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Ceramic tiles

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

National foreword

This British Standard is the UK implementation of EN ISO 10545-3:2018. It is identical to ISO 10545-3:2018. It supersedes BS EN ISO 10545-3:1997, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/539, Ceramic tiles and other flat roofing.

A list of organizations represented on this committee can be obtained on request to its secretary.

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English Version

Ceramic tiles - Part 3: Determination of water absorption,
apparent porosity, apparent relative density and bulk
density (ISO 10545-3:2018)

Carreaux et dalles céramiques - Partie 3:
Détermination de l'absorption d'eau, de la porosité
ouverte, de la densité relative apparente et de la
masse volumique globale (ISO 10545-3:2018)

Keramische Fliesen und Platten - Teil 3: Bestimmung
von Wasseraufnahme, offener Porosität, scheinbarer
relativer Dichte und Rohdichte (ISO 10545-3:2018)

This European Standard was approved by CEN on 22 January 2018.

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European foreword

This document (EN ISO 10545-3:2018) has been prepared by Technical Committee ISO/TC 189 "Ceramic tile" in collaboration with Technical Committee CEN/TC 67 "Ceramic tiles" the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2018, and conflicting national standards shall be withdrawn at the latest by September 2018.

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Endorsement notice

The text of ISO 10545-3:2018 has been approved by CEN as EN ISO 10545-3:2018 without any modification.

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Foreword

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 189, *Ceramic tiles*.

This second edition cancels and replaces the first edition (ISO 10545-3:1995 which has been technically revised. It also incorporates ISO 10545-3:1995/Cor.1:1997.

The main changes compared to the previous edition are as follows:

- The impregnation of the samples is now only done by vacuum.
- The boiling method for impregnation of the samples has been removed.
- Sampling guidelines according to the dimension of tiles are provided.

A list of all parts in the ISO 10545 series can be found on the ISO website.

Introduction

For ceramic tiles, water absorption is used to classify products. This document outlines the procedures for the measurement of water absorption and related properties using classical Archimedeian techniques. Impregnation of the open porosity is achieved by a vacuum method only. Accommodations are provided for large or irregularly shaped ceramic tile.

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Ceramic tiles —

Part 3:

Determination of water absorption, apparent porosity, apparent relative density and bulk density

1 Scope

This document specifies a method for determining water absorption, apparent porosity, apparent relative density and bulk density of ceramic tiles. This method is applicable to classification of tiles and product specifications.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

4 Principle

Impregnation of dry tiles with water and then suspension in water. Calculation of the listed properties using the relationships between dry, saturated and suspended masses.

5 Apparatus

5.1 Drying oven, capable of being operated at least at (110 ± 5) °C. Microwave, infrared, or other drying systems may be used provided that it has been determined that the same results are obtained.

5.2 Balance, accurate to 0,01 % of the mass of a test specimen.

5.3 Deionized or distilled water

5.4 Dessicator

5.5 Microfibre cloth

5.6 Wire loop, halter or basket, capable of supporting specimens under water for making suspended mass measurements.

5.7 Glass beaker, or similar container of size and shape such that the sample, when suspended from the balance (5.2) by the wire loop (5.6), is completely immersed in water, with the test specimen and the wire loop being completely free of contact with any part of the container.

5.8 Vacuum chamber and vacuum system, of sufficient capacity to accommodate the test specimens and evacuate to a pressure of 10 ± 5 kPa (91 ± 5 kPa below standard atmospheric pressure of 101 kPa) for 30 min.

6 Test specimens

6.1 Sampling

Sampling shall be carried out according to the dimension of tiles as reported in Table 1. In Table 2 some examples of different common sizes are reported. The number of the specimens to be tested for each tile as well the number of tiles are a function of the tile dimension. Tiles and relevant specimens shall not contain visible damage or cracks prior to testing and shall not have been previously tested. Any loose or contaminating material shall be removed. This includes any mesh, paper and adhesive that has been applied to mosaics.

When the mass of each individual tile is below 50 g, a sufficient number of tiles shall be taken so that each test specimen reaches a mass of 50 g to 100 g. For those specimens, 6.2 is not applicable.

Table 1 — Sampling

Maximum area A cm ²	Reference paragraph for sample cutting	n° of specimens per tile to be tested	Total n° of tiles	Total n° of specimens
$A \leq 400$	6.2.2	1	5	5
$400 < A \leq 3\,600$ (with x and $y > 20$ cm)	6.2.3	1	5	5
$400 < A \leq 3\,600$ (with minor edge $y \leq 20$ cm, and major edge $x < 100$ cm)	6.2.4	1	5	5
$400 < A \leq 3\,600$ (with minor edge $y \leq 20$ cm, and major edge $x \geq 100$ cm)	6.2.4	2	5	10
$A > 3\,600$ (with minor edge $y \leq 20$ cm, and major edge $x \geq 100$ cm)	6.2.5	2	3	6
$A > 3\,600$ (with minor edge $y > 20$ cm)	6.2.5	4	3	12

NOTE For non-rectangular tile, consider the area of the minimum rectangle in which the tile can be fit.

