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## Metallic materials — Fatigue testing — Axial plane bending method

*Matériaux métalliques — Essais de fatigue — Méthode par flexion  
plane axiale*

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ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

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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](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 4, *Fatigue, fracture and toughness testing*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

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# Metallic materials — Fatigue testing — Axial plane bending method

## 1 Scope

This document specifies the conditions for conducting the plane bending fatigue test on an axial machine, constant-amplitude, force or displacement controlled, at room temperature (ideally between 10 °C and 35 °C) on metallic specimens, without deliberately introduced stress concentrations. This document does not include the reversed/partially loading test. The purpose of the test is to provide relevant results, such as the relation between applied stress and number of cycles to failure for a given material condition, expressed by hardness and microstructure, at various stress ratios.

Although the shape, preparation and testing of specimens of rectangular and bevelled cross-section are specified, component testing and other specialized forms of testing are not included in this document.

Fatigue tests on notched specimens are not covered by this document since the shape and size of notched test pieces have not been specified in any standard so far. Guidelines are given in [Annex A](#). However, the fatigue-test procedures described in this document can be used for testing such notched specimens.

It is possible for the results of a fatigue test to be affected by atmospheric conditions. Where controlled conditions are required, ISO 554:1976, 2.1 applies.

## 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 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

ASTM E2309/E2309M, *Standard Practices for Verification of Displacement Measuring Systems and Devices Used in Material 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:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

### 3.1

#### thickness of test section

$\delta$

thickness of reduced section of rectangular test specimen

Note 1 to entry: See [Figure 1](#).

**3.2**  
**width of test section**

$w$   
width of reduced section of rectangular test specimen

Note 1 to entry: See [Figure 1](#).

**3.3**  
**specimen length**

$L_z$   
overall length of test specimen

**3.4**  
**specimen cross-section**

$S$   
surface of the specimen cross-section

**3.5**  
**corner radius**

$r_c$   
radius of the corner of rectangular cross-section specimen

**3.6**  
**distance between inner loading points**

$d_1$   
distance between the axes of the two inner rollers

Note 1 to entry: See [Figure 3](#).

**3.7**  
**distance between outer loading points**

$d_2$   
distance between the axes of the two outer rollers

Note 1 to entry: See [Figure 3](#).

**3.8**  
**roller diameter**

$D_R$   
diameter of the four rollers

**3.9**  
**stress cycle**

smallest segment of stress-time that is repeated identically

Note 1 to entry: See [Figure 4](#).

**3.10**  
**maximum stress**

$\sigma_{\max}$   
greatest algebraic value of stress in a stress cycle

Note 1 to entry: See [Figure 4](#).

**3.11**  
**mean stress**

$\sigma_m$   
one-half the algebraic sum of the maximum stress and the minimum stress in a stress cycle

Note 1 to entry: See [Figure 4](#).



### 3.12 minimum stress

$\sigma_{\min}$   
least algebraic value of stress in a stress cycle

Note 1 to entry: See [Figure 4](#).

### 3.13 stress amplitude

$\sigma_a$   
one-half the algebraic difference between the maximum stress and the minimum stress in a stress cycle

Note 1 to entry: to entry:

$$\sigma_a = \Delta\sigma/2$$

Note 2 to entry: See [Figure 4](#).

### 3.14 stress range

$\Delta\sigma$   
arithmetic difference between the maximum and minimum stress

Note 1 to entry: to entry:

$$\Delta\sigma = \sigma_{\max} - \sigma_{\min}$$

Note 2 to entry: See [Figure 4](#).

### 3.15 stress ratio

$R_\sigma$   
ratio of minimum to maximum stress during any single cycle of fatigue operation

Note 1 to entry: to entry:

$$R_\sigma = \sigma_{\min}/\sigma_{\max}$$

Note 2 to entry: See [Figure 5](#).

### 3.16 load ratio

$R_F$   
ratio of minimum to maximum load during any single cycle of fatigue operation

Note 1 to entry: to entry:

$$R_F = F_{\min}/F_{\max}$$

Note 2 to entry: See [Figure 5](#).

### 3.17 number of cycles

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

**3.18**  
**fatigue life**

$N_f$   
number of applied cycles to achieve a defined failure criterion

**3.19**  
**applied force**

$F$   
force applied during the test (for force-controlled test)

**3.20**  
**bending moment**

$M$   
constant moment between the inner rollers, calculated with the applied force and the distances between the rollers ( $d_1$  and  $d_2$ )

Note 1 to entry: to entry:

$$M = \frac{F}{4}(d_2 - d_1)$$

## 4 Symbols

### 4.1 Symbols related to specimen geometry

Symbol	Designation	Unit
$\delta$	Thickness of test section	mm
$\delta_1$	Reduced thickness of the bevelled specimen	mm
$w$	Width of test section	mm
$w_1$	Reduced width of the bevelled specimen	mm
$L_z$	Specimen length	mm
$I$	Second moment of area	mm <sup>4</sup>
$d_{nba}$	Maximum distance from the neutral bending axis	mm
$S$	Specimen cross-section	mm <sup>2</sup>
$r_c$	Corner radius	mm

### 4.2 Symbols related to testing device

Symbol	Designation	Unit
$d_1$	Distance between inner loading points	mm
$d_2$	Distance between outer loading points	mm
$D_R$	Roller diameter	mm

### 4.3 Symbols related to fatigue test

Symbol	Designation	Unit
$\beta_{hi}$	Stress homogeneity for load $i$	
$\sigma_{max}$	Maximum stress	MPa