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

**Part 1:  
Basic principles**

*Caoutchouc vulcanisé — Détermination de l'élévation de température et  
de la résistance à la fatigue dans les essais aux flexomètres —  
Partie 1: Principes fondamentaux*

ISO 4666-1:2010

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Case postale 56 • CH-1211 Geneva 20  
Tel. + 41 22 749 01 11  
Fax + 41 22 749 09 47  
E-mail [copyright@iso.org](mailto:copyright@iso.org)  
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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 4666-1 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 4666-1:1982), which has been technically revised.

ISO 4666 consists of the following parts, under the general title *Rubber, vulcanized — Determination of temperature rise and resistance to fatigue in flexometer testing*:

- Part 1: *Basic principles*
- Part 2: *Rotary flexometer*
- Part 3: *Compression flexometer (constant-strain type)*
- Part 4: *Constant-stress flexometer*

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## Introduction

All rubbers show viscoelastic behaviour. When subjected to cyclic deformation, they absorb a part of the deformation energy and convert this into heat. The heat generated leads to a temperature rise, which can be considerable in the interior of relatively thick components because of the low thermal conductivity of rubbers. In cases where the cyclic deformation is large or the temperature reaches high values, it is possible for damage to the rubber to occur through fatigue-initiated breakdown. The breakdown begins in the interior of the rubber, spreads outwards, and can finally lead to the complete breakdown of the component.

The tests specified in the various parts of this International Standard yield either temperature rise data or the fatigue life of the rubber under given test conditions. Measurement of fatigue life over a range of conditions can be used to determine the limiting fatigue deformability or limiting fatigue stress of the rubber. The instruments used, commonly called flexometers, subject test pieces to cycles of either constant-stress amplitude or constant-strain amplitude.

A distinction should be made between flexometer tests and fatigue tests conducted on thin test pieces undergoing tensile deformation or bending. In the fatigue tests, the temperature rise is generally negligible owing to the rapid dissipation of heat generated, and failure results from the initiation and growth of cracks which ultimately sever the test piece. ISO 132<sup>[1]</sup> specifies tests for the determination of flex cracking and cut growth using the De Mattia-type machine. The determination of resistance to tension fatigue is specified in ISO 6943<sup>[3]</sup>.

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

## Part 1: Basic principles

### 1 Scope

This part of ISO 4666 establishes general principles for flexometer testing and defines the terms used.

Flexometer testing makes possible predictions regarding the durability of rubbers in finished articles subject to dynamic flexing in service such as tyres, bearings, supports, V-belts, and cable-pulley insert rings. However, owing to the wide variations in service conditions, no simple correlation between the accelerated tests specified in the various parts of this International Standard and service performance can be assumed.

### 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 4664-1:—<sup>1</sup>), *Rubber, vulcanized or thermoplastic — Determination of dynamic properties — Part 1: General guidance*

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 the following apply.

#### 3.1

##### loading

subjection of the test piece to a predetermined stress or strain, either static or cyclic

#### 3.2

##### pre-stress

$\sigma_p$

constant static stress to which the test piece is subjected during the test

NOTE 1 Pre-stress is expressed in pascals.

NOTE 2 Pre-stress can be used to simulate product requirements or simply to hold the test piece in the apparatus.

NOTE 3 The term “mean stress” (ISO 4664-1:—) is equivalent or near equivalent to “pre-stress”.

1) To be published. (Revision of ISO 4664-1:2005)

**3.3  
pre-strain**

$\varepsilon_p$   
constant static strain to which the test piece is subjected during the test

NOTE 1 Pre-strain can be used to simulate product requirements or simply to hold the test piece in the apparatus.

NOTE 2 The term “mean strain” (ISO 4664-1:—) is equivalent or near equivalent to “pre-strain”.

**3.4  
cyclic stress amplitude**

$\sigma_a$   
 $\tau_a$   
ratio of the force amplitude (cyclic force) superimposed upon the pre-strain or pre-stress to the appropriate cross-sectional area of the unstressed test piece

NOTE 1 Cyclic stress amplitude is expressed in pascals.

