INTERNATIONAL STANDARD

ISO 10545-4

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Ceramic tiles —

Part 4:
Determination of modulus of rupture and breaking strength

Carreaux et dalles céramiques —

Partie 4: Détermination de la résistance à la flexion et de la force de rupture

Reference number
ISO 10545-4:1994(E)

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.

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.

International Standard ISO 10545-4 was prepared by Technical Committee ISO/TC 189, *Ceramic tile*.

ISO 10545 consists of the following parts, under the general title *Ceramic tiles*:

— *Part 1: Sampling and basis for acceptance*

— *Part 2: Determination of dimensions and surface quality*

— *Part 3: Determination of water absorption, apparent porosity, apparent relative density and bulk density*

— *Part 4: Determination of modulus of rupture and breaking strength*

— *Part 5: Determination of impact resistance by measurement of coefficient of restitution*

— *Part 6: Determination of resistance to deep abrasion for unglazed tiles*

— *Part 7: Determination of resistance to surface abrasion for glazed tiles*

— *Part 8: Determination of linear thermal expansion*

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— *Part 9: Determination of resistance to thermal shock*

— *Part 10: Determination of moisture expansion*

— *Part 11: Determination of crazing resistance for glazed tiles*

— *Part 12: Determination of frost resistance*

— *Part 13: Determination of chemical resistance*

— *Part 14: Determination of resistance to stains*

— *Part 15: Extraction of lead and cadmium from glazed tiles*

— *Part 16: Determination of colour differences*

— *Part 17: Determination of coefficient of friction*

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Ceramic tiles —

Part 4:
Determination of modulus of rupture and breaking strength

1 Scope

This part of ISO 10545 defines a test method for determining the modulus of rupture and breaking strength of all ceramic tiles.

NOTE 1 ISO 13006:—, *Ceramic tiles — Definitions, classification, characteristics and marking* (to be published), provides property requirements for tiles and other useful information on these products.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this part of ISO 10545. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this part of ISO 10545 are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 48:1994, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD).*

3 Definitions

For the purposes of this part of ISO 10545, the following definitions apply.

3.1 breaking load: Force, expressed in newtons, necessary to cause the test specimen to break, as read from the pressure gauge.

3.2 breaking strength: Force, expressed in newtons, obtained by multiplying the breaking load by the ratio (span between support rods)/(width of the test specimen).

3.3 modulus of rupture: Quantity, expressed in newtons per square millimetre, obtained by dividing the calculated breaking strength by the square of the minimum thickness along the broken edge.

4 Principle

Determination of the breaking load, breaking strength and modulus of rupture of a tile by applying a force at a definite rate to the centre of the tile, the point of application being in contact with the proper surface of the tile.

5 Apparatus

5.1 Drying oven, capable of being operated at (110 ± 5) °C.

Microwave, infrared or other drying systems may be used provided that it has been determined that equal results are obtained.

5.2 Recording pressure gauge, accurate to 2,0 %.

5.3 Two cylindrical support rods, made of metal, the parts in contact with the test specimens being covered with rubber having a hardness of (50 ± 5) IRHD, measured in accordance with ISO 48. One rod shall be slightly pivotable (see figure 1) and the other shall be slightly rotatable about its own axis. (See table 1 for relevant dimensions.)

