

ICS 81.060.20

CCS Q 32



**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 6569-2006

**Fine ceramics (advanced ceramics, advanced technical
ceramics) - Test method for flexural strength of monolithic
ceramics at room temperature**

(English Translation)

Issued on: February 22, 2006

Implemented on: September 1, 2006

**Issued by: General Administration of Quality Supervision, Inspection and
Quarantine of PRC**

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1 Scope

This standard specifies the test method for flexural strength of fine ceramics and fiber-reinforced or particle-reinforced ceramic composites at room temperature. This standard is applicable to purposes such as material development, quality control, performance characterization, and improvement of design data.

2 Normative references

The provisions in the following standards become the provisions of this part through reference in this part. For dated references, the subsequent amendments (excluding corrections) or revisions do not apply to this part; however, parties who reach an agreement based on this part are encouraged to study if the latest versions of these documents are applicable. For undated references, the latest editions of the referenced documents apply to this part. [Translator's note. "this part" should be "this standard"]

GB/T 1216-2004 External micrometer (neq ISO 3611)

ISO 7500.1.1999 Metallic materials - Verification of static uniaxial testing machines - Part 1. Tension/compression testing machines - Verification and calibration of the force-measuring system [Translator's note. here should be ISO

7500-1.1999]

3 Terms and definitions

The following terms and definitions apply to this standard.

3.1

flexural strength

The maximum stress at the fracture of a specific elastic beam under bending load.

3.2

four-point flexure

A stress structure for measuring flexural strength, wherein the specimen is positioned between two lower rollers and two upper rollers, and the relative movement of the upper and lower rollers causes the specimen to bend. [See Figure 1(a) and Figure 1(b)]

NOTE: The roller can be a round bar or a cylindrical bearing.

3.3

four-point-1/4 point flexure

One of the four-point flexure structures, which refers to a situation where the distance between the lower and upper rollers on the same side of the specimen is 1/4 of the span [see Figure 1(a)].

3.4

four-point-1/3 point flexure

One of the four-point flexure structures, which refers to a situation where the distance between the lower and upper rollers on the same side of the specimen is 1/3 of the span [see Figure 1(b)].

3.5

three-point flexure

A stress structure for measuring flexural strength, wherein the specimen is positioned between two lower rollers and one upper roller, with the upper roller located at the mid-span, and the relative movement of the upper and lower rollers causes the specimen to bend [see Figure 1(c)].

4 Principle

A bending load is applied to a beam specimen with a rectangular cross-section until the specimen fractures. The specimen material is assumed to be isotropic and linearly elastic.

The flexural strength of the specimen can be calculated using the critical load at fracture and the dimensions of the fixture and the specimen.

5.1 Testing machine

A material testing machine with uniform crossbeam displacement velocity. It shall conform to ISO 7500-1:1999 Class 1, showing a load error of less than 1% at fracture.

5.2.1 Overview

The three-point or four-point flexure test shall use the structure shown in Figure 1. A four-point-1/4 point flexure structure is recommended. If the parallelism of the specimen meets the requirements of 6.1, a semi-adjustable fixture shall be used.

Otherwise, a fully adjustable fixture shall be used. A fully adjustable fixture shall be used for machined specimens.

NOTE 1: Sintered, heat-treated, and oxidized specimens typically lack flat and parallel surfaces.

Specimen distortion can severely impact strength evaluation; therefore, fully adjustable fixtures shall be used. The purpose of using adjustable fixtures is to ensure good contact between the fixture and the specimen surface.

NOTE 2: The fully adjustable fixture with bearings allows for free rolling to eliminate friction. Each roller maintains close contact with the specimen. (See Figure B.1 and Figure B.2.)

NOTE 3: A pair of rollers in the semi-adjustable fixture can slide freely and maintain close contact with the specimen. (See Figure B.1 and Figure B.2.)

5.2.2 Rollers

The specimen is supported and loaded by rollers. The rollers can be cylindrical bearings or round bars. When metal rollers are used, for specimens with a strength of up to 1400

MPa, the Rockwell hardness of the rollers shall not be lower than HRC40; for specimens with a strength of up to 2000 MPa, the Rockwell hardness shall not be lower than HRC46. For ceramic rollers, the elastic modulus shall be between 200 GPa and

500 GPa, and the flexural strength shall be greater than 275 MPa. The roller length shall be greater than or equal to 12 mm. The roller diameter shall be approximately 1.5 times the specimen thickness. The roller surface shall be smooth, with a diameter uniformity error within ± 0.015 mm. The rollers shall be able to roll freely to eliminate friction.

NOTE 1: Friction will affect strength calculations. Roller rolling can be achieved in various ways. The method shown in Figure 2, where the roller rolls on the fixture surface, is a simple and feasible one.

and placed perpendicular to the specimen.

5.2.4 Four-point flexure structure. fully adjustable fixture

Figure B.1(b) in Appendix B illustrates the movement of the rollers in this structure.

All four rollers can roll freely. One roller does not require adjustment. The other three rollers shall be independently adjustable to ensure close contact with the specimen. The rollers shall be placed perpendicular to the specimen.

5.2.5 Three-point flexure structure. semi-adjustable fixture

Figure B.2(a) in Appendix B illustrates the movement of the rollers in this structure.

The loading roller in the middle shall be fixed and not roll, while the two supporting rollers shall be able to roll freely outwards. The parallelism error between the rollers shall not exceed 0.015 mm. All rollers shall be placed perpendicular to the specimen to ensure close contact with it.

5.2.6 Three-point flexure structure. fully adjustable fixture

Figure B.2(b) in Appendix B illustrates the movement of the rollers in this structure.

The middle roller shall be fixed and not roll. The two support (outer) rollers shall be able to roll freely outwards. Either of the two supporting rollers shall be independently adjustable to ensure close contact with the specimen. All rollers shall be placed perpendicular to the specimen.

5.2.7 Positioning of the rollers

The roller positioning shall be accurate to ± 0.1 mm. In a three-point flexure structure, the middle roller shall be positioned midway between the two support rollers. In a four-point flexure device, the two loading rollers shall be placed between the two supporting rollers.

NOTE: The position of the rollers can be determined using positioning devices. The span shall be measured with calipers or other instruments to an accuracy of 0.1 mm. Alternatively, the span can be determined by measuring the distance between the positioning devices and then adding (for the outer rollers) or subtracting (for the inner rollers) the radius of the rollers.

5.2.8 Fixture material

The fixture shall have sufficient rigidity to prevent permanent deformation.

NOTE: Line contact loads may cause deformation of the fixture. The hardness requirement of the fixture is related to its dimensions. If the roller is at least 12 mm long and the fixture width is 12 mm or wider, then the fixture shall be made of a metal with a Rockwell hardness of at least 25.