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Rubber and plastics test equipment — Tensile, flexural and compression types (constant rate of traverse) — Specification

Appareils d'essai du caoutchouc et des plastiques — Types pour traction, flexion et compression (vitesse de translation constante) — Spécifications

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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 analyses*.

This fourth edition cancels and replaces the third edition (ISO 5893:2002), of which it constitutes a minor revision. A few editorial changes have been made.

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.

Rubber and plastics test equipment — Tensile, flexural and compression types (constant rate of traverse) — Specification

1 Scope

This document specifies requirements for tensile-testing systems operating at constant rate of traverse and suitable for testing rubbers, plastics and adhesives, although any one system might only be applicable to a narrower range of materials. It also covers such systems when used for flexural, shear and compression tests.

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 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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 http://www.electropedia.org/

3.1
tensile-testing system
machine composed of a nominally fixed member and a movable member, to which may be attached suitable grips or jigs for holding a test piece

Note 1 to entry: The movable member is power-driven and might be equipped with adjustable speed control. The machine has a force-measuring system complete with indicator and/or recorder. In addition, a system might be included for measuring the extension or deflection of the test piece.

3.2
applied force
force which produces the distortion in the test piece, measured along the strain axis of the machine

Note 1 to entry: For the purpose of this definition, "grip" is taken to mean "platen" or other member for application of force to the test piece when the machine is used for tests other than tensile tests. Depending on the arrangement of the grips or jigs, the test piece will be in tension, shear, compression or flexure.

3.3
elongation
increase in the gauge length of a tensile test piece when subjected to a tensile force

3.4
deflection
distortion, in the direction of the applied force, of a test piece in compression, shear or flexure

4 Designation of machine class

Machines shall be designated according to their accuracy in measuring the following parameters:

a) force (class 0,5, 1, 2 or 3 as given in ISO 7500-1);

b) elongation or deflection (class A, B, C, D or E as given in Table 1).

For example, a machine of the highest accuracy is designated "Force: class 0,5; Elongation (deflection): class A".

It is not implied that test machines are available commercially in all the theoretically possible classes.

If, for any application, it is not considered necessary to specify the accuracy of measurement of either of these parameters, then no class number or letter is quoted.

NOTE Stringent specifications of test machine accuracy are of little value unless testing technique is closely controlled. Correlation of test data from different laboratories depends as much upon testing techniques as on machine specifications. Operator errors, test piece installation technique and test piece variability are major sources of error.

Care shall be taken to avoid exposure of the machine to draughts or to radiant heat.

5 Design features

5.1 Size and construction

The size and construction shall be such that the machine is capable of testing all materials for which it is intended to be used and has no features which might adversely affect the test results.

The moving grip shall be capable of traversing a distance sufficient to accommodate the maximum elongation of the test piece. In the case of the more highly extensible materials, a traverse distance in excess of 1 m might be necessary.

5.2 Axial alignment of the machine

The coupling between the force-measuring system and the test piece grips or jigs shall be accurately aligned with the strain axis. When fitted in place, the test piece shall also be accurately aligned with the strain axis, and the test axis of the test piece shall coincide with the direction of the applied force.

NOTE Non-axial alignment of a test piece in the grips and lack of test piece symmetry are particularly important causes of variation in test results.

5.3 Test piece grips

For testing dumb-bell, parallel-strip and similar tensile test pieces of flexible materials, the machine shall be provided with a type of grip which closes automatically as the tension increases (e.g. wedge or pneumatic) and which exerts a uniform pressure across the whole width of the test piece. For rigid materials, screw-action grips are also suitable. The test piece shall be held in such a manner that slippage relative to the grips is prevented as far as possible.

For testing ring test pieces, the machine shall be provided with two pulleys, both of which are free to rotate; one at least being automatically rotated by the machine at between 3 r/min and 50 r/min to equalize the strain in the ring during the test. The pulleys shall be 25 mm in diameter for large rings (44,6 mm ID) and 4,5 mm in diameter for small rings (8,0 mm ID).

For testing adhesion in the peel mode, the machine shall be provided either with the grips described in the relevant test method or with grips which exert a uniform pressure across the whole width of the test piece.

The test piece shall be held in such a manner that slip relative to the grips is prevented. When an adhesion test piece is made from different adherends, then grips of a different design might be required for each adherend.

5.4 Drive characteristics

The moving crosshead of the machine shall be driven smoothly at all test speeds, and the drive shall be without any significant backlash.

5.5 Jigs for use in compression, shear and flexure testing

Such jigs or fixtures shall conform with the requirements of the relevant method of test or material specification. They shall not significantly affect the accuracy of the machine by the introduction of friction, backlash or misalignment.

6 Types of force-measuring system

In all cases, a continuous indication of the force applied to the test piece, preferably recorded automatically with a permanent indication of the maximum force, shall be provided.

Machines with low-inertia force-measuring systems are preferred.

NOTE Pendulum-type machines might have levels of friction and inertia which will significantly affect their dynamic response and decrease their accuracy.

7 Steady-state machine accuracy

For each force scale, an accuracy class of 0,5, 1, 2 or 3 is specified (see Clause 4). The designation of each scale of a machine depends upon the values of relative errors of accuracy, repeatability and reversibility found when the machine is verified in accordance with ISO 7500-1.

When separate scales for use in compression or other modes of operation are provided, these shall be verified separately.

8 Dynamic machine accuracy

Tensile-testing machines fitted with electronic force-measuring devices may be regarded as sufficiently free of inertia at the test speeds given in Clause 10. This does not necessarily apply to the electronic recorders normally used with them, and in many cases the dynamic inaccuracy of these recorders considerably exceeds their steady-state inaccuracy.

