BSI Standards Publication

Raw rubber or unvulcanized compounds — Determination of green strength

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National foreword

This British Standard is the UK implementation of ISO 9026:2021. It supersedes BS ISO 9026:2007, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PRI/22, Testing and analysis of rubber.

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

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INTERNATIONAL STANDARD

ISO 9026

Third edition
2021-07-29

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

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This third edition cancels and replaces the second edition (ISO 9026:2007), of which it constitutes a minor revision. The changes compared to the previous edition are as follows:

— the Normative references in Clause 2 have been updated.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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., 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.

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INTERNATIONAL STANDARD ISO 9026:2021

Raw rubber or unvulcanized compounds — Determination of green strength

WARNING 1 — Persons using this document should be familiar with normal laboratory practice. This document 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 determine the applicability of any other restrictions.

WARNING 2 — Certain procedures specified in this document might 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 document 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 documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 5893:2019, *Rubber and plastics test equipment — Tensile, flexural and compression types (constant rate of traverse) — Specification*

ISO 23529:2016, *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.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

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 1 to entry: 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

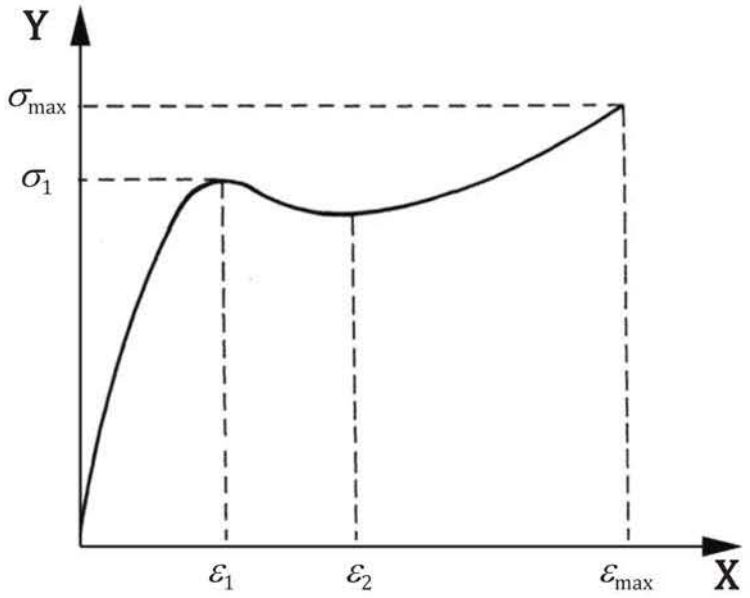
5.1 Tensile-testing machine, complying with the requirements of ISO 5893:2019, class 2. It shall be capable of maintaining a constant rate of separation of the jaws at the preferred value of 100 mm/min. Other values can be used for special purposes. It shall have a means of measuring the force on the 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.

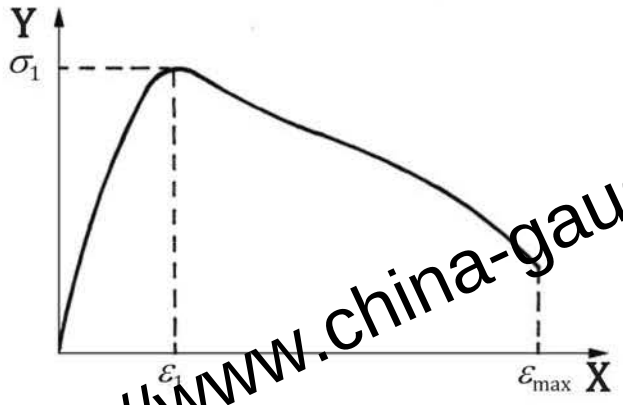
5.2 Mould, which meets the requirements of ISO 2393. If the test piece with beaded ends (see 6.1) is required, a special grooved mould, capable of producing a sheet 2 mm in thickness and 50 mm in length with a bead at both ends, as shown in Figure 2, shall be used.

