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NATIONAL METROLOGICAL VERIFICATION REGULATION
OF THE PEOPLE'S REPUBLIC OF CHINA

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Extensometer

引伸计

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Verification Regulation for Extensometer

1 Scope

This Regulation is applicable to the first verification, subsequent verification and in-service verification of extensometers.

2 Citations

The following documents are cited in this Regulation:

GB/T 228-2002, Metallic materials - Tensile testing at ambient temperature

GB/T 1040.1-2006, Plastics - Determination of tensile properties - Part 1: General principles

GB/T 7314-2005, Metallic materials - Compression testing at ambient temperature

GB/T 12160-2002/ ISO 953:1999, Calibration of extensometers used in uniaxial testing

JJF 1096-2002, Calibration Specification for Calibrator of Extensometers

ASTM E83-02, Standard Practice for Verification and Classification of Extensometer System

During the use of this Regulation, please pay attention to the currently valid version of the above-cited documents.

3 Overview

3.1 Extensometer is a device for the measurement of sample line deformation when the test machine applies axial force to the sample, including the measurement, indicating or recording systems. According to the structural characteristics, it is divided into two types: electronic and mechanical.

Note: Electronic extensometers, such as resistance-strain and inductive extensometers, need to be equipped with corresponding amplifiers, computers or indicating devices to automatically record or display the measured displacement indications. Therefore, the calibration of electronic extensometer must include the entire measurement system. Mechanical extensometers, such as dial gauge, lever type, and optical extensometers, directly indicate the displacement indications by a pointer or a cursor.

5 General technical requirements

5.1 Nameplate

The nameplate of the extensometer and its supporting instruments shall be marked with the instrument name, model, manufacturer name, product number and date of manufacture.

5.2 Appearance and quality

The extensometer and its accessories shall not have obvious mechanical damage; the blade, shaft tip and other structures that set the gauge length shall not have obvious wear; the indicating device and measuring mechanism shall not have defects that affect the measurement results.

5.3 Display and output

The display of the electronic extensometer shall be clear, complete and stable; the printed results or drawn curves shall be consistent with the indicated values.

6 Control of measuring instruments

Control of measuring instruments includes: first verification, subsequent verification and in-service verification.

6.1 Verification conditions

6.1.1 Environmental conditions

The verification temperature range shall be $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$; the temperature during the verification shall be stable; the temperature change shall not exceed 2°C ; the air convection that affects the verification result of the extensometer is not allowed during the verification.

For the test extensometer in the temperature range of $10^{\circ}\text{C} \sim 35^{\circ}\text{C}$, if necessary, the test can also be carried out at or near the test temperature.

The extensometer and the calibrator shall be placed at the same room temperature for not less than 30 minutes; the verification shall be performed after the temperature is equilibrated.

6.1.2 Standard equipment for verification

6.1.2.1 The extensometer calibrator shall meet the requirements of JJF 1096-2002; its allowable error shall conform to the requirements of Table 2.

The relative error of the extensometer gauge length is calculated according to Formula (1).

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

Where:

q_{L_e} -- relative error of the extensometer gauge length, %;

L'_e -- measurement value of the extensometer gauge length, mm;

L_e -- standard value of the extensometer gauge length, mm.

When the extensometer has multiple gauge lengths, each gauge length shall be measured separately.

For extensometers that use the sample to determine the gauge length (for example, use the sample diameter or width to determine the extensometer gauge length; for samples with lugs, use the centerline distance of the two lugs to determine the extensometer gauge length), the relative error of the tested sample gauge length shall be consistent with the allowable error of the corresponding level of the to-be-used extensometer.

6.2.4 Verification of resolution

Absolute resolution r is the minimum magnitude that can be read from the indicator of the extensometer. Relative resolution is the ratio of the minimum magnitude r that can be read from the instrument to the displacement l_i that is indicated by the extensometer. Visually inspect and calculate the resolution of the extensometer. The results shall meet the requirements of Table 1.

