
**Rubber, vulcanized — Determination
of temperature rise and resistance to
fatigue in flexometer testing —**

**Part 4:
Constant-stress flexometer**

*Caoutchouc vulcanisé — Détermination de l'élévation de température
et de la résistance à la fatigue dans les essais aux flexomètres —*

Partie 4: Flexomètre à contrainte constante

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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. www.iso.org/directives

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received. www.iso.org/patents

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 the following URL: <http://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 second edition cancels and replaces the first edition (ISO 4666-4:2007), which has been technically revised.

The main changes compared to the previous edition are as follows:

- in [Clause 11](#), the requirement for the temperature at breakdown has been added in the test report.
- the former [Annex B](#), Guidance for using precision results, has been removed.
- calibration schedule has been added as new [Annex B](#).

A list of all parts in the ISO 4666 series can be found on the ISO website.

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

This document describes a method of compression flexometer testing with constant-stress dynamic loading. The features and usefulness of constant-stress flexometer testing are as follows:

- a) In order to exactly simulate the behaviour of a rubber product in use, an important consideration is where the temperature is measured. The constant-stress flexometer measures the temperature directly at the centre of the inside of the test piece (the source of heat generation), using a device as shown in [Figure 4](#) of this document, while in ISO 4666-3 the temperature is measured on the surface of the test piece.
- b) A servo control system based on real-time feedback of the strain or stress is used to enable the measurement of dynamic properties (viscoelastic parameters) of the rubber as a function of time during the test run.
- c) The accumulation of feedback information allows the detection of an initial stage, or the first signs of breakdown due to heat generation, which was once thought to be very difficult.

It has been reported^[5] that how well the rise in tyre temperature correlates with the temperature rise in the constant-stress flexometer test in comparison with the result from the method in ISO 4666-3.

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Rubber, vulcanized — Determination of temperature rise and resistance to fatigue in flexometer testing —

Part 4: Constant-stress flexometer

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 constant-stress flexometer test for the determination of the temperature rise and resistance to fatigue of vulcanized rubbers.

Many rubber products, such as tyres and belts, are tested by subjecting them to an oscillating load with a constant peak stress amplitude. In order to obtain good correlation between accelerated tests and in-service exposure of these products, this document gives instructions for carrying out measurements under such conditions.

This method is not applicable for rubber having a hardness greater than 85 IRHD.

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 4664-1, *Rubber, vulcanized or thermoplastic — Determination of dynamic properties — Part 1: General guidance*

ISO 4666-1, *Rubber, vulcanized — Determination of temperature rise and resistance to fatigue in flexometer testing — Part 1: Basic principles*

ISO 18899:2013, *Rubber — Guide to the calibration of test equipment*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4664-1 and ISO 4666-1 apply.

ISO and IEC maintain terminological 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/>

4 Principle

A cylindrical test piece is subjected to dynamic loading with constant peak stress cycles in compression superimposed on a static prestress.

The temperature rise of the test piece is measured, and the fatigue life of the test piece is given by the number of cycles, or the test time, until breakdown occurs. The change in height (creep) and dynamic properties are also measured as a function of time, and the compression set is measured at the end of the test.

5 Apparatus

The apparatus is shown schematically in [Figure 1](#), and an example is shown in [Figure 2](#).

5.1 Anvils

A pair of anvils (upper and lower) support the test piece. The lower anvil is connected to an oscillator to apply static and dynamic compression deformation to the test piece, and the upper anvil transmits the static and dynamic compression loads, via a shaft, to a load detector. The parts of the upper and lower anvils which come in contact with the test piece shall be made of a heat-insulating material of thermal conductivity 0,28 W/(m·K) maximum. A hole shall be provided in the centre of the upper anvil for insertion of a needle-type thermometer for measuring the temperature inside the test piece. An example of upper and lower anvil construction is shown in [Figure 3](#).

5.2 Oscillator

The oscillator used to apply static and dynamic compression loads to the test piece shall have a capacity of at least 2 kN and be capable of applying an oscillating force of 0,75 kN peak amplitude at 50 Hz.

A hydraulic servo-control system is preferably used to control the oscillator.