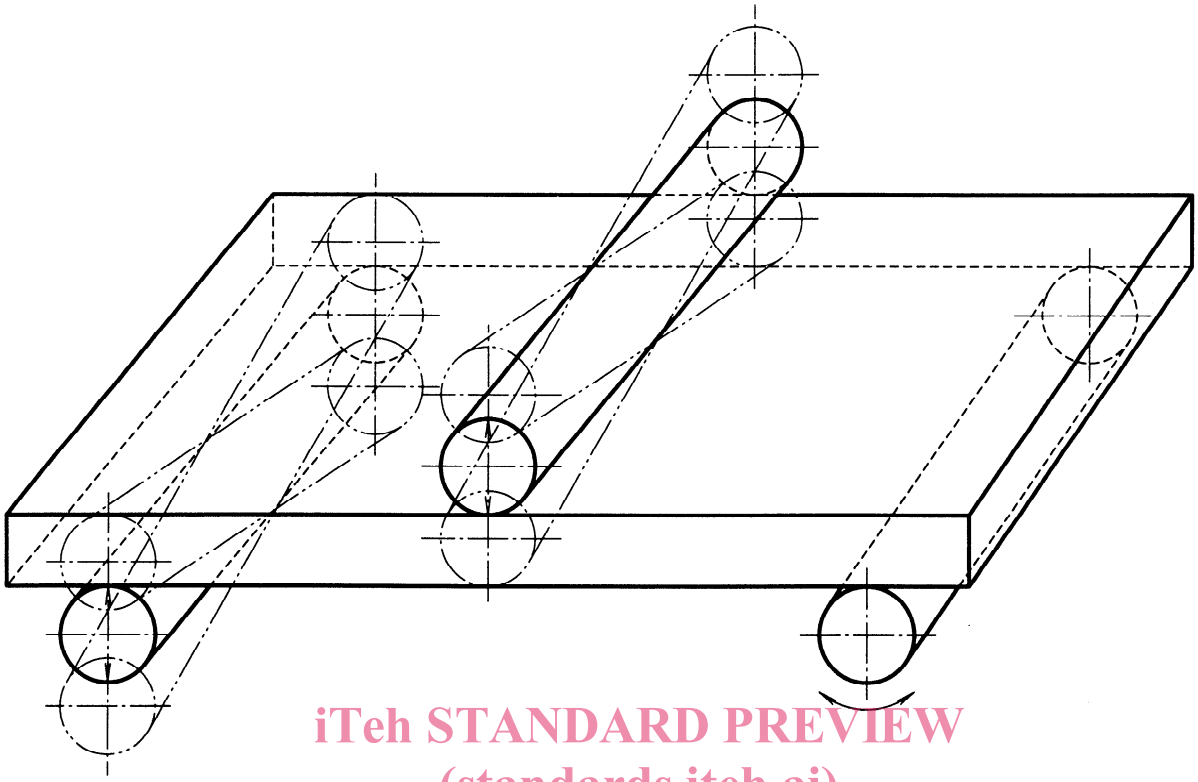

Figure 1

Table 1 — Diameter of rods, thickness of rubber and length *l* (see figure 2)

Dimensions in millimetres

Dimension of tile	Diameter of rod *d*	Thickness of rubber *t*	Overlap of tile beyond the edge supports *l*
⩾ 95	20	5 ± 1	10
< 95 but ⩾ 48	10	2,5 ± 0,5	5
< 48 but ⩾ 18	5	1 ± 0,2	2

5.4 Central cylindrical rod, of the same diameter as the support rods (5.3) and covered with a similar rubber, for transmission of the load F. This rod shall also be slightly pivotable (see figure 1). (See table 1 for relevant dimensions.)

6 Test specimens

6.1 Select the specimens at random from the lot to be tested. Whenever possible, whole tiles shall be tested. However, it may be necessary to cut exceptionally large tiles (that is, those greater than 300 mm in length) and some non-rectangular shapes in order to fit them in the apparatus. Rectangular test specimens of the largest possible size shall then be cut, having their centres coinciding with the centres of the tiles. In case of doubt, results obtained using whole tiles shall always be preferred to results obtained with cut tiles.

6.2 The minimum number of test specimens for each sample is given in table 2.

7 Procedure

7.1 Remove any loosely adhering particles from the back of each test specimen with a stiff brush. Dry each test specimen in the oven (5.1) maintained at (110 ± 5) °C until constant mass is reached; i.e. when the difference between two successive weighings at intervals of 24 h is less than 0,1 %. The test specimens may be cooled in the closed oven or in a desiccator over silica gel or another suitable desiccant, but not an acid, until they reach room temperature.

Test specimens shall be tested not later than 3 h after they have reached room temperature.

7.2 Place a test specimen on the support rods (5.3), with the glazed or proper surface uppermost so that the test specimen projects by a length l (see table 1 and figure 2) beyond each support rod.

7.3 In the case of reversible tiles, such as unglazed ceramic mosaic tiles, it does not matter which side of the tile is uppermost. For extruded tiles, place the test specimen so that the projecting ribs are at right angles to the support rods. For all other rectanglar tiles, place the test specimens so that the longer side is at right angles to the support rods.

7.4 For tiles with a relief surface, place a second layer of rubber, of the appropriate thickness given in table 1, on the central rod (5.4) in contact with the relief surface.