6.2.5 Verification of indication error

6.2.5.1 When the temperature is stabilized, use a calibrator to pre-add at least two displacements corresponding to the calibration range of the extensometer to the extensometer before the verification. After checking that the return-to-zero is normal, apply a small negative displacement to the extensometer and return to zero position; reset the extensometer to zero.

6.2.5.2 Perform the verification according to the verification range that is determined in 4.4.

There are three sets of measurements for verification; each set of measurements generally has not less than 10 measurement points (excluding zero). According to the selected verification range, use a calibrator to apply given displacement to the extensometer point by point. When the maximum displacement of the verification range is reached, return it to the zero position.

u -- relative forward-return error of indicating-value of the extensometer, %;

l'_i -- return-stroke displacement indicating-value that is indicated by the extensometer at the same detection point, mm;

l_i -- forward-stroke displacement indicating-value that is indicated by the extensometer at the same detection point, mm;

6.3 Processing of verification results

6.3.1 Assess the level of the extensometer according to the verification results of this Regulation, and issue a verification certificate. The format of the inside page of the certificate is shown in Appendix A.

The extensometer that fails to pass the verification is issued with a notice of the verification result. The unqualified items shall be indicated. For the format of the inner page, see Appendix A.

For the extensometer that is verified for multiple verification ranges and multiple gauge lengths, the level of the extensometer shall be assessed separately and a certificate in accordance with the corresponding level shall be issued.

6.3.2 At any time, if it is necessary to adjust the extensometer to meet the level requirements of its intended use, the verification result of the verification certificate shall be marked "adjusted".

6.4 Verification cycle

The verification cycle of the extensometer depends on the form, maintenance standard and frequency of use of the extensometer. Under normal circumstances, the verification cycle of the extensometer is generally 12 months. Unless that the test lasts for more than 18 months, but the verification period shall not exceed 18 months; in this case, the extensometer shall be verified before and after the test.

E -- the modulus of elasticity of steel, about 200 000 N/mm²;

$\epsilon_{p0.2}$ -- specified non-proportional elongation, 0.002 mm/mm;

C -- width margin of measurement range, 0.3 mm.

Substitute into the formula (D.1):

$$\Delta L = \left(\frac{500}{200000} + 0.002 \right) \times 50 + 0.3 = 0.225 + 0.3 = 0.525 \text{ mm} \quad (\text{D. 3})$$

The above $\Delta L = 0.525$ mm is the measurement range. The verification range of the extensometer shall be larger than the measurement range. In this example, perform rounding; the verification range of the extensometer is 1mm.

The displacement value that is verified according to the first verification point shall not exceed the requirement of non-proportional elongation during the actual test. For an extensometer with a gauge length of 50 mm, the first verification point is 0.1 mm (0.2% of 50 mm). The point interval value is 0.1 mm. Verify 10 points, that is:

10 points including 0.1 mm, 0.2 mm, ..., 0.9 mm, 1.0 mm.

According to the requirements of Regulation 6.2.5.2, the extensometer is repeatedly installed three times for verification.

It is known from formula (D.3) that for a 100 mm gage-length extensometer, the verification range is also 1 mm. For the extensometer with a gauge length of 25 mm, the verification range is 0.5 mm; but the interval value of each point is 0.05 mm.

The extensometer can perform only the forward-stroke verification during the above test.

D.2.3.2 The hysteresis loop method is used to measure the specified non-proportional extension strength R_p or the specified residual extension strength R_r .

Conditions: perform the above test on the steel sample, for the verification of the selected 50 mm gauge-length extensometer.

The test must be carried out under loading and unloading conditions of the sample; so, the extensometer must be checked for the return-stroke.

According to regulations of 6.2.5.3, the maximum value of the verification range of the return-stroke is generally 2% of the gauge length of the used extensometer. For a 50 mm gauge-length extensometer, the verification range ΔL_H of the return-stroke is calculated according to Formula (D.4):

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