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**Metallic materials - Fatigue testing - Rotating bar bending
method**

(English Translation)

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1 Scope

This document specifies the principle, specimen shape and dimensions, specimen preparation, accuracy of testing equipment, heating device and temperature measuring device, test procedure, test report, expression of test results and measurement uncertainty of the rotating bar bending method for fatigue testing of metallic materials.

This document applies to fatigue tests of metallic materials under conditions of rotating bending of specimens at room temperature or in high-temperature air. Rotating bending fatigue tests under other environments (such as corrosion) shall be performed with reference to this document.

This document does not include fatigue testing of notched specimens because the shape and dimensions of notched specimens have not been standardized. However, the fatigue testing procedures described in this document can also be applied to fatigue testing of notched specimens.

2 Normative references

The following referenced documents are indispensable for the application 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.

GB/T 3075, Metallic materials - Fatigue testing - Axial force-controlled method (GB/T 3075-2021, ISO 1099.2017, MOD)

GB/T 10623, Metallic material - Mechanical testing - Vocabulary (GB/T 10623-2008, ISO 23718.2007, MOD)

GB/T 13634, Metallic materials - Calibration of force-proving instruments used for the verification of uniaxial testing machines (GB/T 13634-2019, ISO 376.2011, IDT)

GB/T 24176, Metallic materials - Fatigue testing - Statistical planning and analysis of data (GB/T 24176-2009, ISO 12107.2003, IDT)

GB/T 26077, Metallic materials - Fatigue testing - Axial-strain-controlled method (GB/T 26077-2021, ISO 12106.2017, MOD)

3 Terms and definitions

For the purposes of this document, the following terms and definitions, as well as those given in GB/T 3075, GB/T 10623, GB/T 24176 and GB/T 26077, apply.

3.1

fatigue

The process by which metallic materials develop cracks or fail under alternating stress or strain.

3.2

fatigue life

N_f

The actual number of cycles required to reach the fatigue failure criterion.

3.3

S-N diagram

Stress-life curve.

3.4

bending moment

The product of force and moment arm.

3.5

section modulus

The ratio of the moment of inertia of a beam subjected to bending to the moment of inertia at the point of maximum distance from the beam's neutral axis.

3.6

machine lever ratio

Mlr

The force-lever ratio, which is a fixed value provided by the testing machine manufacturer for similar rotating-bending fatigue testing machines.

3.7

moment arm

The distance between the fulcrum and the point of application of force, as shown in Figures 1 ~ 7.

Note: For four-point bending, the applied forces $L1$ and $L2$ are equal.

4 Symbols and their meanings

The following symbols apply to this document (see Table 1).

5 Principle

The specimen rotates and is subjected to bending moment, while the force generating the bending moment remains constant and does not rotate. The specimen can be mounted as a cantilever, with force applied at one or two points; or as a beam, with force applied at four points. The test shall continue until the specimen fails or the predetermined number of stress cycles is reached.

6.1 Shape of the specimen

6.1.1

The specimen may be of one of the following shapes.

- a) cylindrical (see Figures 1, 4 and 5);
- b) conical (see Figure 2);
- c) funnel-shaped (see Figures 3, 6 and 7).

Note: Under two-point and four-point loading conditions, the test material in the gauge length portion of the uniform-section cylindrical specimen shall experience the same maximum stress. For

all other loading conditions, only one cross-section of the uniform-section cylindrical specimen and the funnel-shaped specimen shall experience the maximum stress.

corresponding stress depend on the specimen geometry and the length of the horizontal arm. For this type of machine, a cylindrical funnel-shaped specimen is recommended because the higher stresses are close to the stress calculated for the smallest diameter section.

6.1.6

The recommended ratio of the cross-sectional area of the test part to the cross-sectional area of the clamping part should not be less than 1.2. It is recommended to use clamps that will not cause significant stress concentration.

6.1.7

For certain materials, high stress and high-speed rotation may cause the specimen to heat up. If this occurs, the volume of material in the specimen subjected to high stress shall be reduced, or the test frequency shall be decreased (see 10.3). If the specimen is cooled during testing, the test medium should be stated in the test report.

6.2 Specimen dimensions

6.2.1

The specimens used in the same batch of fatigue tests shall have the same diameter, the same shape and dimensional tolerances.

6.2.2 To accurately calculate the applied force, the actual minimum diameter of each

specimen shall be measured to an accuracy of 0.01 mm. Before the test, it shall be ensured that the specimen surface is not damaged when measuring the specimen dimensions.

6.2.3 For cylindrical specimens subjected to constant bending (see Figures 4 and 5), the parallelism of the test part shall not exceed 0.025 mm. For cylindrical specimens of other shapes (see Figure 1), the parallelism of the test part shall not exceed 0.05 mm.

The radius of the transition arc between the specimen clamping part and the test section should preferably not be less than 3 d. For funnel-shaped specimens, the radius of the arc of the test section should preferably not be less than 5 d.

6.2.4 The shape and dimensions of the cylindrical specimen are shown in Figure 8.

Recommended diameters d are 6 mm, 7.5 mm, and 9.5 mm. The deviation of diameter d should preferably not exceed 0.005d. Figure 9 shows a typical funnel-shaped smooth specimen for high-temperature fatigue testing.