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Test method for strength of ceramic materials

陶瓷材料强度试验方法

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1 Scope

This document describes methods for determining the compressive strength and the bending strength of ceramic materials at room temperature.

This document applies to the determination of ceramic materials and of the auxiliary materials used with them.

2 Normative references

This document has no normative references.

3 Terms and definitions

The following terms and definitions apply to this document.

3.1 compressive strength: the maximum load that the material can bear per unit of area.

3.2 bending strength: the maximum stress in a test specimen under a static bending force at the moment of failure. Note: it is expressed as the ratio of the bending force borne by the specimen at failure to the modulus of rupture at the place of fracture.

4 Apparatus

4.1 Compressive strength testing machine: the load at which the specimen is fully crushed shall lie between 10 percent and 90 percent of the range of the machine. The relative error of the machine shall be not greater than 1 percent and it shall be able to load at a constant rate. One of the platens carries a spherical seat, so that a small departure from parallelism between the loaded face of the specimen and the platen can be taken up.

4.2 Bending strength testing machine: relative error not greater than 1 percent, able to load at a constant rate, with loading and supporting knife edges 10 mm plus or minus 0.1 mm in diameter.

4.3 Vernier caliper: accurate to 0.02 mm.

4.4 Drying oven: able to hold 110 degrees Celsius plus or minus 5 degrees Celsius.

4.5 Desiccator.

4.6 Balance: accurate to 0.1 g.

5 Test specimens

5.1.1 Compressive strength specimens: ten cylinders, diameter d of 20 mm plus or minus 2 mm and length L of 20 mm plus or minus 2 mm; for coarse pottery the diameter d is 50 mm plus or minus 5 mm and the length L is 50 mm plus or minus 5 mm.

5.1.2 The specimens are made by the same process as is used for that material in actual production.

5.1.3 The specimens are machined so that the departure from parallelism of the two end faces is less than 0.1 mm per mm and the departure from squareness between the generatrix and the end face is less than 1 degree.

5.1.4 The specimens shall be free from visible defects and shall have a clean surface.

5.2.1 Bending strength specimens: ten rectangular bars, length L of 120 mm plus or minus 1 mm, width b of 20 mm plus or minus 1 mm, with a width to thickness ratio of 1 to 1.

5.2.2 The specimens are made under the same process conditions as are used for that material in actual production.

5.2.3 The specimens shall be machined true and shall be free from visible defects.

6 Test procedure

6.1.1 Place the specimens in a drying oven at 110 degrees Celsius plus or minus 5 degrees Celsius, dry them to constant mass, then place them in a desiccator and cool them to room temperature.

6.1.2 Measure and record the diameter and the length of each specimen to the nearest 0.1 mm.

6.1.3 Place the specimen at the centre of the platens of the compression testing machine, with a 1 mm thick strawboard pad on each of the two loaded faces.

6.1.4 Choose a suitable range and load uniformly at a rate of 2 times 10 to the power 2 newtons per second, or 1.5 times 10 to the power 2 newtons per second for coarse pottery,

until the specimen is crushed; record the maximum load at which it is crushed.

6.2.1 Place the specimens in a drying oven at 110 degrees Celsius plus or minus 5 degrees Celsius, dry them to constant mass, then place them in a desiccator and cool them to room temperature.

6.2.2 Set the specimen on the supporting knife edges and adjust the distance between them so that 10 mm of the specimen projects beyond each supporting knife edge; the two supporting knife edges shall lie in the same plane and be parallel to each other, and the loading knife edge shall be placed midway between them.

6.2.3 Start the bending testing machine. Take care that the loading knife edge does not strike the specimen when it makes contact; load at a constant rate averaging 10 N/s to 50 N/s, choosing the lower rate for specimens of lower bending strength, until fracture. Record the maximum load at the moment of fracture.

6.2.4 Measure the width and the thickness of the specimen at the place of fracture with the vernier caliper, to the nearest 0.1 mm.

7 Calculation of results and treatment of data

7.1.1 The compressive strength is calculated by Formula (1). In the formula, the compressive strength of a single specimen is expressed in megapascals (MPa); P is the maximum load at which the specimen is crushed, in newtons (N); and d is the diameter of the specimen, in millimetres (mm).

7.1.2 Where the maximum relative deviation is greater than 10 percent, the specimen with the largest relative deviation is discarded and the remaining values are recalculated, until the requirement is met; the maximum relative deviation is calculated by Formula (2). In the formula, R is the maximum relative deviation in percent; the maximum, or minimum, compressive strength value is expressed in megapascals (MPa); and the mean compressive strength is expressed in megapascals (MPa).

7.1.3 Where the number of specimens discarded exceeds 40 percent of the total number of specimens, new specimens shall be made and tested.

7.1.4 The arithmetic mean of the valid specimens is taken as the compressive strength of the sample, the figure being given to the nearest 0.1 MPa.

7.2.1 The bending strength is calculated by Formula (3). In the formula, the bending strength of a single specimen is expressed in megapascals (MPa); F is the load at the moment of fracture of the specimen, in newtons (N); L is the distance between the supporting knife edges, in millimetres (mm); b is the width of the specimen at the fracture, in millimetres (mm); and h is the thickness of the specimen at the fracture, in millimetres (mm).

7.2.2 Where the maximum relative deviation is greater than 10 percent, the specimen with the largest relative deviation is discarded and the remaining values are recalculated, until the requirement is met; the maximum relative deviation is calculated by Formula (4). In the formula, R is the maximum relative deviation in percent; the maximum, or minimum, bending strength value is expressed in megapascals (MPa); and the mean bending strength is expressed in megapascals (MPa).

7.2.3 Where the number of specimens discarded exceeds 40 percent of the total number of specimens, new specimens shall be made and tested.

7.2.4 The arithmetic mean of the valid specimens is taken as the bending strength of the sample, the figure being given to the nearest 0.1 MPa.

8 Test report

The test report shall contain the following:

a) the basis of the test;

b) a description of the sample, including its name, quantity, type and dimensions;

c) for compressive strength, the compressive strength values, the number of valid tests and the final test result;

d) for bending strength, the distance between the knife edges, the loading rate, the thickness and the width at the fracture, the bending strength values, the number of valid tests and the final test result;

e) the person carrying out the test and the date of the test;

f) any other matter that needs to be stated.