INTERNATIONAL STANDARD

ISO 9026

Second edition
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Raw rubber or unvulcanized compounds — Determination of green strength

Caoutchouc brut ou mélanges de caoutchoucs non vulcanisés — Détermination de la cohésion à cru

Reference number
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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 9026 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 2, *Testing and analysis*.

This second edition cancels and replaces the first edition (ISO 9026:1991), which has been revised to update the normative references (ISO 471, ISO 3383 and ISO 4648 have been replaced by ISO 23529 and ISO 1796 by ISO 1795). In addition, the list of usable test pieces in 6.1 has been extended with the addition of the type 1A dumbbell and the text has been clarified in places.

Introduction

The stress-strain properties of unvulcanized rubber (either a prepared mix or in the raw state) are important to certain processing operations in the rubber industry. These unvulcanized-rubber properties are frequently referred to as “green strength”, denoting that the final vulcanization cycle has not yet been achieved. The word “green” is thus a synonym for uncured or unvulcanized.

Green strength is determined primarily by the physical and chemical characteristics of polymers, such as molecular mass, tendency to crystallize, degree of branching, etc. It is also related to the compound formulation, particularly filler and plasticizer content and the presence of peptizers. It is a particularly important characteristic for all processing operations in which elongation predominates, for example elongation caused by the expansion of the green tyre during the building operation.

Green strength is dependent on the test piece preparation (thermal, mechanical), rate of extension and test temperature. Therefore a single-point method cannot be expected to give correlation between green strength and processing behaviour over the whole range of processing conditions.

Raw rubber or unvulcanized compounds — Determination of green strength

WARNING — Persons using this International Standard should be familiar with normal laboratory practice. This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

CAUTION — Certain procedures specified in this International Standard may involve the use or generation of substances, or the generation of waste, that could constitute a local environmental hazard. Reference should be made to appropriate documentation on safe handling and disposal after use.

1 Scope

This International Standard specifies a method for the determination of the green strength of raw rubber or unvulcanized rubber compounds using a tensile stress-strain test, the test pieces being prepared following standard test conditions or cut from calendered sheets.

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

ISO 1795, *Rubber, raw natural and raw synthetic — Sampling and further preparative procedures*

ISO 2393, *Rubber test mixes — Preparation, mixing and vulcanization — Equipment and procedures*

ISO 5893:2002, *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
green strength
resistance of raw or unvulcanized compounded rubber to tensile deformation or fracture and thereby a measure of the ability of a rubber or rubber compound to resist tensile distortion during processing and in fabrication, e.g. tyre-building operations

NOTE Several types of curve can be obtained, depending on the nature of polymer (see Figure 1). Usually, the green strength is expressed in terms of the yield stress or maximum stress.

4 Principle

The tensile stress-strain characteristics of a dumbbell or other recommended test piece of raw or unvulcanized compounded rubber are determined on a tensile-testing machine capable of maintaining a substantially constant rate of separation of the jaws.

5 Apparatus

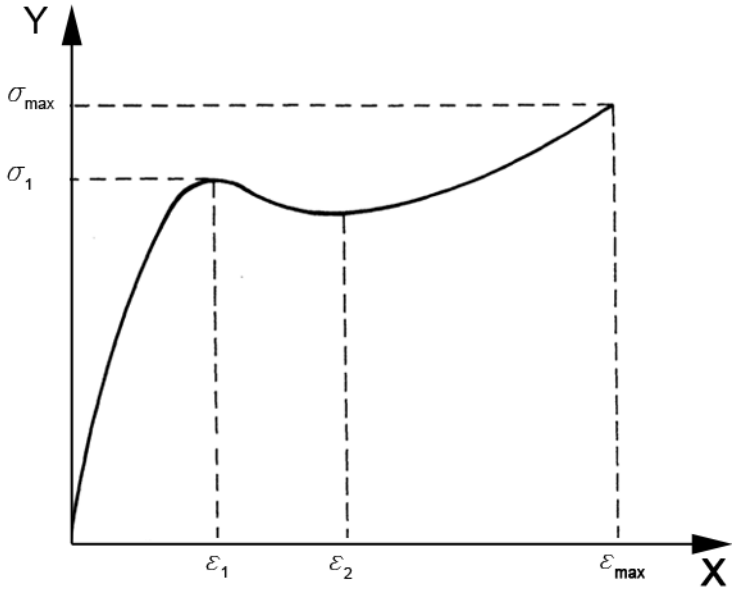
5.1 Tensile-testing machine, complying with the requirements of ISO 5893:2002, class 2. It shall be capable of maintaining a constant rate of separation of the jaws at the preferred value of 100 mm/min. Other values can be used for special purposes. It shall have means of measuring the force on the test piece and the increase in the distance between the gauge marks on the dumbbell. It shall be capable of recording the force/elongation curve obtained during the test.

