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# INTERNATIONAL STANDARD 4965

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## **Axial load fatigue testing machines — Dynamic force calibration — Strain gauge technique**

*Machines d'essai de fatigue par charge axiale — Étalonnage dynamique — Technique des jauges de déformation*

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## FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4965 was developed by Technical Committee ISO/TC 17, *Steel*, and was circulated to the member bodies in December 1976. Subsequently, responsibility for this document was transferred to ISO/TC 164, *Mechanical testing of metals*, which was set up in 1975.

It has been approved by the member bodies of the following countries :

|                |                       |                |
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| Australia      | Hungary               | Sweden         |
| Austria        | India                 | Switzerland    |
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The member bodies of the following countries expressed disapproval of the document on technical grounds :

Germany, F.R.  
Romania

# Axial load fatigue testing machines — Dynamic force calibration — Strain gauge technique

## 0 INTRODUCTION

**0.1** It is recognized that whilst calibration services are offered by some laboratories, it is frequently more expedient for fatigue machine users to undertake the regular calibration of their machines themselves. More especially is this so in organizations where technically qualified staff and suitable instrumentation are readily available, albeit for wider engineering applications. In such instances, machine calibration can be conveniently phased to suit the operating needs of a particular fatigue machine.

**0.2** This International Standard is particularly concerned with the calibration of axial load machines as the procedures for their calibration are generally more complex. The calibration of rotating bending and torsional fatigue testing machines can usually be carried out simply by direct measurements of the effective test piece length and by direct verification of the applied force or displacement.

**0.3** A strain gauge test bar should always be used to check axial load fatigue machines, even though the machine may rely upon a strain gauge load cell for its force measurement, since the force measuring system may have its own mechanical and electrical dynamic characteristics.

## 1 SCOPE AND FIELD OF APPLICATION

**1.1** This International Standard lays down guidelines for dynamic force calibration of fatigue testing machines including special attachments, for example grips, which may affect the calibration of the machine. It deals exclusively with axial load machines in which test pieces, usually symmetrical about a longitudinal axis, are subjected to fluctuating and reversed forces along that axis (see also ISO 1099).

**1.2** Whilst it is recognized that unsymmetrical specimens (components and structures), are sometimes tested, it is common practice to determine stresses within them from measurements by strain gauges applied to the test specimens as required, and in such cases dynamic force calibration of the machine may not be necessary.

**1.3** This International Standard applies both to the calibration of new testing machines by the manufacturer and to the verification of machines in service. In the latter case, it may not be necessary to apply all the procedures required for the overall calibration of a machine.

**1.4** The calibration of special-purpose machines and test rigs are not specifically covered in this International Standard, but procedures similar to those described may be applied to suit particular applications.

## 2 REFERENCES

ISO/R 147, *Load calibration of testing machines for tensile testing of steel*.

ISO/R 373, *General principles for fatigue testing of metals*.

ISO 1099, *Metals — Axial load fatigue testing*.

## 3 SYMBOLS AND DEFINITIONS

In this International Standard the following symbols are used. Further symbols and definitions relating to fatigue testing are given in ISO/R 373.

### 3.1 Calibration bars (see also figures 1 and 2)

| Symbol | Definition                                                                                                            |
|--------|-----------------------------------------------------------------------------------------------------------------------|
| $D$    | The diameter of the gripped end of the test piece                                                                     |
| $d$    | The diameter of the test piece where the stress is a maximum                                                          |
| $L_c$  | The parallel length of the test piece                                                                                 |
| $l$    | The total length of the electrical resistance strain (ERS) gauges used, i.e. the length of the gauge backing material |
| $r$    | The transition radius from the parallel length to the gripped ends                                                    |
| $a$    | The thickness of test section of a rectangular cross-section                                                          |
| $b$    | The width of a rectangular cross-section where the stress is a maximum                                                |
| $B$    | The width of a rectangular cross-section at the gripped end                                                           |

