

BS ISO 1352:2011



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Metallic materials — Torque-controlled fatigue testing

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National foreword

This British Standard is the UK implementation of ISO 1352:2011.

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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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Metallic materials — Torque-controlled fatigue testing

*Matériaux métalliques — Essais de fatigue par couple de torsion
commandé*



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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 1352 was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 5, *Fatigue testing*.

This second edition cancels and replaces the first edition (ISO 1352:1977), which has been technically revised.

Metallic materials — Torque-controlled fatigue testing

1 Scope

This International Standard specifies the conditions for performing torsional, constant-amplitude, nominally elastic stress fatigue tests on metallic specimens without deliberately introducing stress concentrations. The tests are typically carried out at ambient temperature in air (ideally at between 10 °C and 35 °C) by applying a pure couple to the specimen about its longitudinal axis.

While the form, preparation and testing of specimens of circular cross-section and tubular cross-section are described in this International Standard, component and other specialized types of testing are not included. Similarly, low-cycle torsional fatigue tests carried out under constant-amplitude angular displacement control, which lead to failure in a few thousand cycles, are also excluded.

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.

ISO 554:1976, *Standard atmospheres for conditioning and/or testing — Specifications*

3 Terms and definitions

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

3.1

maximum stress

$\tau_{\max}$
highest algebraic value of shear stress in the stress cycle

3.2

minimum stress

$\tau_{\min}$
lowest algebraic value of shear stress in the stress cycle

3.3

mean stress

τ_m
static component of the shear stress

NOTE It is one half of the algebraic sum of the maximum shear stress and the minimum shear stress:

$$\tau_m = \frac{\tau_{\max} + \tau_{\min}}{2}$$

3.4 stress amplitude

τ_a
variable component of stress

NOTE It is one half of the algebraic difference between the maximum shear stress and the minimum shear stress:

$$\tau_a = \frac{\tau_{\max} - \tau_{\min}}{2}$$

3.5 number of cycles

N
number of cycles applied at any stage during the test

3.6 stress ratio

R
algebraic ratio of the minimum shear stress to the maximum shear stress in one cycle

NOTE It is expressed as

$$R = \frac{\tau_{\min}}{\tau_{\max}}$$

3.7 stress range

$\Delta\tau$
range between the maximum and minimum shear stresses

NOTE It is expressed as

$$\Delta\tau = \tau_{\max} - \tau_{\min}$$

3.8 fatigue life at failure

N_f
number of stress cycles to failure in a specified condition

3.9 fatigue strength at N cycles

τ_N
value of the shear stress amplitude at a stated stress ratio under which the specimen would have a life of N cycles

3.10 torque

T
twisting force producing shear stress or twisting deformation about the axis of the specimen

4 Symbols and abbreviated terms

D diameter or width across flats of the gripped ends of the specimen

NOTE The value of D may be different for each end of the specimen.

d diameter of specimen of circular cross-section, where stress is maximum

d_o outer diameter of test section of specimen of tubular cross-section, where stress is maximum

d_i inner diameter of test section of specimen of tubular cross-section

L_c length of test section

L_p parallel length of specimen's test section

L_g gauge length of the specimen's test section

r transition blending radius at ends of test section which starts the transition from d to D (see Figures 3 and 4)

NOTE This curve need not be a true arc of a circle over the whole of the distance between the end of the test section and the start of the enlarged end for specimens of the types shown in Figure 3.

5 Principle of test

Nominally identical specimens are mounted on a torsional fatigue testing machine and subjected to the loading condition required to introduce cycles of torsional stress. Any one of the types of cyclic stress illustrated in Figure 1 may be used. The test waveform shall be constant-amplitude sinusoidal, unless otherwise specified.

In an axially symmetrical specimen, change of mean torque does not introduce a different type of stress system and mean stress in torsion may always be regarded as positive in sign.

The torque is applied to the specimen about the longitudinal axis passing through the centroid of the cross-section.

The test is continued until the specimen fails or until a predetermined number of stress cycles has been exceeded.

Cracks produced from torsional fatigue testing may be parallel to the longitudinal axis of the specimen, perpendicular to the longitudinal axis or at any angle between these two.

Tests shall be conducted at ambient temperature (ideally between 10 °C and 35 °C) unless otherwise agreed with the customer.

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

6 Test plan

Before commencing testing, the following shall be agreed by the parties concerned and any modifications shall be mutually agreed upon:

- a) the form of specimen to be used (see Clause 7);
- b) the stress 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 number of cycles;
 - a full Wöhler or S–N curve;
- d) the number of specimens to be tested and the test sequence;
- e) the number of cycles a specimen is subjected to before the test is terminated.

NOTE 1 Some methods of data presentation are given in Annex A. See ISO 12107 for details, including data analysis procedure and statistical presentation.

NOTE 2 Commonly employed numbers of cycles for test termination are

- 10^7 cycles for structural steels, and
- 10^8 cycles for other steels and non-ferrous alloys.

7 Shape and size of specimen

7.1 Form

Generally, a specimen having a fully machined test section of one of the types shown in Figures 3 and 4 should be used.

The specimen may be of

- circular cross-section, with tangentially blending fillets between the test section and the ends (see Figure 3), or
- tubular cross-section, with tangentially blending fillets between the test section and the ends in the outer surface (see Figure 4).

For tubular specimens, the diameter of the inner surface at the ends may be greater than or equal to that at the test section. For a specimen having an inner diameter at the ends greater than that at the test section, crack initiation or failure outside the test section invalidates the test, which should be counted as a discontinued (stopped) test at the number of cycles completed.

Fatigue test results determined using the specimen of tubular cross-section are not always comparable to those obtained from the specimen of circular cross-section. Therefore, caution should be exercised when comparing fatigue lives obtained on the same material from specimens having different cross-sections.

Typical specimen ends are shown in Figure 5. It is recommended that ends suitable for meeting the alignment criterion be chosen.