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METHODS FOR CALIBRATION AND GRADING OF EXTENSOMETERS FOR TESTING OF METALS

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OF EXTENSOMETERS FOR
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This standard makes reference to the following British Standards:

- BS 18. Methods of tensile testing of metals.
- BS 970. Wrought steels in the form of blooms, billets, bars and forgings. Part 2.* Direct hardening alloy steels.
- BS 1474. Wrought aluminium and aluminium alloys for general engineering purposes. Bars, extruded round tubes and sections.
- BS 1610. Methods for the load verification of testing machines.
- BS 3500. Methods for creep and rupture testing of metals.
- BS 3688. Methods for mechanical testing of metals at elevated temperatures.
Part 1. Tensile testing.

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* In course of preparation.

The following BSI references relate to the work on this standard :
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CO-OPERATING ORGANIZATIONS

The Mechanical Engineering Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

- Associated Offices' Technical Committee
- Association of Consulting Engineers
- Association of Mining Electrical and Mechanical Engineers
- Board of Trade
- British Chemical Plant Manufacturers' Association
- British Compressed Air Society
- *British Electrical and Allied Manufacturers' Association
- British Gear Manufacturers' Association
- British Internal Combustion Engine Manufacturers' Association
- *British Steel Industry
- British Mechanical Engineering Confederation
- British Pump Manufacturers' Association
- Crown Agents for Oversea Governments and Administrations
- Department of Employment and Productivity (H.M. Factory Inspectorate)
- *Ministry of Technology—National Engineering Laboratory
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- Gas Council
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- Institution of Mechanical Engineers
- Institution of Mechanical Engineers (Automobile Division)
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- *Ministry of Defence, Army Department
- Ministry of Public Building and Works
- Ministry of Technology
- Ministry of Transport
- National Coal Board
- *National Physical Laboratory (Ministry of Technology)
- Royal Institute of British Architects
- Water-tube Boilermakers' Association

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the Committee entrusted with the preparation of this standard:

- Aluminium Federation
- British Cast Iron Research Association
- British Non-ferrous Metals Federation
- British Society for Strain Measurement
- British Non-ferrous Metals Research Association
- Geochemical Laboratories
- Ministry of Public Building and Works—Building Research Station
- Ministry of Technology—Forest Products Laboratory
- Welding Institute
- Institution of Engineering Inspection
- Lloyd's Register of Shipping
- Spring Research Association
- Scientific Instrument Manufacturers' Association
- Testing machine manufacturers and individual firms

BRITISH STANDARD METHODS FOR CALIBRATION AND GRADING OF EXTENSOMETERS FOR TESTING OF METALS

FOREWORD

The widespread use of extensometers of various types led to the publication in 1965 of the first edition of a standard describing methods and procedures for the calibration of these instruments, establishing the requirements for calibration devices, and grading extensometers in terms of accuracy and repeatability. This second edition of the standard has been prepared primarily in view of the change-over to the metric system and also to clarify certain of the technical requirements in the light of practical experience.

The standard unifies methods for calibrating extensometers at room temperature and establishes grading requirements. In addition, it is intended to guide committees responsible for the preparation or revision of standards covering methods of mechanical testing in which measurement of strain is required.

METHODS

1. GENERAL

1.1 SCOPE

This British Standard deals with methods for the calibration at room temperature and grading of extensometers used in the testing of metals in tension and compression. (See 5.1.1 regarding the use of extensometers at other than room temperature.) It defines the terms used and describes the standard methods of calibration; the requirements for calibration devices are stated.

Extensometers are graded in terms of accuracy and repeatability, and instructions for the issue of certificates of calibration are included together with recommendations on certain constructional features of extensometers and the use of calibrating equipment.

1.2 DEFINITIONS

For the purposes of this British Standard the following definitions apply:

(1) *Extensometer*. A device comprising measuring and recording or indicating equipment used for determining extension and hence strain.