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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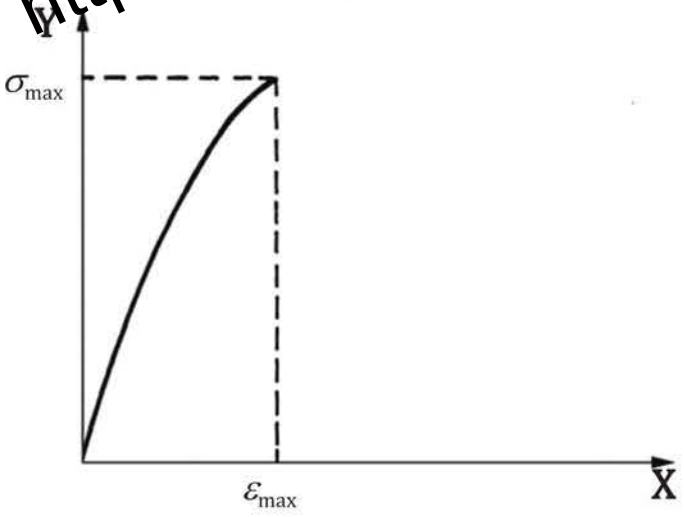
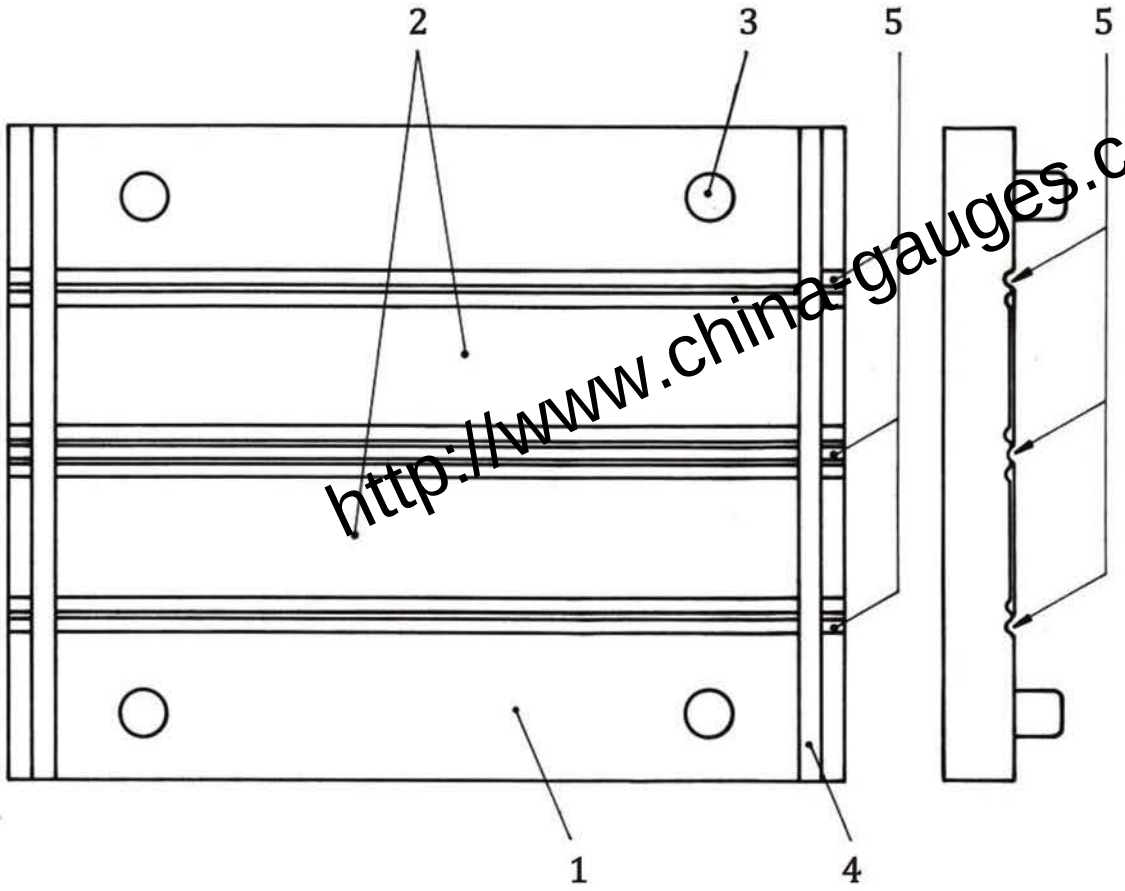


c) Type 3

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

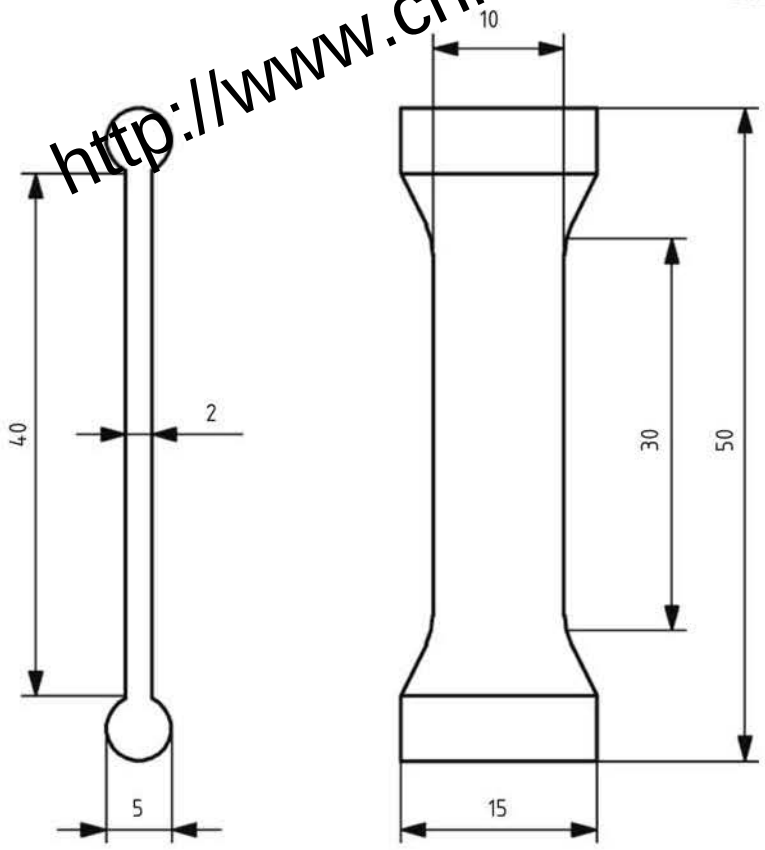


Figure 4 — Dumbbell test piece with beaded ends

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 23529:2016, method A, with a pressure of 10 kPa ± 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 (see 7) 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) a full description of the sample and its origin,

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

   3) the type and dimensions of test piece,

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

b) reference number of this document, i.e. ISO 9026;

c) test details:

   1) the standard temperature chosen,

   2) the time of conditioning,

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

   4) the temperature of test,

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

   6) details of any procedures not specified in this document;

d) test results;

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

e) the date of the test.

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