If an automatic extensometer is used, it shall be one of the non-contacting type.

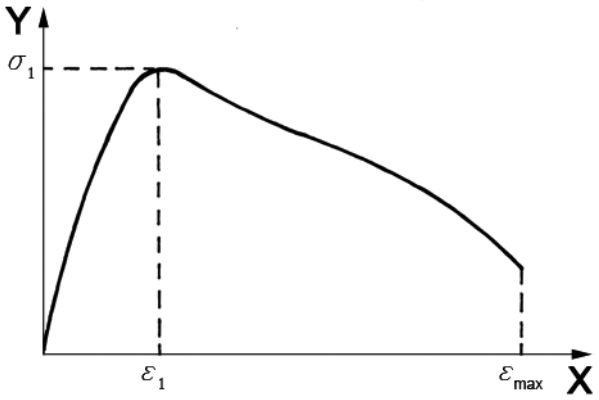
5.2 Mould, which meets the requirements of ISO 2393. If the test piece with beaded ends (see 6.1) is required, a special grooved mould, capable of producing a sheet 2 mm in thickness and 50 mm in length with a bead at both ends, as shown in Figure 2, shall be used.

5.3 Curing press, large enough to take the mould, meeting the requirements of ISO 2393.

5.4 Fixture, for holding the test piece in the test machine. For the test piece with beaded ends, the fixture shall possess a suitable slot for gripping the test piece without any damage or slippage (see Figure 3).



a) Type 1



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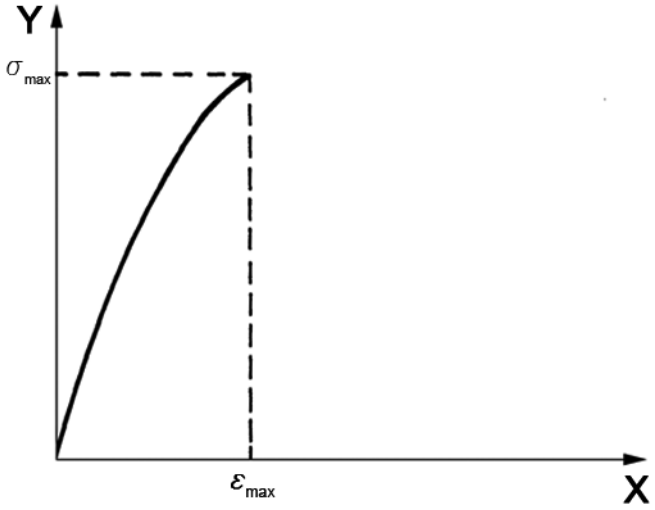
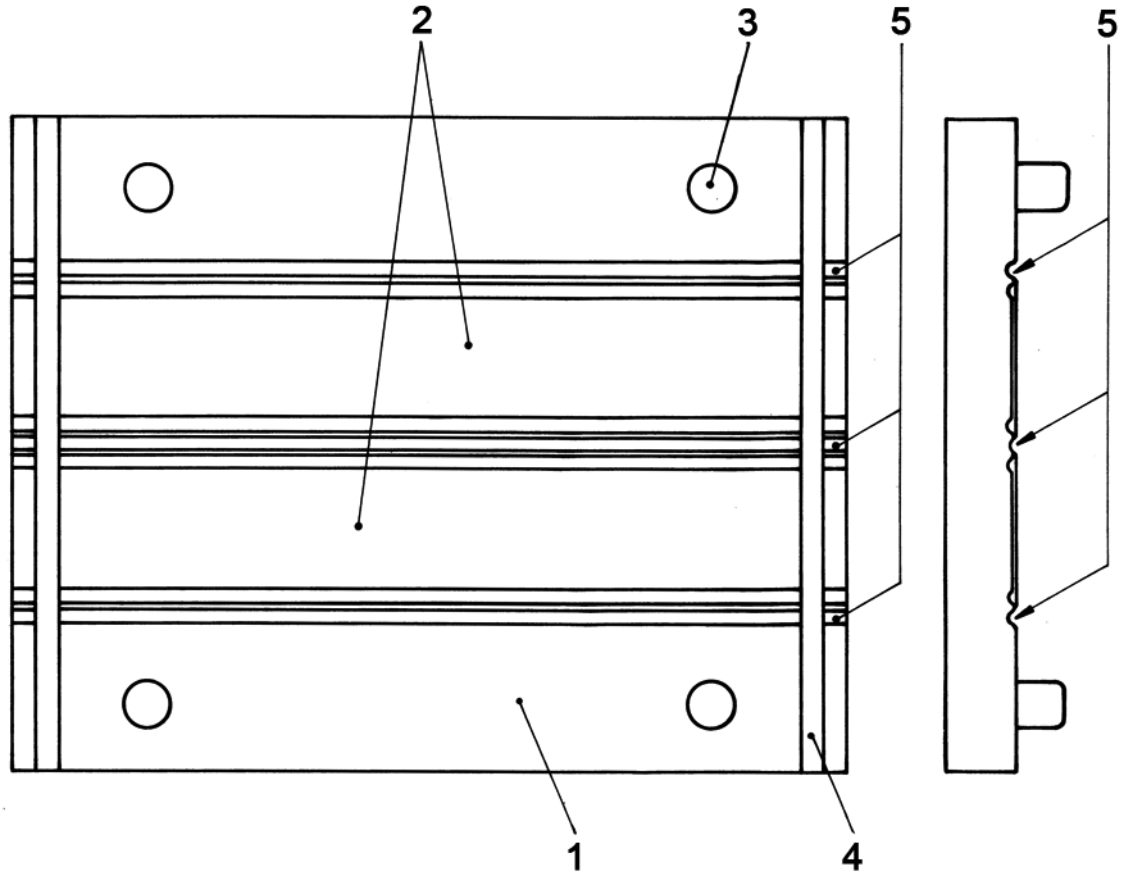


