
**Raw rubber or unvulcanized
compounds — Determination of green
strength**

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

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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.

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. 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.

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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

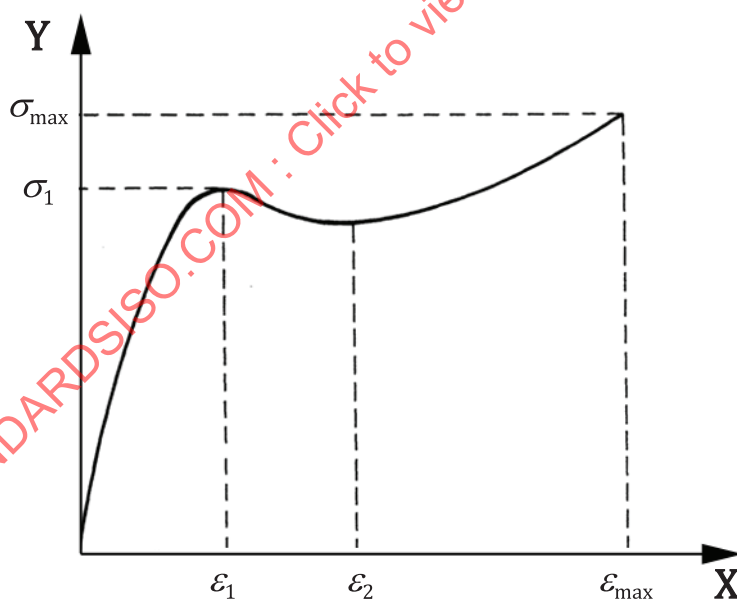
5.1 Tensile-testing machine, complying with the requirements of ISO 5893:2019, class 2. It shall be capable of maintaining a constant rate of separation of the jaws at the preferred value of 100 mm/min. Other values can be used for special purposes. It shall have means of measuring the force on the test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

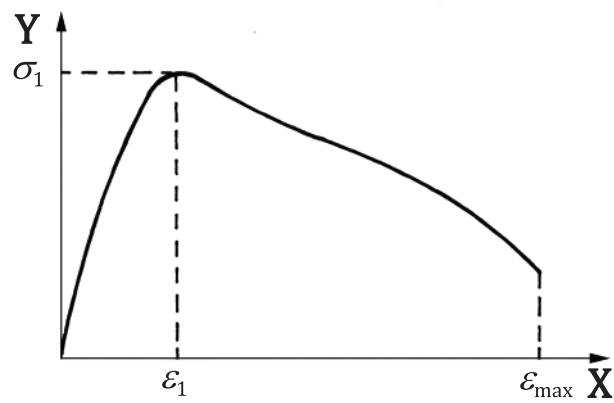
5.2 Mould, which meets the requirements of ISO 2393. If the test piece with beaded ends (see 6.1) is required, a special grooved mould, capable of producing a sheet 2 mm in thickness and 50 mm in length with a bead at both ends, as shown in Figure 2, shall be used.

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

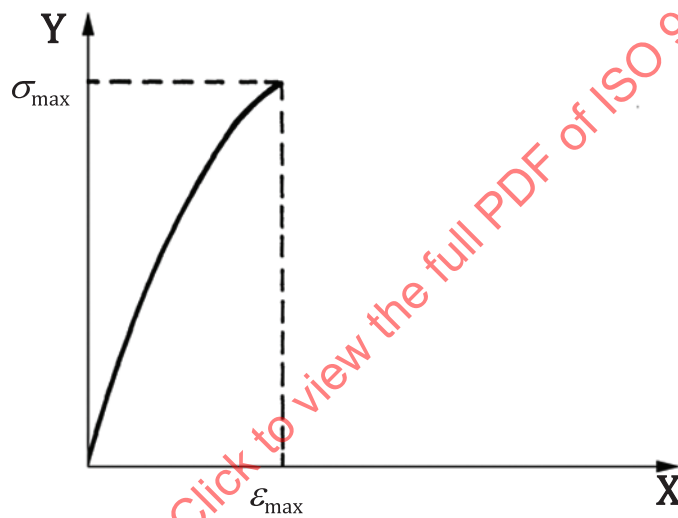
5.4 Fixture, for holding the test piece in the test machine. For the test piece with beaded ends, the fixture shall possess a suitable slot for gripping the test piece without any damage or slippage (see Figure 3).