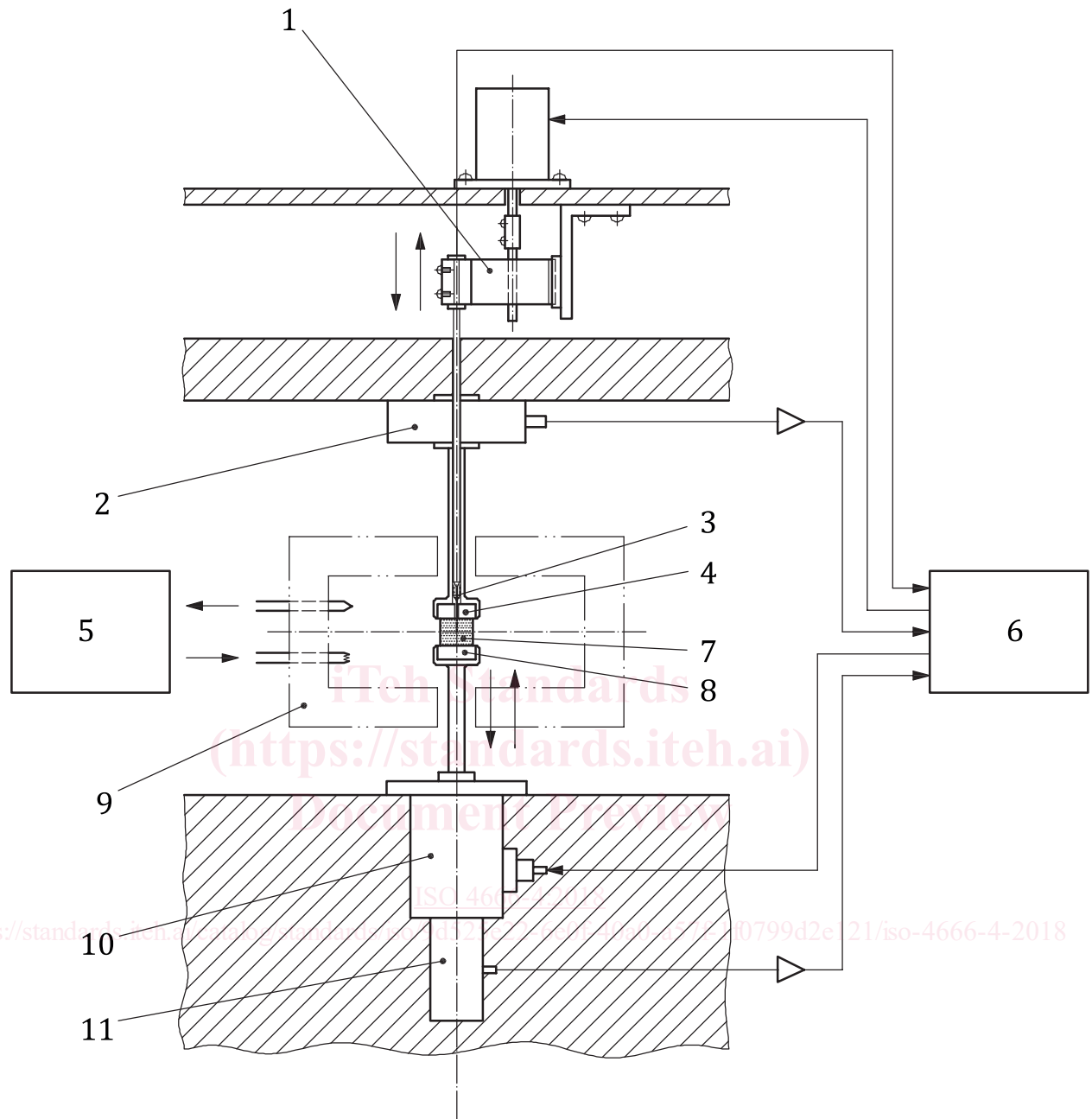
The maximum stroke is preferably 20 mm to 25 mm.

5.3 Displacement detector

The displacement detector shall be capable of measuring the motion of the lower anvil (the deformation of the test piece in compression) to within 0,01 mm, and shall have a response time suitable for the maximum frequency used.