NOTE. An extensometer may measure on one side or on opposite sides of a test piece. Where the latter type does not average the readings, it is hereafter referred to as a 'dual extensometer'.

(2) *Extensometer gauge length*. The initial length, at room temperature, used for the measurement of extension. (The extensometer gauge length is hereafter referred to as the gauge length.)

(3) *Indicated extension (or displacement)*. The change in length, as indicated by an extensometer, of the gauge length from its original value.

If, at the commencement of a series of readings, the initial reading of an extensometer is not zero, the indicated extension is the difference between the reading obtained and the initial reading at the beginning of that series.

NOTE. Decrease in length of the gauge length in compression testing is regarded as negative extension.

(4) *Strain*. The extension per unit length of the gauge length.

(5) *Calibration*. Determination of the relation between the extension indicated by an extensometer and the displacement applied in a calibrating rig.

(6) *Discrimination*. The smallest change of extension which can be indicated or estimated from the extensometer scale.

(7) *Error*. The difference between the indicated and the actual displacement.

(8) *Accuracy*. The degree of closeness of indicated to actual extension, at any one value of extension, derived from the arithmetic mean of the errors obtained at that extension during repeated series of observations.

(9) *Repeatability of indicated extension*. The difference between the highest and lowest values of indicated extension at the same displacement setting during repeated series of calibration readings.

Alternatively, the repeatability of indicated extension is the difference between the highest and lowest of the actual displacements as obtained from a calibrating rig when an extensometer is repeatedly set to the same reading.

(10) *Calibration (or multiplication) factor*. The factor by which an extensometer reading is multiplied to obtain the extension or strain.

NOTE. If the response is not linear, a calibration curve may serve the same purpose.

(11) *Nominal range*. The limits of extension between which an extensometer is designed to operate.

(12) *Grading range*. The limits of extension, and hence strain, within which an extensometer has been demonstrated to comply with grading requirements.

(13) *Grade*. A specified standard of accuracy and repeatability: gauge length setting and discrimination of reading are also taken into account (see 3.5).

2. DESCRIPTION OF METHODS

2.1 INTRODUCTION

This section deals with the general principles involved in the calibration of extensometers, and the following methods of calibration are described:

- (1) By means of a calibrating rig.
- (2) By means of elastic devices calibrated with a Grade A extensometer.

2.2 CALIBRATION BY MEANS OF A CALIBRATING RIG

This method consists of applying displacements to the extensometer and using suitable apparatus for measuring these displacements. The apparatus may consist of a rigid frame with suitable coaxial spindles, or other fixtures forming a 'divided test piece' to which the extensometer may be attached. A mechanism is provided for moving one spindle or fixture axially relative to the other and a means for measuring to a prescribed degree of accuracy the axial displacement produced. Any other device or mechanism that will accomplish the purpose with the required degree of accuracy may also be used (see 4.2.1). The apparatus should preferably be portable to enable calibrations to be carried out on site.

2.3 CALIBRATION BY MEANS OF ELASTIC DEVICES

In this method a specially prepared elastic device, e.g. a standard test piece or ring, whose load/strain or load/displacement characteristics have been determined in a Grade A1 testing machine (see BS 1610*) by means of a Grade A extensometer, is used to calibrate the extensometer under test. Load/strain or load/displacement readings are taken and the error of the ungraded extensometer is determined on the basis that the Grade A instrument is free from error.

This method is not considered suitable for the calibration of Grade A and B extensometers, but is deemed to be adequate for extensometers used in many types of commercial testing.

A limitation of this method when using a calibrated tensile or compression test piece is the necessity of ensuring that during loading it is not deformed beyond its elastic range. The range over which calibration may be made is usually therefore substantially less than 0.01 strain and depends on the material used. However, if a ring is used the range of displacement may be increased to 5 mm, i.e. approximately 0.1 strain on a 50 mm gauge length.

* BS 1610, 'Methods for the load verification of testing machines'.