c) Type 3

Key

X	strain	ε_1, ε_2	yield elongation	ε_{max}	max. elongation
Y	stress	σ_1	yield stress	σ_{max}	max. stress

Figure 1 — Typical tensile stress-strain curves



Key

1 half mould (top view)
2 two cavities
3 adjusting bolt
4 stop
5 outflow grooves

Figure 2 — Mould for test piece with beaded ends

Dimensions in millimetres

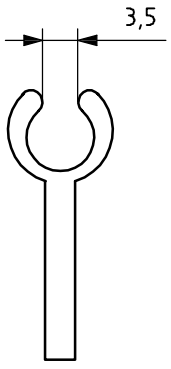


Figure 3 — Fixture with slot

6 Test piece

6.1 Dimensions

The recommended type of test piece is the one with beaded ends, of which the shape and dimensions are given in Figure 4. Dumbbell test pieces of type 1, type 1A or type 2 as specified in ISO 37 can also be used, in which case the ends of test pieces held in the grips can be protected by low-hardness vulcanized rubber, to avoid any damage. Since different types of test piece do not necessarily give the same values, comparison of the results from different dumbbells shall be avoided.

Dimensions in millimetres

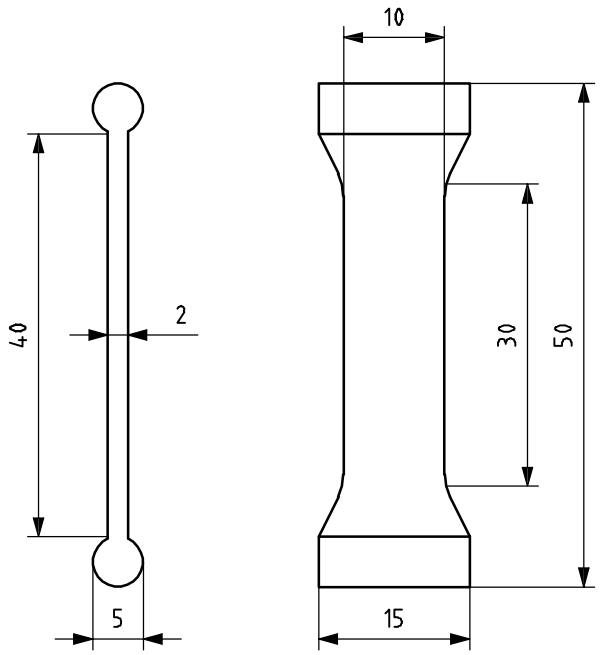


Figure 4 — Dumbbell test piece with beaded ends

6.2 Preparation

6.2.1 General

Standard test conditions shall be followed where determination of green strength of raw rubber or unvulcanized compounded rubber is to be made with no reference given to any particular process (see Clauses 7 to 9).