NOTE 2 The term “maximum stress amplitude” (ISO 4664-1:—) is equivalent or near equivalent to “cyclic stress amplitude”.

**3.5  
cyclic strain amplitude**

$\varepsilon_a$   
 $\gamma_a$   
deformation amplitude (cyclic deformation) superimposed upon the pre-strain or pre-stress

NOTE 1 For certain flexometers, the cyclic strain is smaller than the pre-strain.

NOTE 2 In a compression flexometer, the pre-stress,  $\sigma_p$ , acts in the same direction as the cyclic strain amplitude,  $\varepsilon_a$ . In a rotary flexometer, a cyclic shear strain,  $\gamma_a$ , or cyclic shear stress,  $\tau_a$ , acts at right angles to an axial compression pre-strain,  $\varepsilon_p$ , or axial compression pre-stress,  $\sigma_p$ .

NOTE 3 The term “maximum strain amplitude” (ISO 4664-1:—) is equivalent or near equivalent to “cyclic strain amplitude”.

**3.6  
heat generation**

total heat generated in the test piece by energy absorption during the test

NOTE “Heat generation” should be distinguished from the deprecated, but sometimes used, expression “heat build-up”, which is normally associated with the temperature rise in the test piece.

**3.7  
temperature rise**

increase in temperature of the test piece

NOTE The temperature rise is taken as the difference between the temperature measured at a given point in the test piece at a given time during the test and either the temperature at the beginning of the test or the ambient temperature.

**3.8  
fatigue breakdown**

change in chemical structure, physical structure or composition of the test piece under the simultaneous action of stress and temperature

**3.9  
fatigue life**

$N$   
number of cycles required to produce failure or breakdown under a given static and cyclic loading



**3.10****fatigue deformability**

cyclic strain amplitude corresponding to a given fatigue life

**3.11****fatigue stress**

cyclic stress amplitude corresponding to a given fatigue life

**3.12****limiting fatigue deformability**
 $\varepsilon_{\infty}$ 
 $\gamma_{\infty}$ 

cyclic strain amplitude at which the fatigue life curve becomes essentially parallel to the log  $N$  axis

See Figure 1.

**3.13****limiting fatigue stress**
 $\sigma_{\infty}$ 
 $\tau_{\infty}$ 

cyclic stress amplitude at which the fatigue life curve becomes essentially parallel to the log  $N$  axis

See Figure 1.

**4 Test conditions**

The relative ratings of rubbers having different moduli depend upon the type of loading used to evaluate them:

- a)  $\sigma_p$  and  $\sigma_a$  or  $\tau_a$  constant; [ISO 4666-1:2010](https://standards.iteh.ai/catalog/standards/sist/58fb459b-5f78-485b-b41b-6562a29006e4/iso-4666-1-2010)  
<https://standards.iteh.ai/catalog/standards/sist/58fb459b-5f78-485b-b41b-6562a29006e4/iso-4666-1-2010>
- b)  $\sigma_p$  and  $\varepsilon_a$  or  $\gamma_a$  constant; [6562a29006e4/iso-4666-1-2010](https://standards.iteh.ai/catalog/standards/sist/58fb459b-5f78-485b-b41b-6562a29006e4/iso-4666-1-2010)
- c)  $\varepsilon_p$  and  $\sigma_a$  or  $\tau_a$  constant;
- d)  $\varepsilon_p$  and  $\varepsilon_a$  or  $\gamma_a$  constant.

Both the type and magnitude of loading should be governed by the intended use of the rubber. In tests for heat generation, the magnitude should be high enough to generate a temperature rise that is sufficient to be discriminating, but not high enough to cause breakdown.

In tests for fatigue life, choose the loading that yields results capable of discriminating between materials.

NOTE It is also possible to conduct tests under constant-strain energy conditions.

**5 Test pieces****5.1 Form and dimensions**

Test pieces for flexometer testing shall be cylindrical. Dimensions differ according to the test method used.

**5.2 Preparation**

Test pieces shall be prepared and stored in accordance with ISO 23529. Test pieces may be prepared by vulcanization in moulds, or from slabs or finished parts by cutting, boring, and buffing. If test pieces are cut from a finished part, this shall be mentioned in the test report.