a) Type 1



b) Type 2

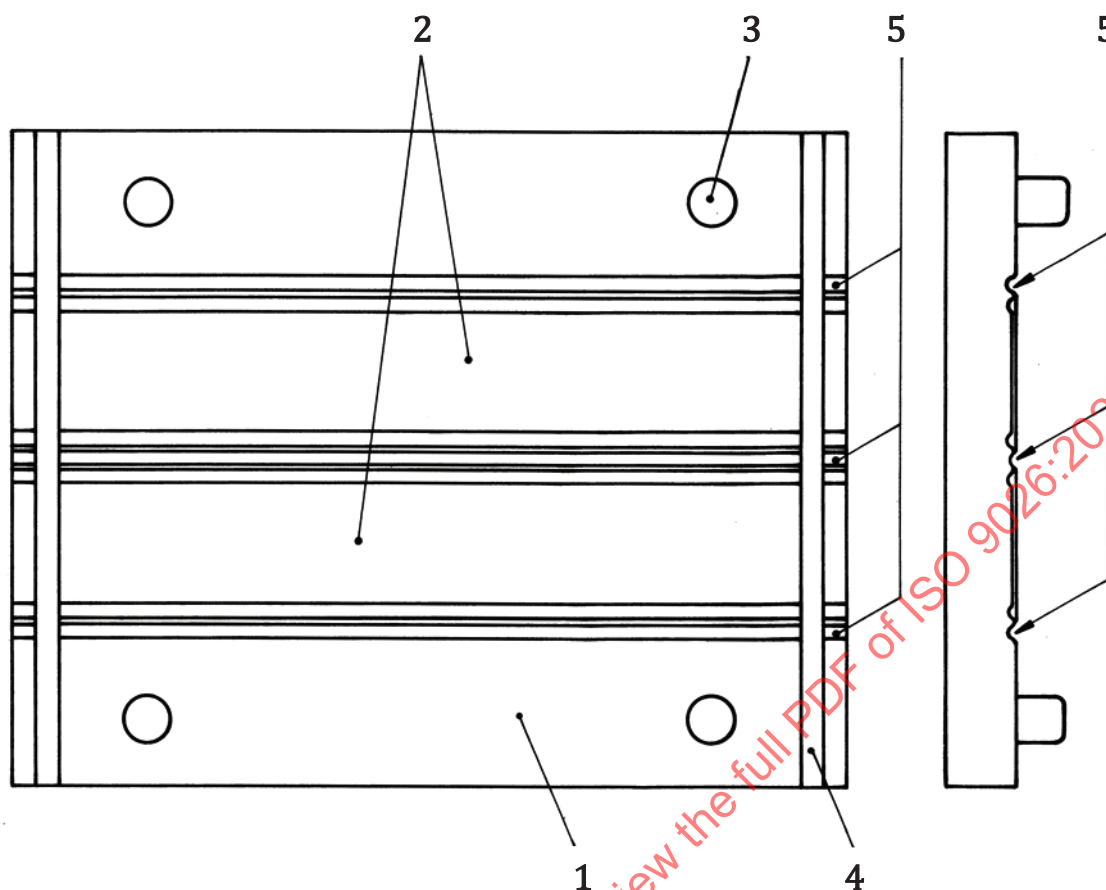


c) Type 3

Key

X	strain	ϵ_1, ϵ_2	yield elongation	$\epsilon_{\max}$	max. elongation
Y	stress	σ_1	yield stress	$\sigma_{\max}$	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

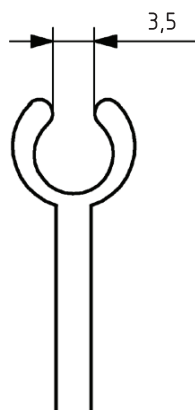


Figure 3 — Fixture with slot

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.

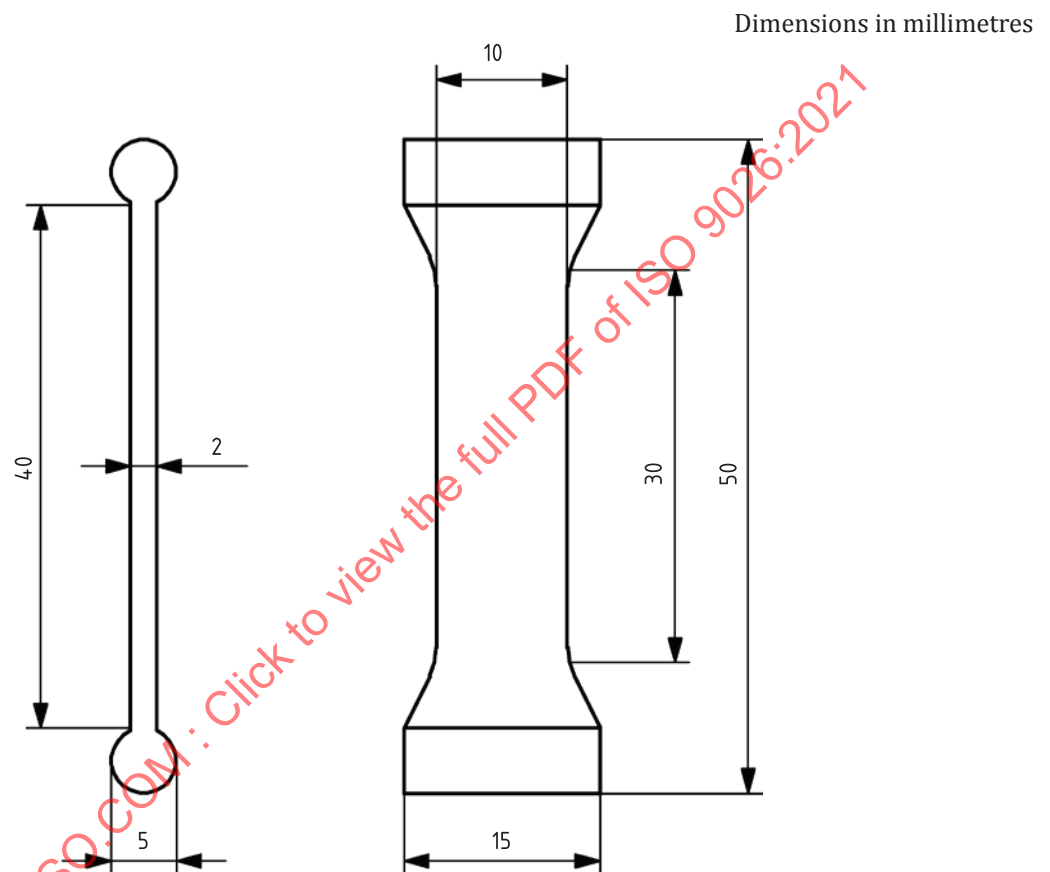


Figure 4 — Dumbbell test piece with beaded ends

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