



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

GB/T 3001-2017

**Refractory products -- Determination of modulus of rupture at
ambient temperature**

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1 Scope

This standard specifies the principle, equipment, specimen, test procedures, result calculation, test report of the test method for the modulus of rupture of refractory materials at ambient temperature.

This standard applies to both shaped and unshaped refractory materials.

2 Normative references

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document;

for the undated documents, only the latest version (including all the amendments) is applicable to this standard.

GB/T 4513.5 Monolithic (unshaped) refractory products - Part 5: Preparation and treatment of test pieces (GB/T 4513.5-2017, ISO 1927-5:2012, MOD)

GB/T 4513.6 Monolithic (unshaped) refractory products - Part 6: Measurement of physical properties (GB/T 4513.6-2017, ISO 1927-6:2012, MOD)

GB/T 7321 Sample preparation for testing of shaped refractory products

GB/T 8170 Rules of rounding off for numerical values & expression and judgement of limiting values

GB/T 10325 Shaped refractory products-rule of acceptance, sampling and inspection (GB/T 10325-2012, ISO 5022:1979, NEQ)

3 Terms and definitions

The following terms and definitions apply to this document.

3.1 Modulus of rupture The maximum stress, that a refractory strip specimen of a certain size can withstand, on a three-point bending device.

4 Principles

At room temperature, stress is applied to the specimen at a constant loading rate, until the specimen breaks.

5.1.1 The loading device shall have three blades, where the lower two blades support

the specimen, AND the upper blade apply load (see Figure 1). The radius of curvature of the three cylindrical blades shall comply with the requirements in Table 1. The length of the blade shall be at least 5 mm larger than the width (b) of the specimen (see Figure 2). The contact lines between the three blades and the specimen shall be parallel to each other AND perpendicular to the side of the pressure surface of the specimen, in the length direction. The two lower blades shall be located on an intermediate support block, whose bottom surface is part of a cylindrical surface, so that each lower blade can be adjusted independently, when the specimen is slightly deflected in the vertical plane (see Figure 2). One lower blade can also be fixed, so that the other lower blade and the upper blade can be adjusted on the vertical plane. The distance between the two blades is as shown in Table 1. The upper blade is located in the middle of the two lower blades, which has a deviation within 2 mm.

5.1.2 The loading device shall be able to load uniformly, in the middle of the specimen

at a constant rate; have an instrument capable of recording or indicating the breaking load. The error of the force indication shall be within $\pm 2\%$.

5.2 Electric blast drying oven

It can be controlled at $110\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$.

5.3 Vernier calipers

The division value is not more than 0.05 mm.

7 Test steps

7.1 Dry the specimen in a drying oven (5.2), at 110 °C +/- 5 °C, to constant weight. Cool it to room temperature, in a desiccator. If used in chemically bonded or tar bonded bricks, these products are subject to some form of prior heat treatment. The specific provisions of such pre-heat treatment conditions are beyond the scope of this standard AND must be determined, through consultation between relevant parties, meanwhile indicated in the test report.

Note: For other specimens that are not suitable for drying at 110 °C +/- 5 °C, the drying conditions should be determined through consultation with relevant parties.

7.2 Measure the width and height of the middle part of each specimen, accurate to 0.1 mm. Measure the distance between the lower blades, accurate to 0.5 mm.

7.3 Place the specimen symmetrically on the lower edge of the loading device (5.1). If the specimen is a whole brick, the pressure surface shall be the formed pressure surface.

If the specimen is cut from a brick, the pressure side shall be the formed pressure surface of the original brick.

7.4 Apply a load vertically to the specimen at room temperature until it breaks, at a loading rate of:

- a) 0.15 MPa/s +/- 0.015 MPa/s for dense refractory products;
- b) 0.05 MPa/s +/- 0.005 MPa/s for insulation and refractory products.

7.5 Record the load (F_{max}) at which the specimen breaks.

8 Calculation of results

8.1 The modulus of rupture at ambient temperature is calculated by formula (1):

Where:

α_F - Modulus of rupture at ambient temperature, in megapascals (MPa);

F_{max} - The maximum pressure applied to the specimen, in Newton (N);

L_S - The distance between the lower blades, in millimeters (mm);

b - The width of the specimen, in millimeters (mm);

h - The height of the specimen, in millimeters (mm).

8.2 For shaped products, if it is a whole brick, the measured value of one brick is the result of this specimen.

8.3 For the cut specimen, when the specimen cut from the sample is 1 piece, the single value represents the result of this specimen. When the specimen cut from the sample is more than 1 piece, use the single value and the calculated average value to indicate the result of this specimen.

8.4 The result shall be rounded off according to GB/T 8170, with one decimal place retained.

9 Test report The test report shall include the following:

- a) The name of the laboratory;
- b) Test items;
- c) Test date;
- d) Implemented standards, such as "in accordance with GB/T 3001-2017";
- e) Identification of test bricks (manufacturer, variety, brick type, batch number);
- f) Test sample name, quantity, number of specimens;
- g) Whether the specimen has been pretreated (drying, heat treatment temperature, holding time, etc.);
- h) Specimen size;
- i) Loading rate (MPa/s);
- j) When more than one specimen is cut from each sample, report the individual and average values of the modulus of rupture of each specimen in each sample; when testing with a whole brick, report the modulus of rupture of each sample.