
**Fine ceramics (advanced ceramics,
advanced technical ceramics) — Test
method for cyclic bending fatigue of
monolithic ceramics at room temperature**

*Céramiques techniques — Méthode d'essai pour la fatigue de courbure
cyclique de céramiques monolithiques à température ambiante*

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ISO 22214:2006

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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 22214 was prepared by Technical Committee ISO/TC 206, *Fine ceramics*.

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Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for cyclic bending fatigue of monolithic ceramics at room temperature

1 Scope

This International Standard specifies a test method for four-point cyclic bending fatigue of fine ceramics that are carried out in the air at room temperature. This test may be used as a pass/fail test for material qualification purposes, or for determination of the overall fatigue behaviour at several different stress levels.

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 31-0:1992, *Quantities and units — Part 0: General principles*

ISO 14704:2000, *Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for flexural strength of monolithic ceramics at room temperature*

ISO/IEC 17025:2005, *General requirements for the competence of testing and calibration laboratories*

3 Terms and definitions

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

3.1

fatigue test

test where repeated stress is applied to a test specimen, and the number of cycles to fracture is measured

3.2

fatigue failure

fracture due to cyclic loading well below the strength under monotonic loading

3.3

suspending time

time at which test is intentionally interrupted without fracture

3.4

four-point bending stress

maximum value of stress generated in a test specimen when a test specimen is loaded equally by two bearings symmetrically located between two support bearings

3.5

cyclic stress

stress which is simply and cyclically varied between a specific maximum value and a specific minimum value

See Figure 1.

3.6
maximum stress

σ_{max}
algebraic maximum value of cyclic stress

See Figure 1.

3.7
minimum stress

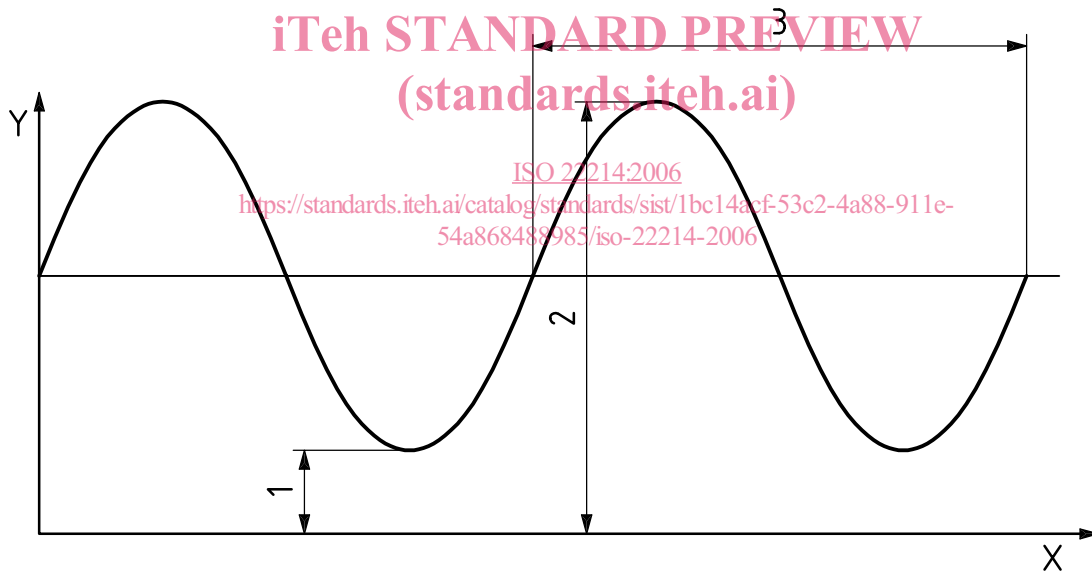
σ_{min}
algebraic minimum value of cyclic stress

See Figure 1.

NOTE For maximum stress or minimum stress, the sign is considered. A tensile stress is taken as positive, and a compressive stress is taken as negative.

3.8
stress cycle
one period of the cyclic stress

See Figure 1.



- Key**
- X Time
 - Y Stress
 - 1 σ_{min}
 - 2 σ_{max}
 - 3 One stress cycle

Figure 1 — Cyclic stress

3.9
minimum to maximum stress ratio

R
algebraic ratio of minimum stress to maximum stress

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

3.10
number of cycles
number of cycles of stress in fatigue test

3.11
number of cycles to failure
 N
number of cycles of stress until fatigue failure occurs