All electromechanical recorders suffer from dynamic errors which are usually made up of acceleration errors, stemming from the inertia of the device, and pen-lag errors due to mechanical and electrostatic friction effects. Measurement of dynamic recorder accuracy is best achieved by recording the error-signal level during the test. This can be done without affecting instrument performance, but it is usually technically difficult. It is therefore not considered practicable at present to specify limits and a calibration procedure for dynamic accuracy in this document. Consequently, the user is advised to obtain from the test-machine manufacturer dynamic-accuracy figures for the recorder with which he/she can calculate the probable measurement error, and assess whether or not it is significant. In cases where it is, either the test speed can be reduced, or the full-scale reading of the output device can be increased, in order to reduce the acceleration and velocity levels. As a guide to recorder requirements, the response time for full-scale travel should be considerably less than the rise time of the force, if the dynamic errors are to be comparable with the steady force with the steady-state inaccuracy. It is recommended therefore that the maximum demanded pen velocity v_D should be less than the maximum possible pen velocity v_{max} by a factor dependent on the machine class as follows:

$$v_D \le \frac{v_{max}}{10} \quad \text{for class 0,5 and 1 machines}$$

$$v_D \le \frac{v_{max}}{5} \quad \text{for class 2 and 3 machines}$$

If only the recorder response time T is known, then v_{max} may be calculated approximately from the following formula:

$$v_{max} = \frac{R}{T}$$

where R is the full-scale deflection of the recorder.

If the above recommendations are not followed, the user is advised to obtain details of recorder errors arising from dynamic operation from the manufacturer.

9 Measurement of elongation (deflection)

The elongation (deflection) of rubber and plastics test pieces may be measured by methods of test utilizing

a) grip separation;

b) extensometers attached to the test piece;

c) optical or other remote (non-attached) extensometers.

When elongation is measured, a continuous indication of the elongation (deflection), preferably recorded autographically in the form of a force/elongation (deflection) curve, and a permanent indication of the maximum elongation (deflection) shall be given.

For some purposes, particularly the elongation of ring test pieces and for tests in flexure, shear or compression, the measurement of grip separation is the most convenient method. In such cases, it is essential that there be no play in the elongation (deflection) measuring system, nor any slippage between the grips and the test piece, which will significantly affect the accuracy of the test results.

When an extensometer attached to the test piece is used, there shall be no sign of distortion or damage to the test piece, nor any slippage between the extensometer grips and the test piece, which would significantly affect the test results.

When extensometer accuracy is specified, five classes, A, B, C, D and E, are recognized. The grading of each range of each measuring device depends on the maximum error when the extensometer is verified.

The values in Table 1 for error are given in percent of scale reading. The manufacturer shall state the lowest elongation at which the specified accuracy can be achieved. For all classes, the gauge length shall be as specified in the relevant method of test or material specification; the gauge length shall be accurate to within ±1 %. The method of verification shall be in accordance with national standards, subject to the verification device being within the accuracy limit given in Table 1.

Table 1 — Accuracy classes for elongation (deflection) measurement

Class	Maximum elongation (deflection) ΔL on given gauge length L	Maximum permissible error %	Accuracy of verification device %
A	5 % on 25 mm (ΔL = 1,25 mm)	±2	±0,5
B	10 % on 25 mm (ΔL = 2,5 mm)	±2	±0,5
C	50 % on 25 mm (ΔL = 12,5 mm)	±2	±0,5
D	1 200 % on 20 mm (ΔL = 240 mm)	±2	±0,5
E	1 200 % on 10 mm (ΔL = 120 mm)	±2	±0,5

10 Rate of displacement of driven grip

The test machine will be power-driven, and shall be capable of being set at one or more of the following rates of displacement of the driven grip:

1 mm/min ± 0,2 mm/min

2 mm/min ± 0,4 mm/min

5 mm/min ± 1 mm/min

10 mm/min ± 2 mm/min

20 mm/min ± 2,5 mm/min

25 mm/min ± 2,5 mm/min

50 mm/min ± 5 mm/min

100 mm/min ± 10 mm/min

200 mm/min ± 20 mm/min

250 mm/min ± 25 mm/min

500 mm/min ± 50 mm/min

After setting, the rate shall not vary during the course of any test or series of tests by more than ± 5 % of the mean rate and shall remain within the limits imposed in the above list.

Verification of the accuracy of the rate of displacement of the driven grip shall be done whilst increasing the load uniformly from zero to some specified maximum within the machine force range. Unless otherwise stated, this maximum shall be the normal maximum force capacity of the machine. Verification can be carried out by obtaining a displacement/time recording. To make a realistic assessment of the rate of displacement of the driven grip, the displacement of the driven grip during the verification test shall be at least 10 mm and the duration of the verification test shall be at least 1,0 min.

The rates of displacement listed are those more generally in use. However, it should be noted that particular specifications might require rates (e.g. between 0,1 mm/min and 1 000 mm/min) and tolerances other than the above.

11 Machine stiffness

Machine stiffness (also referred to as hardness) is the ratio between the force and the deflection of the test system. This includes the frame of the machine, the strain-application mechanism, the force-measuring device and the grips and attachments by which the test piece is held. For a "soft" machine, such as the pendulum type, the rate of traverse of the driven element is not necessarily the same as the rate of separation of the grips. Consequently, the uncorrected crosshead movement cannot be used as a measure of test piece deflection. Preference should therefore be given to a machine which is stiff in comparison to the test piece so that the speeds of grip separation, and, if required, their accuracy of measurement, are in accordance with the requirements in Clause 10 and Clause 9, respectively.