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Metallic materials — Calibration of extensometers used in uniaxial testing

Matériaux métalliques — Étalonnage des extensomètres utilisés lors d'essais unaxiaux

Reference number
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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 3.

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.

International Standard ISO 9513 was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 1, *Uniaxial testing*.

This second edition cancels and replaces the first edition (ISO 9513:1989) which has been technically revised.

This corrected and reprinted version incorporates the changes specified in ISO 9513:1999/Cor.1:2000 (E), which is hereby cancelled and replaced, together with an additional change to Table 2, row 4, column 3.

Annexes A and B of this International Standard are for information only.

Metallic materials — Calibration of extensometers used in uniaxial testing

1 Scope

This International Standard specifies a method for the static calibration of extensometers used in uniaxial testing.

The term "extensometer" is understood to mean the displacement measuring device and the system for indicating or recording this displacement.

NOTE This International Standard does not at present provide detailed guidance on the calibration of those types of extensometer which have:

— variable gauge lengths;

— no contact with the test piece;

— full field strain measurements devices.

Special consideration should be given to such devices. These issues should be addressed at the next revision of this International Standard. However some guidance on this subject might be found in ASTM E83:1996 (see Bibliography).

2 Symbols and designations

Symbols used throughout this International Standard are given in Table 1 together with their designation.

Table 1 — Symbols and designations

Symbol	Designation	Unit
L_e	Nominal value of gauge length of extensometer	mm
L'_e	Measured value of gauge length of extensometer	mm
E_{max}	Maximum limit of calibration range	mm
E_{min}	Minimum limit of calibration range	mm
l_i	Displacement indicated by extensometer	µm
l_t	True displacement given by calibration apparatus	µm
q_{Le}	Relative gauge length error	%
q	Relative bias error of extensometer	%
r	Resolution of extensometer	µm

3 Principle

The calibration of an extensometer involves a comparison of the readings given by the extensometer with known variations in length provided by a calibration apparatus.

4 Calibration apparatus

The calibration apparatus which allows a known displacement l_t, to be applied to the extensometer, may consist of a rigid frame with suitable coaxial spindles or other fixtures to which the extensometer can be attached. The calibration apparatus shall comprise a mechanism for moving at least one of the axial spindles and a device for accurately measuring the change in length produced. The variations in length can be measured, for example, using an interferometer or gauge blocks and a comparator or a screw micrometer. The gauge blocks, comparator, micrometer or interferometer used shall be calibrated by a method which is traceable to the international unit (SI) of length and their accuracy shall be known. The error of the calibration apparatus shall not be greater than one-third of the permissible error of the extensometer (see Table 2).

The resolution of the calibration apparatus shall be in accordance with Table 2.

5 Procedure

5.1 Position of the extensometer

The extensometer shall be placed in the calibration apparatus in the same position and orientation in which it is used during uniaxial testing so as to avoid errors due to loss of equilibrium or deformation of any part of the extensometer.

The extensometer shall be attached in the same way as during uniaxial testing.

5.2 Temperature at which the calibration is made

In general, the calibration of the extensometer shall be carried out at a temperature stable to within ± 2 °C; this temperature shall be within the range 18 °C to 28 °C.

For extensometers used for uniaxial testing at temperatures within the range 10 °C to 35 °C, it is recommended that the calibration be carried out at or near the test temperature, if facilities exist.

The extensometer shall be placed near the calibration apparatus or mounted on it for a sufficient length of time prior to its calibration so that the parts of the extensometer and of the calibration apparatus which are in contact shall attain the calibration temperature.

5.3 Accuracy of gauge length of the extensometer

The gauge length of the extensometer can be measured directly or indirectly. The following indirect method is given as an example.

The extensometer is placed on a soft metal test piece in such a way that the blades or points of the extensometer leave their marks. Once the extensometer is removed, the distance between the marks on the test piece is measured.

The relative error on the gauge length, q_{Le}, calculated from the following formula shall not exceed the values given in Table 2 .

$$q_{Le} = \frac{L'_e - L_e}{L_e} \times 100 \qquad (1)$$

In the case of an extensometer having several gauge lengths, the calibration shall be carried out for each of the gauge lengths required by the user.

