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Metallic materials — Verification of extensometers used in uniaxial testing

Matériaux métalliques — Vérification des extensomètres utilisés lors d'essais uniaxiaux

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.

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

Annexes A and B are for information only.

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Metallic materials — Verification of extensometers used in uniaxial testing

1 Scope

This International Standard specifies a method for the static verification 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.

2 Symbols and their meanings

Symbols used throughout this International Standard and their meanings are given in table 1.

Table 1 — Symbols and their meanings

Symbol	Meaning	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 verification range	mm
E_{min}	Minimum limit of verification 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 verification 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 measuring accurately 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 and comparator or micrometer 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 as given in 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 verification is made

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

For extensometers used for uniaxial testing at temperatures outside the range specified above, it is recommended that the verification 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 verification so that the parts of the extensometer and of the calibration apparatus which are in contact shall attain the same 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 mark. Once the extensometer is removed, the distance between the marks on the test piece is measured.

The relative error on the gauge length, q_{L_e}, calculated from the following formula shall not exceed the values given in table 2 :

$$\frac{L'_e - L_e}{L_e} \times 100$$

In the case of an extensometer having several gauge lengths, the verification shall be carried out for each gauge length.

5.4 Range of verification

The verification 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 verification range shall be such that

$$\frac{E_{max}}{E_{min}} \approx 10$$

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

5.5 Verification procedure

5.5.1 When the temperature has stabilized, it is recommended that, before verification, the extensometer be extended at least twice by the verification apparatus over the verification 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 verification consists first of one series of at least 10 measurements, l_i, distributed approximately evenly throughout the verification 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. For each series of measurements the successive variations in length shall be of the same type (i.e. either increases or decreases).

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, the relative bias error is calculated (see 5.6.2).

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

$$\frac{l_i - l_t}{l_t} \times 100$$

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					Calibration apparatus (Maximum values)	
	Maximum relative error on the gauge length	Resolution[1]		Bias[1]			
		Maximum percentage of reading	Maximum absolute value	Maximum relative error	Maximum absolute error	Resolution	Absolute bias error
	q_{L_e} %	r/l_i %	r µm	q %	$l_i - l_t$ µm	µm	µm
0,5	± 0,5	0,25	± 0,5	± 0,5	± 1,5	0,25	± 0,5
1	± 1,0	0,50	± 1,0	± 1,0	± 3,0	0,50	± 1,0
2	± 2,0	1,0	± 2,0	± 2,0	± 6,0	1,0	± 2,0

1) Whichever value is the greater.

7 Frequency of verification

The time between two verifications 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 verification be carried out at intervals of approximately 12 months. In no case shall the interval exceed 18 months.

If a test is expected to last more than 18 months, the extensometer shall be verified before and after the test.

The extensometer shall be verified if it undergoes any major repairs or adjustments.

8 Verification report

The verification report shall contain at least the following information :

a) General information :

1) reference to this International Standard;

2) identification of the extensometer (type, make, serial number and mounting position);

3) type and reference number of calibration apparatus;

4) temperature at which the verification was carried out;

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

6) date of verification;

7) name or mark of the service which carried out the verification;

8) date of expiry of the verification report.

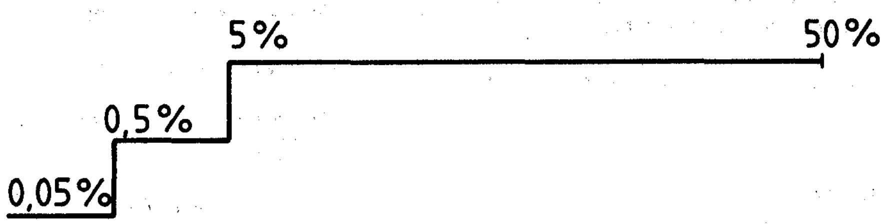
b) Results of the verification :

1) class of each range of the extensometer;

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

Annex A
(informative)

Example of verification ranges of an extensometer



First verification range :	0,05 % to 0,5 %	of the nominal value of the extensometer travel
Second verification range :	0,5 % to 5 %	of the nominal value of the extensometer travel
Third verification range :	5 % to 50 %	of the nominal value of the extensometer travel

Annex B
(informative)

Parameters for classification of an extensometer

In order to clarify the definition of the parameters used for the classification of an extensometer in accordance with clause 6

a) table B.1 gives three examples of calculations of these parameters;

b) the diagrams in figures B.1 and B.2 illustrate clearly, for class 1 extensometers, how to decide which of the two limits, "relative" or "absolute", should be chosen.