3.12
time to failure
 T
loading time until fatigue failure occurs

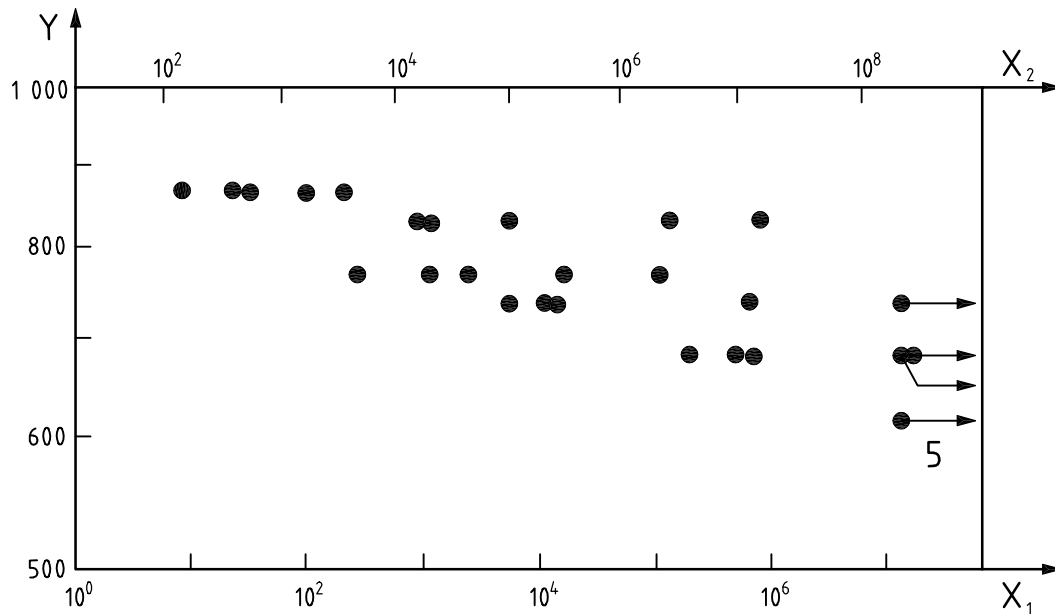
3.13
 $S-N$ plot
diagram where maximum stress is taken as the ordinate and the number of cycles to failure as the abscissa

See Figure 2.

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NOTE When the test is interrupted, the result is plotted as the maximum stress and the number of cycles at the suspending time.

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Key

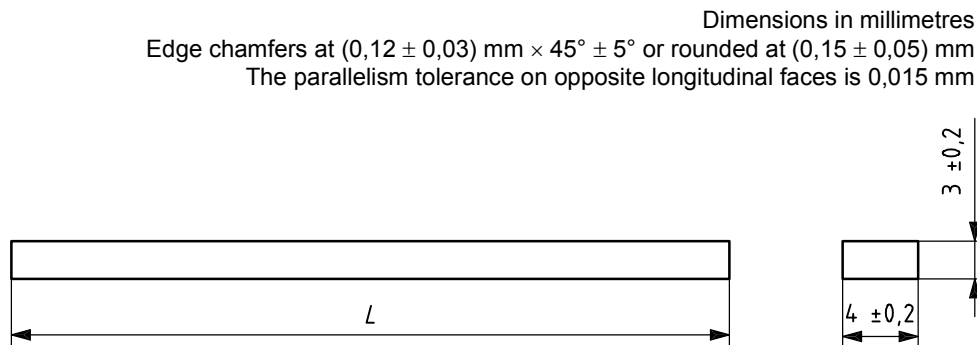
- | | | | |
|-------|-------------------------------------|-----|-------------------------------|
| X_1 | Number of cycles to failure (N) | Y | Maximum stress (MPa) |
| X_2 | Time to failure (s) | 5 | Number of superimposed points |

Figure 2 — Example of $S-N$ plot

4 Test specimens

4.1 Test specimen size

The test specimen dimensions and tolerances, which are shown in Figure 3, shall be in accordance with ISO 14704. Cross-sectional tolerances shall be 0,2 mm. The use of test specimens having twisting or warpage, which may lead to uneven contact, is not permitted.



Key

L Specimen length ($\geq 35 \text{ mm}$ for 30 mm test fixture but $\geq 45 \text{ mm}$ for 40 mm test fixture).

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4.2 Specimen preparation

Machining for surface preparation of test specimens shall be based on the procedure described in ISO 14704. The surface roughness should be $0,20 \mu\text{m Ra}$ or smaller, as defined in ISO 4287, and be reported. The width and thickness of the test specimen shall be measured according to ISO 14704.

4.3 Number of test specimens

The number of identical test specimens that should be prepared depends on the purpose of the fatigue tests. If test conditions for a pass/fail test are set, it is recommended that at least three test specimens be prepared. If the determination of an *S-N* plot is required, at least 15 test specimens should be prepared, of which three to five are used to determine the flexural strength under monotonic loading based on the testing procedure described in ISO 14704 and the remainder are used to determine the number of cycles to failure for at least three different stress levels.