For extensometers where gauge length is defined by the test piece then the gauge length of this test piece shall be measured to an accuracy consistent with the class of extensometer to be used.

5.4 Range of calibration

The calibration range shall be defined by the user to cover the measuring range required to determine a given material property. The maximum and minimum limits E_{max} and E_{min} of the calibration range shall be such that:

$$5 \leqslant \frac{E_{max}}{E_{min}} \leqslant 10 \quad (2)$$

If several calibration ranges are specified by the user, each one shall be calibred. An example of calibration ranges is given in annex A. The ranges of calibration shall be noted in the calibration report.

5.5 Calibration procedure

5.5.1 When the temperature has stabilized, it is recommended that, before calibration and by means of the calibration apparatus, the extensometer be tried for at least two lengths over the calibration range of the extensometer. If possible, the displacement is taken to a slightly negative value and returned to zero. Where appropriate, the extensometer is reset to zero.

5.5.2 The calibration consists first of one series of at least 10 measurements, l_i, distributed approximately evenly over the calibration range of the extensometer. The extensometer is removed and then placed back on the calibration apparatus. A second series of measurements is then made in the same manner as the first. Depending on the expected use of the extensometer, the two series of measurements are made for increases in length or for decreases in length or for both.

For each measurement point, calculate the relative bias error (see 5.6.2).

The calibration shall be made without cleaning or lubricating any part of the extensometer. Whenever adjustements are needed for the extensometer to comply with class requirements for its intended use, the results shall be noted "after adjustment" on the calibration certificate.

5.6 Determination of the characteristics of the extensometer

5.6.1 Resolution

The resolution, r, is the smallest quantity which can be read on the instrument. The values of the resolution of the extensometer shall be in accordance with the values given in Table 2.

5.6.2 Relative bias error

The relative bias error, q, for a given displacement, l_t, is calculated from the formula :

$$q = \frac{l_i - l_t}{l_t} \times 100 \quad (3)$$

6 Classification of the extensometer

Table 2 gives the maximum permissible values for the relative gauge length error, the resolution and the relative bias error.

Table 2 — Classification of extensometers

Class of extensometer	**Extensometer** (maximum values)					**Calibration apparatus** (maximum values)			
	Relative error on the gauge length	Resolution[a]		Bias error [a]		Resolution[a]		Bias error[a]	
		Percentage of readings	Absolute value	Relative error	Absolute value	Relative error	Absolute value	Relative error	Absolute value
	q_{Le} %	r/l_i %	r µm	q %	$l_i - l_t$ µm	%	µm	%	µm
0,2	± 0,2	0,1	0,2	± 0,2	± 0,6	0,05	0,1	± 0,06	± 0,2
0,5	± 0,5	0,25	0,5	± 0,5	± 1,5	0,12	0,25	± 0,15	± 0,5
1	± 1,0	0,50	1,0	± 1,0	± 3,0	0,25	0,50	± 0,3	± 1,0
2	± 2,0	1,0	2,0	± 2,0	± 6,0	0,5	1,0	± 0,6	± 2,0
NOTE For small gauge lengths (≤ 25 mm) and for small strains, the user should consider one of the better classes of extensometer.									
[a] Whichever value is the greater.									

7 Frequency of calibration

The time between two calibrations depends on the type of extensometer, the maintenance standard and the number of times the extensometer has been used. Under normal conditions, it is recommended that calibration be carried out at intervals of approximately 12 months. This interval shall not exceed 18 months unless the test is expected to last more than 18 months; in such case the extensometer shall be calibrated before and after the test.

The extensometer shall be calibrated after each repair or adjustment of its constituent elements which could affect the accuracy of measurements.

8 Calibration report

The calibration report shall contain at least the following information:

a) general information:

1) reference to this International Standard, i.e. ISO 9513;

2) identification of the extensometer (type, gauge length, mark, serial number and mounting position);

3) type and reference number of calibration apparatus;

4) temperature at which the calibration was carried out;

5) nature of variations of length for which the calibration was carried out, i.e. either for increases and/or for decreases in length;

6) date of calibration;

7) name or mark of the organisation which carried out the calibration;

8) date of expiry of the calibration report.

b) results of the calibration:

1) class of each range of the extensometer;

2) the individual values of the bias errors, if requested.