Raw rubber shall be homogenized in accordance with ISO 1795.

6.2.2 Preparation of moulded test pieces

Raw rubber and unvulcanized rubber shall be sheeted out to approximately 2,2 mm thickness and placed in the mould with the grain direction oriented so as to have the grain direction along the length of the test pieces, care being taken that a suitable film is placed between the mould walls and the rubber compound in order to promote mould release. Polyester or PTFE film 0,25 mm thick has been found suitable. The sample shall be compressed for 5 min at 100 °C under 2,5 MPa platen pressure, then removed after cooling to a chosen standard laboratory temperature under pressure.

NOTE 1 For some raw rubbers, longer times or higher moulding temperatures can be necessary in order to obtain a smooth sheet free from porosity. For some compounds, a lower temperature can be necessary when there is a danger of scorch at the preferred temperature.

NOTE 2 The cooling time depends on the apparatus used.

The test piece shall be cut from the sheet using a suitable die.

When it is necessary to characterize the behaviour of compounds intended to be used in a given application, the test pieces shall be prepared in such a way that the properties of the rubber are not altered.

6.2.3 Preparation of test pieces from calendered sheet

The dumbbell test pieces shall be prepared directly by die-cutting the test pieces from a sheet calendered from 2 mm to 4 mm thickness.

6.3 Number of test pieces

The test shall be carried out on at least five test pieces.

6.4 Measurement

Thickness shall be measured, using a micrometer gauge, in accordance with ISO 23529:2004, method A, with a pressure of 10 kPa $\pm$ 2 kPa on the rubber. The result shall be taken as the median of three measured values.

The width shall be assumed to be equal to the width between the cutting edges of the central part of the die.

7 Conditioning

After suitable preparation, the test pieces shall be conditioned at the chosen standard laboratory temperature (see ISO 23529) for a fixed conditioning period between 24 h and 72 h.

The same conditioning period shall be used throughout the test and throughout a series of tests intended to be comparable.

8 Temperature of test

The test shall normally be carried out at the chosen standard laboratory temperature (see ISO 23529). Where other temperatures are used, take the preferred test temperatures as given in ISO 23529.

The same temperature shall be used throughout the test and throughout a series of tests intended to be comparable.

9 Procedure

After removal of the mould-release film, when applicable (see 6.2.2), insert test pieces with beaded ends in the fixture illustrated in Figure 3. Adjust the rate of displacement of the moving jaw to 100 mm/min and start the tensile test. If the test piece breaks at the grips, that result shall be discarded and a retest carried out.

NOTE The preferred rate of separation of the jaws is 100 mm/min. In special cases, other rates can be used, but only tests carried out at the same rate can be compared.

10 Expression of results

Using the typical stress-strain curves given in Figure 1, determine the yield stress or maximum stress in megapascals. Other parameters can be determined, such as yield elongation (ε_1), or the stress at a definite reference elongation corresponding to the deformation entailed by a subsequent processing operation.

The stresses are calculated from the initial cross-sectional area of the parallel-sided portion of the dumbbell. The stresses and elongation shall be calculated using the procedures and equations given in ISO 37.

11 Test report

The test report shall include the following information:

a) sample details:

   1) full description of the sample and its origin,

   2) method of preparation of the test pieces (i.e. time and temperature of moulding, if not standard conditions),

   3) type and dimensions of test piece,

   4) any relevant fact about the pre-test history of the test pieces;

b) reference number of this International Standard;

c) test details:

   1) standard temperature chosen,

   2) time of conditioning,

   3) rate of separation of the moving jaw, if not the preferred rate of 100 mm/min,

   4) temperature of test,

   5) number of test pieces tested if more than five,

   6) details of any procedures not specified in this International Standard;

d) test results: the medians and ranges of all results (i.e. yield stress, maximum stress and, if applicable, yield elongation — see Clause 10);

e) date of the test.

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ICS 83.040.10; 83.060

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