5.4 Load detector

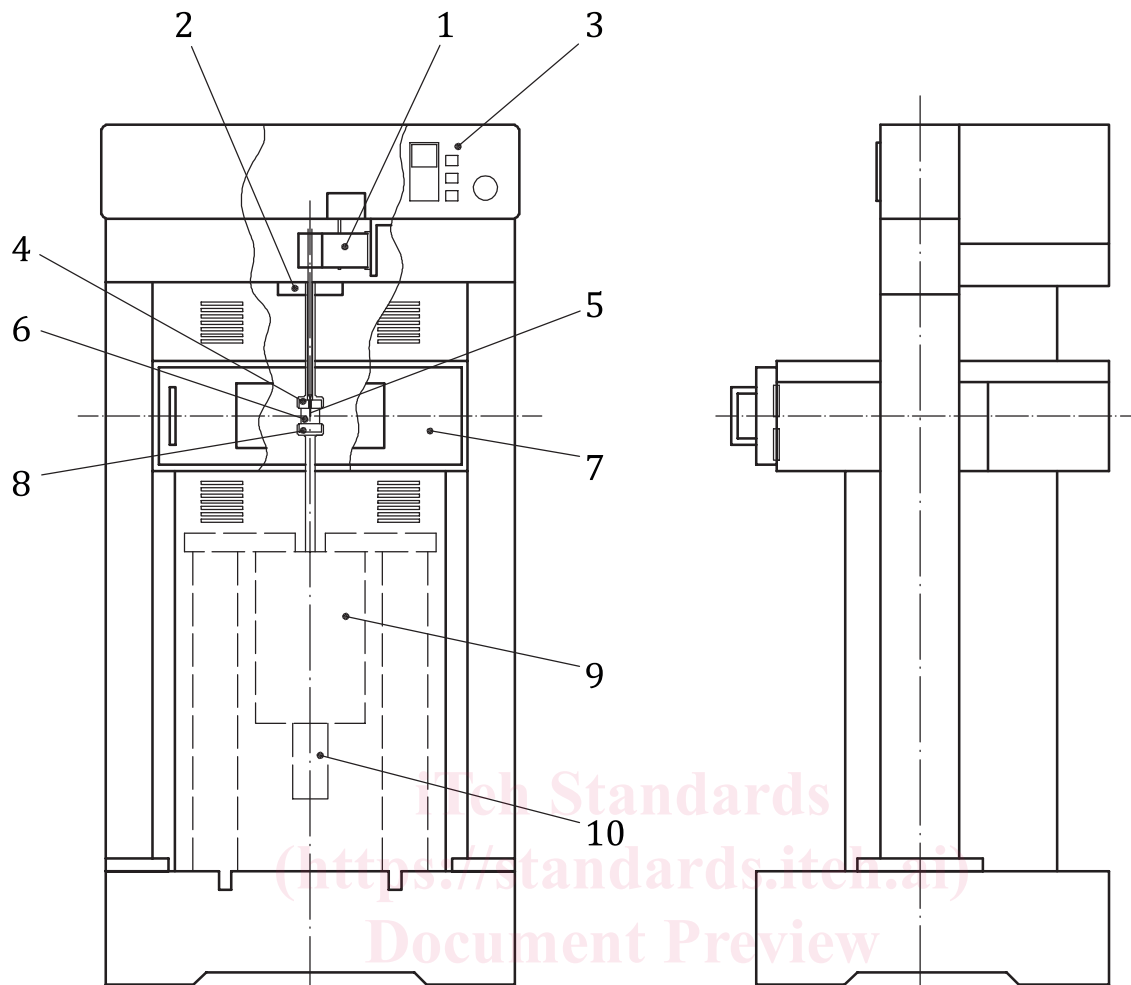
The load detector shall be capable of measuring the compression load up to a maximum of 2,0 kN in 5 N increments, shall have a response time suitable for the maximum frequency used, and shall have a high natural frequency.



Key

- 1 position controller
- 2 load detector
- 3 needle-type temperature detector
- 4 upper anvil
- 5 temperature controller
- 6 computer control unit
- 7 test piece
- 8 lower anvil
- 9 heating chamber
- 10 oscillator
- 11 displacement detector

Figure 1 — Principle and fundamental structure of a constant-stress flexometer



Key

- 1 position controller
- 2 load detector
- 3 temperature controller
- 4 upper anvil
- 5 needle-type temperature detector
- 6 test piece
- 7 heating chamber
- 8 lower anvil
- 9 oscillator
- 10 displacement detector

Figure 2 — An example of a constant-stress flexometer