7.5 Position the central rod equidistant between the support rods. Apply the load evenly in such a way as to obtain a rate of increase of stress of (1 ± 0,2) N/mm^2 per second; the actual rate per second can be calculated by equation (2) given in clause 8. Note the breaking load F.

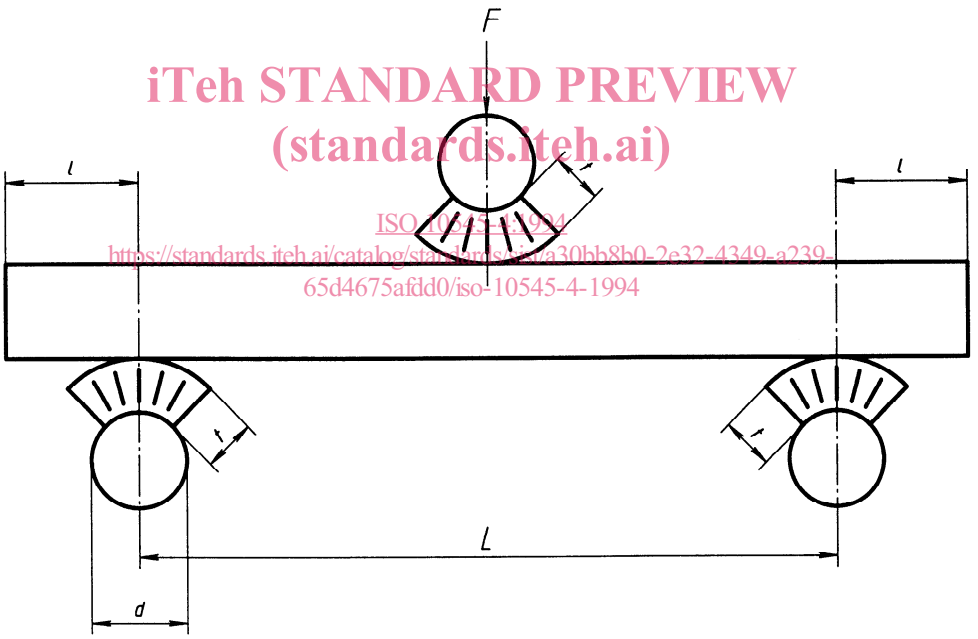

Figure 2

Table 2 — Minimum number of test specimens

Dimension of tile mm	Minimum number of test specimens
⩾ 48	7
< 48 but ⩾ 18	10

8 Expression of results

Use only the results for test specimens that break within a central portion of length equivalent to the diameter of the central rod to calculate the average breaking strength and the average modulus of rupture. A minimum of five acceptable results is necessary to calculate the average value.

If there are fewer than five acceptable results, a second sample shall be tested consisting of twice the number of tiles. A minimum of 10 acceptable results is then required to calculate the average value.

The breaking strength S, expressed in newtons, is calculated by means of the equation

$$S = \frac{FL}{b} \quad \ldots (1)$$

where

F is the breaking load, in newtons;

L is the span, in millimetres, between the support rods (see figure 2);

b is the width of the test specimen, in millimetres.

The modulus of rupture R, expressed in newtons per square millimetre, is calculated by means of the equation

$$R = \frac{3FL}{2bh^2} = \frac{3S}{2h^2} \quad \ldots (2)$$

where

F is the breaking load, in newtons;

L is the span, in millimetres, between the support rods (see figure 2);

b is the width of the test specimen, in millimetres;

h is the minimum thickness of the test specimen, in millimetres, measured after the test along the broken edge.[1)]

Note all individual results.

Calculate the average breaking strength and the average modulus of rupture of the sample as the average of the acceptable results.

9 Test report

The test report shall include the following information:

a) reference to this part of ISO 10545;

b) description of the tiles, including relief surface, if any;

c) number of test specimens in the sample;

d) the values of d, t, l and L (see figure 2);

e) the breaking load F of each test specimen;

f) the average breaking load;

g) the breaking strength S of each test specimen;

h) the average value of the breaking strength;

i) the modulus of rupture R of each test specimen;

j) the average value of the modulus of rupture.

1) The calculation of the modulus of rupture is based on a rectangular cross-section. In the case of tiles with variable thickness along the broken edge, approximate results only are produced. The shallower the relief, the more exact are the approximations.

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