Table B.1 — Examples of calculation of parameters for the classification of extensometers

Gauge length of the extensometer	True value		Measured value		Error		Relative bias error[1)], q (%)	
	Displacement	Deformation	Displacement	Deformation	Displacement	Deformation	Displacement	Deformation
L_e	l_t	$l_t/L_e = \varepsilon_t$	l_i	$l_i/L_e = \varepsilon_i$	$l_i - l_t$	$\varepsilon_i - \varepsilon_t$	$\frac{l_i - l_t}{l_t} \times 100$	$\frac{\varepsilon_i - \varepsilon_t}{\varepsilon_t} \times 100$
mm	µm		µm		µm			
50	100	2×10^{-3}	110	$2{,}2 \times 10^{-3}$	10	$0{,}2 \times 10^{-3}$	10	10
100	100	1×10^{-3}	110	$1{,}1 \times 10^{-3}$	10	$0{,}1 \times 10^{-3}$	10	10
100	200	2×10^{-3}	210	$2{,}1 \times 10^{-3}$	10	$0{,}1 \times 10^{-3}$	5	5

1) For a given displacement error, the relative error, q, is independent of the gauge length of the extensometer, L_e, but is dependent on the displacement value, l_t.

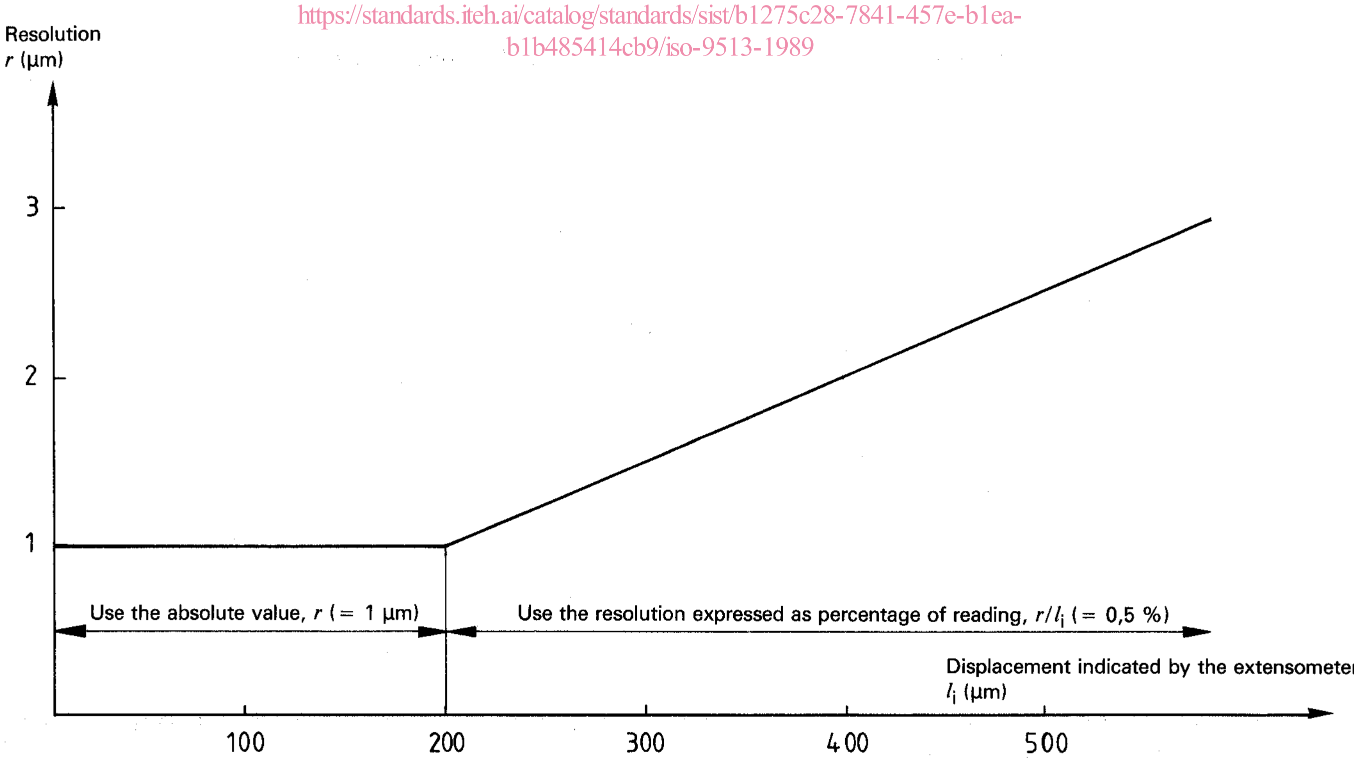


Figure B.1 — Resolution of a class 1 extensometer

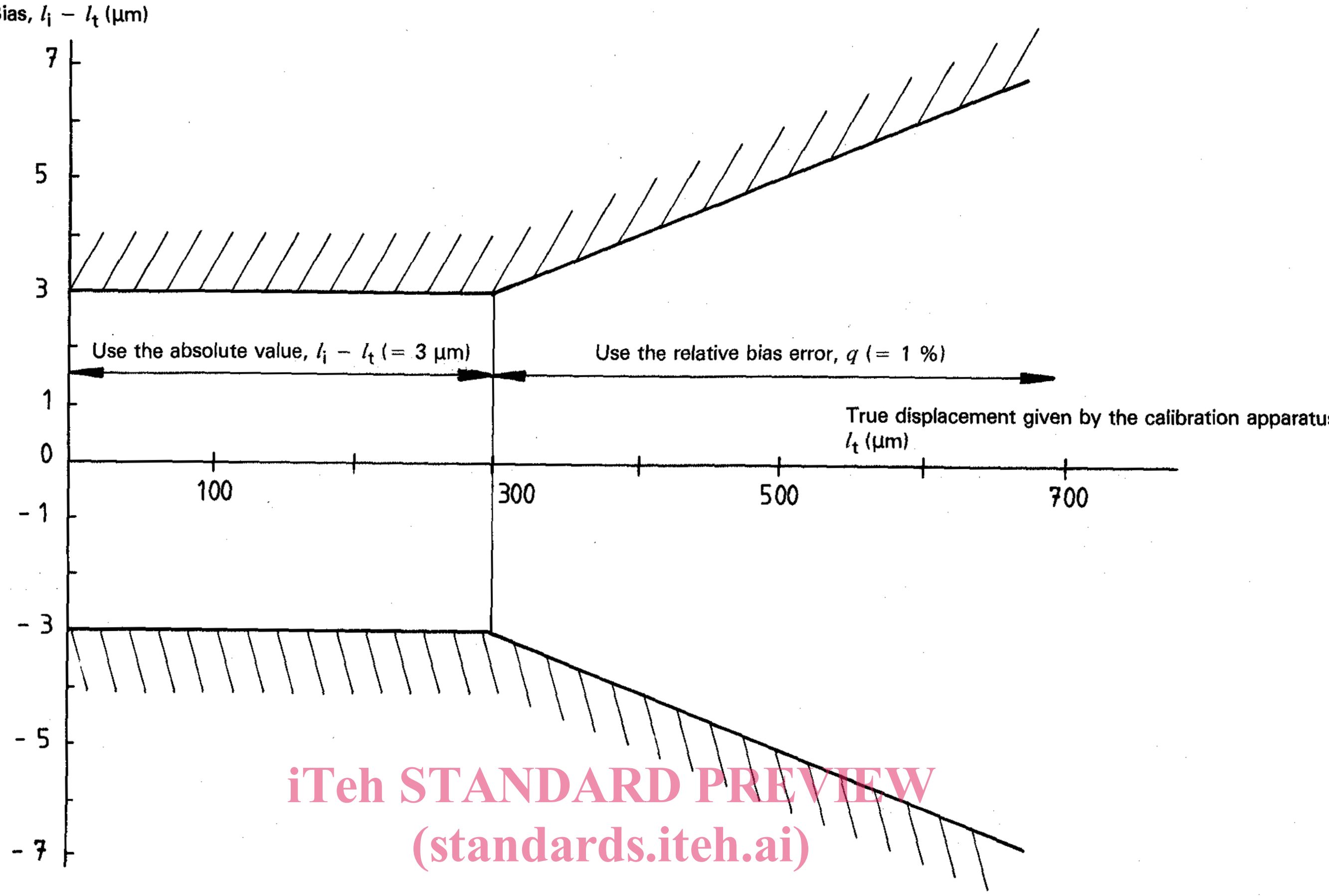


Figure B.2 — Limits of bias error of a class 1 extensometer

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Descriptors: metals, tests, mechanical tests, tension tests, test equipment, dilatometers, verification.

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