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BSI Standards Publication

Metallic materials — Fatigue testing — Axial force-controlled method

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National foreword

This British Standard is the UK implementation of ISO 1099:2017.

The UK participation in its preparation was entrusted to Technical Committee ISE/101/6, Fatigue testing of metals and metal matrix composites.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 5, *Fatigue testing*.

This third edition cancels and replaces the second edition (ISO 1099:2006), which has been technically revised.

It shall be noted that this document does not address safety or health concerns, should such issues exist, that may be associated with its use or application. The user of this document has the sole responsibility to establish any appropriate safety and health concerns as well as to determine the applicability of any national or local regulatory limitations regarding the use of this document.

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Introduction

This document is intended to provide guidance for conducting axial, constant-amplitude, force-controlled, cyclic fatigue tests on specimens of a metal for the sake of generating fatigue-life data (i.e. stress vs. cycles to failure) for material characterization.

Nominally identical specimens are mounted in an axial force-type fatigue-testing machine and subjected to the required cyclic force conditions that introduce any one of the types of cyclic stress as illustrated in Figure 1. The test waveform should be of constant amplitude and sinusoidal unless otherwise specified.

The force being applied to the specimen is along the longitudinal axis passing through the centroid of each cross-section. The test is continued until the specimen fails or until a predetermined number of stress cycles have been exceeded (See Clauses 4 and 13). Tests are typically conducted at ambient temperature (ideally between 10 °C to 35 °C).

NOTE The results of a fatigue test can be affected by atmospheric conditions and where controlled conditions are required, ISO 554:1976, 2.1 applies.

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Metallic materials — Fatigue testing — Axial force-controlled method

1 Scope

This document specifies the conditions for conducting axial, constant-amplitude, force-controlled, fatigue tests at ambient temperature on metallic specimens, without deliberately introduced stress concentrations. The object of testing while employing this document is to provide fatigue information, such as the relation between applied stress and number of cycles to failure for a given material condition, such as hardness and microstructure, at various stress ratios.

While the form, preparation and testing of specimens of circular and rectangular cross-section are described, component testing and other specialized forms of testing are not included in this document.

NOTE 1 Fatigue tests on notched specimens are not covered by this document since the shape and size of notched test pieces have not been standardized. However, fatigue-test procedures described in this document can be applied to fatigue tests of such notched specimens.

NOTE 2 Throughout this document, the engineering stress is employed. Engineering stress is defined as the quotient of the axially applied force to the cross-sectional area of the test specimen, S = Force/Area, at the test temperature.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4965-1, *Metallic materials — Dynamic force calibration for uniaxial fatigue testing — Part 1: Testing systems*

ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines – Verification and calibration of the force-measuring system*

ISO 23788, *Metallic materials — Verification of the alignment of fatigue testing machines*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
test specimen diameter
d
diametric distance or width of the specimen or test piece where the stress is at a maximum

3.2
grip diameter
D
diameter of the specimen at grip end

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3.3
thickness of test section
t
thickness of reduced section of rectangular test specimen

3.4
width of test section
w
width of reduced section of rectangular test specimen

3.5
parallel length
L_p
length in the gauge test section of a specimen or test piece that has equal test diameter or test width and is parallel

3.6
specimen length
L_z
overall length of test specimen

3.7
fillet radius
r
radius between the parallel length and the grip end of test specimen

Note 1 to entry: The curve need not be a true arc of a circle over the whole of the distance between the end of the parallel length and the start of the grip end.

3.8
maximum stress
S_{max}
greatest algebraic value of stress in a stress cycle

Note 1 to entry: See Figure 2.

3.9
mean stress
S_m
one-half the algebraic sum of the maximum stress and the minimum stress in a stress cycle

Note 1 to entry: See Figure 2.

3.10
minimum stress
S_{min}
least algebraic value of stress in a stress cycle

Note 1 to entry: See Figure 2.

3.11
stress amplitude
S_a
one-half the algebraic difference between the maximum stress and the minimum stress

Note 1 to entry: See Figure 2.

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3.12
stress range
ΔS
algebraic difference between the maximum and minimum stress

$$\Delta S = S_{max} - S_{min}$$

Note 1 to entry: See Figure 2.

3.13
stress ratio
R_s
ratio of minimum to maximum stress during any single cycle of fatigue operation

$$R_s = S_{min}/S_{max}$$

Note 1 to entry: See Figure 2.

3.14
stress cycle
variation of stress with time, repeated periodically and identically

Note 1 to entry: See Figure 2.

3.15
number of cycles
N
number of smallest segments of the force-time, stress-time, etc., function that is repeated periodically

3.16
fatigue life
N_f
number of applied cycles to achieve a defined failure criterion

3.17
fatigue strength at *N* cycles
S_N
value of the stress amplitude at a stated stress ratio under which the specimen would have a life of N cycles

4 Test plan

4.1 General outline

Before commencing testing, the following shall be agreed by the parties concerned, unless specified otherwise in the relevant product standard:

a) the form of specimen to be used (see 5.1);

b) the R-ratio(s) to be used;

c) the objective of the tests, i.e. which of the following is to be determined:

— the fatigue life at a specified stress amplitude;

— the fatigue strength at a specified life;

— a full Wöhler or S-N curve.

d) the number of specimens to be tested and the testing sequence;

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