### 3.2 Fatigue machine forces (see also tables 1, 2 and 3)

| Symbol       | Definition                                                                   |
|--------------|------------------------------------------------------------------------------|
| $F_{\max}$   | The maximum force of the machine                                             |
| $F_m$        | The mean force                                                               |
| $F_{m \max}$ | The maximum mean force of the machine                                        |
| $F_R$        | The dynamic force range                                                      |
| $F_{R \max}$ | The maximum dynamic force range of the machine                               |
| $F_{a \max}$ | The maximum force amplitude of the machine<br>( $= \frac{1}{2} F_{R \max}$ ) |

## 4 OBJECT OF CALIBRATION

**4.1** Whilst it is relatively simple to carry out a calibration of the forces applied by a fatigue testing machine under static conditions, it is essential to establish that the dynamic forces actually applied to the test piece are those indicated by the machine within acceptable limits of accuracy.

**4.2** As some fatigue machines operate over a range of testing frequencies, the inertia effects of moving parts are not constant but vary. For such machines, a dynamic correction factor may therefore have to be applied to the indicated forces to obtain the force actually effective at the test piece. This factor is a function, for example, of the vibrating mass of the machine, of the test piece stiffness and the operating frequency, and the correction data are customarily supplied by the manufacturer of the testing machine. Thus, the object of fatigue testing machine calibration is to compare indicated forces, multiplied by an appropriate correction factor where applicable, with actual test forces over the operating range of the machine.

## 5 PROCEDURE

**5.1** Calibration bars, appropriate to the dimensions of the testing machine and the force ranges to be checked, shall be instrumented by the application of electrical resistance strain (ERS) gauges. Each calibration bar shall be subjected to incremental loading in a static testing machine of known accuracy, and the electrical strain outputs from the gauges recorded. The calibration bar, as calibrated statically, shall then be used for direct measurement of the forces applied by the fatigue testing machine and compared with the indicated forces.

The procedure assumes identical performances of the strain-gauged bar, or load-cell, and instrumentation under static and dynamic conditions: this assumption is essentially valid over the range of frequencies covered by fatigue machines in general use.

**5.2** Successful application of the procedure is dependent on a satisfactory design of calibration bar, on the correct use of suitable strain gauges and on the choice of compatible dynamic strain recording instruments (see also clauses 6, 7 and 8).

## 6 CALIBRATION BARS

### 6.1 General

**6.1.1** Calibration bars of any suitable geometry and material may be used but it is recommended that, where possible, they be of similar form to the test piece normally being tested in the particular fatigue machine. They may be of circular, square or rectangular cross-section, and in the case of circular and square bars a hollow-section is permissible to facilitate the measurement of small forces. ERS load-cells which satisfy the recommendations of this sub-clause and of sub-clauses 6.1.2 and 6.1.3 may also be used.

**6.1.2** As a guide to the selection of material and the design of the bar, the maximum stated capacity should be such that 150 % of that capacity does not exceed the 0,01 % proof stress (non-proportional elongation method) of the material.

**6.1.3** It is recommended that, at the rated maximum force range at which the bar is to be used, the strain imposed should be approximately 1 200  $\mu\text{m}/\text{m}$  either in tension or in compression.

### 6.2 Proportions

The proportions of calibration bars which have been found satisfactory for use in axial load fatigue testing machines are as follows:

#### 6.2.1 Bars of circular cross-section (See note 1)

$L_c$  shall be at least  $d + l$ . (See also note 2.)

$r$  and  $D$  should be equal to or greater than  $2d$ .

$r$  should be at least equal to  $D$ .

Where possible, the length of the enlarged end should be at least equal to  $D$ .

#### 6.2.2 Bars of square and rectangular cross-section

$L_c$  shall be at least  $b + l$ . (See also note 2.)

$r$  and  $B$  should be equal to or greater than  $2b$ .

Where possible, the length of the gripped end should be at least equal to  $B$ .

### NOTES

- 1 Bars of square cross-section may have circular ends.
- 2  $L_c$  should not be such that buckling will occur if the strain cycle goes into compression.