum [see Figure 1c)].

3.9**elongation at yield** **E_y**

tensile strain at the first point on the stress-strain curve where some further increase in strain is not accompanied by an increase in stress

NOTE See Figures 1b) and 1c).

3.10**test length of a dumb-bell**

initial distance between reference points within the length of the narrow portion of a dumb-bell test piece used to measure elongation

NOTE See Figure 2.

4 Principle

Standard test pieces, either dumb-bells or rings, are stretched in a tensile-testing machine at a constant rate of traverse of the driven grip or pulley. Readings of force and elongation are taken as required during the uninterrupted stretching of the test piece and when it breaks.

5 General

Dumb-bell and ring test pieces do not necessarily give the same values for their respective stress-strain properties. This is mainly because in stretched rings the stress is not uniform over the cross-section. A second factor is in the existence of "grain" which may cause dumb-bells to give different values depending whether their length is parallel or at right angles to the grain.

The main points to be noted in choosing between rings and dumb-bells are as follows:

a) Tensile strength

Dumb-bells are preferable for determination of tensile strength. Rings give lower, sometimes much lower, values than dumb-bells.

b) Elongation at break

Rings give approximately the same values as dumb-bells, provided that

- 1) the elongation of rings is calculated as a percentage of the initial internal circumference and
- 2) dumb-bells are cut at right angles to the grain if this is present to a significant degree.

Dumb-bells shall be used if it is required to study grain effects for which rings are not suitable.

c) Elongation at a given stress and stress at a given elongation

The larger dumb-bells (types 1, 2 and 1A) are generally preferred.

Rings and dumb-bells give approximately the same values provided that

- 1) the elongation of rings is calculated as a percentage of the initial mean circumference and
- 2) the average value is taken for dumb-bells cut parallel and at right angles to the grain if this is present to a significant degree.

Rings may be preferred in automated testing, due to the ease of handling of the test pieces, and in the determination of stress at a given strain.

d) Miniature test pieces may give somewhat different, usually higher, values for tensile strength and elongation at break than the larger test pieces.

Seven types of test piece are provided, i.e. dumb-bell-shaped types 1, 2, 3, 4 and 1A and ring-shaped types A (normal) and B (miniature). The results obtained for a given material are likely to vary according to the type of test piece used, and the results obtained for different materials should therefore not be regarded as comparable unless the same type of test piece has been used.

Type 3 and 4 dumb-bell test pieces and type B ring test pieces shall only be used where insufficient material is available for the larger test pieces. These test pieces are particularly suitable for testing products and are used in certain product standards, e.g. type 3 dumb-bells have been used for testing pipe sealing rings and cables.

When preparation of test pieces requires buffing or thickness adjustment, results may be affected.