5 Testing machine

5.1 Structure of testing machine

A testing machine shall be configured so that cyclic bending stress can be applied to a test specimen and forces or moments other than that related to the cyclic bending stress are not applied. The testing machine shall be equipped with an apparatus for measuring or indicating the maximum or minimum force, an apparatus capable of obtaining the number of cycles until the test specimen fractures, and a mechanism where automatic reactivation is prevented when the testing machine is stopped for reasons other than test specimen fracture (e.g. power failure, etc.).

5.2 Loading precision

The fluctuation of the maximum stress shall be within $\pm 1\%$ of the chosen value and that of the minimum to maximum stress ratio shall be within $\pm 5\%$ thereof.

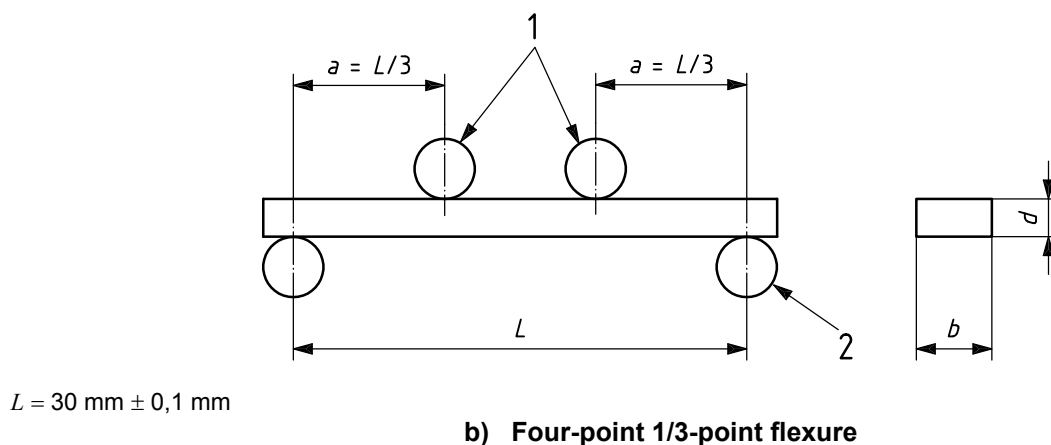
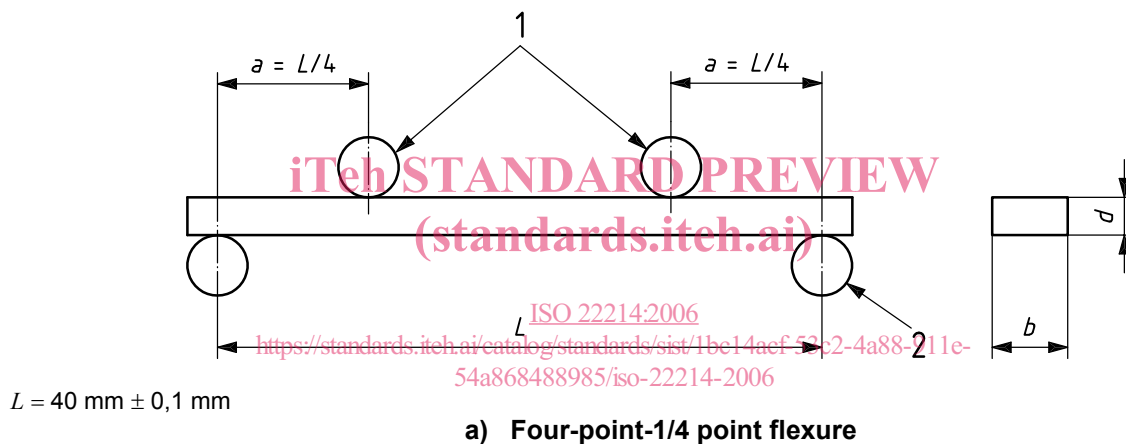
NOTE The scope of ISO 7500-1 does not include dynamic-fatigue machine calibration, but in the absence of a directly applicable standard, the procedure in ISO 7500-1 may be used within this International Standard with the risk of only a small error.

5.3 Test fixture

The four-point flexure fixture specified in ISO 14704 (see Figure 4) shall be used.

A fixture other than one which is semi-articulating or fully articulating (e.g., one not equipped with free-to-roll bearings) may be used if an articulating fixture is not available. Deviations from the specification described in ISO 14704 shall be reported.

NOTE The influence of friction at the contact between the bearing and test specimen on cyclic-fatigue behaviour is not clear at this time and this International Standard provides some latitude in the use of non-articulating fixtures.



Key

- 1 loading bearing
- 2 supporting bearing
- b width of specimen (mm)
- d thickness of specimen (mm)

All bearings shall be free to roll.

Figure 4 — Four-point flexure fixture