Table 2 — Examples of sampling for different common sizes

Maximum area A cm ²	Example of nominal size cm	n° of specimens per tile to be tested	Total n° of tiles	Total n° of specimens
400	20 × 20	1	5	5
600	10 × 60	1	5	5
900	30 × 30	1	5	5
1 350	15 × 90	1	5	5
2 160	18 × 120	2	5	10
2 250	15 × 150	2	5	10
2 500	50 × 50	1	5	5
3 600	60 × 60	1	5	5
4 500	18 × 250	2	3	6
8 100	90 × 90	4	3	12
7 200	60 × 120	4	3	12
16 200	90 × 180	4	3	12
14 400	120 × 120	4	3	12
28 800	120 × 240	4	3	12
30 000	100 × 300	4	3	12
>30 000	120 × 300	4	3	12

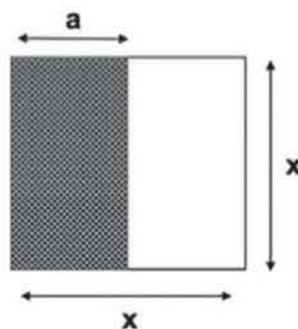
6.2 Sample cutting

6.2.1 General

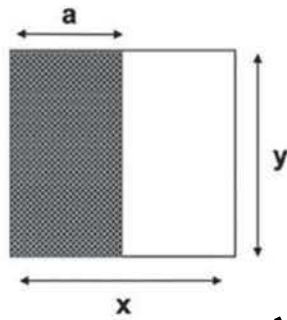
Each tile shall be cut into smaller pieces as described in 6.2.2 through 6.2.5 where some common examples are reported. Cutting of specimens shall consist of scoring and snapping, or sawing when impossible to score and snap with conventional tile-scoring equipment (as can be the case with highly textured and structured porcelain tiles). Cutting may be performed at the factory following the sampling criteria described where the sample being cut is at least 10 cm bigger on each cut side. At the testing facility, cutting shall be done no more than four hours before the specimens are placed in the dryer. Specimens shall be kept clean with no contaminating material after cutting.

6.2.2 Tiles less than or equal to 400 cm²

Specimens shall be cut in half, within 1 cm. Specimens shall be cut perpendicular to the longest side if the specimen has unequal sides. Select one half at random from each specimen for testing (see Figure 1).



a) Equal sides: $x \leq 20$ cm, $a = 1/2 \times x$ (within 1 cm)

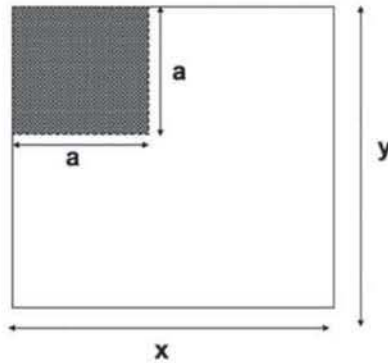


b) Unequal sides: $x > y$, $a = 1/2 y$ (within 1 cm)

Figure 1 — Scheme of cuts for tiles less than or equal to 400 cm²

6.2.3 Tiles greater than 400 cm² and less than or equal to 3 600 cm², where x and $y > 20$ cm

A 20 × 20 cm portion, within 1 cm, shall be cut from one corner of each specimen for testing (see Figure 2).



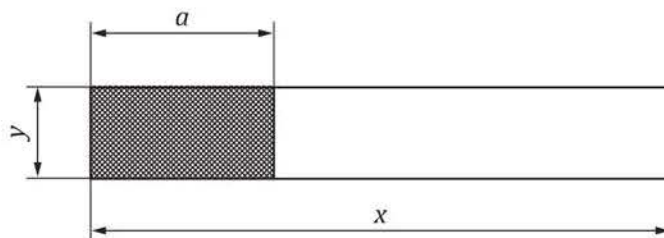
$x > 20$ cm, $y > 20$ cm, $a = 20$ cm (within 1 cm)

Figure 2 — Scheme of cuts for tiles greater than 400 cm² and less than or equal to 3 600 cm² where x and $y > 20$

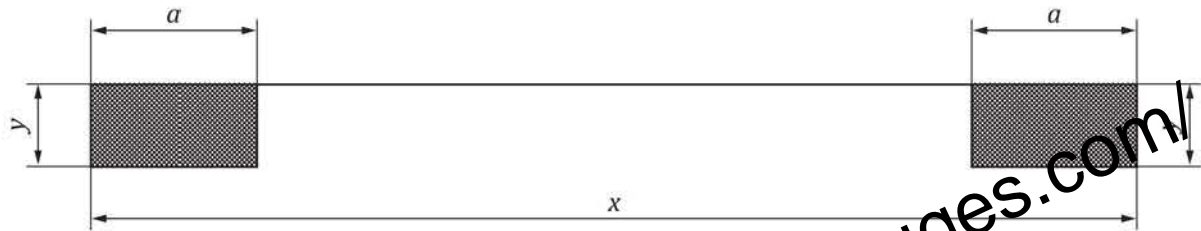
6.2.4 Tiles greater than 400 cm² and less than or equal to 3 600 cm², where only $y \leq 20$ cm

Proceed as follows (Figure 3 b) also applies to tiles over 3 600 cm²):

- $x < 100$ cm, a portion where one dimension is equal to y and the other dimension is equal to 20 cm, within 1 cm, shall be cut of each specimen for testing (see Figure 3 a)).
- $x \geq 100$ cm, two portions where one dimension is equal to y and the other dimension is equal to 20 cm, within 1 cm, shall be cut of each specimen for testing (see Figure 3 b)).



a) $x < 100$ cm, $y \leq 20$ cm, $a = 20$ cm (within 1 cm)



b) $x \geq 100$ cm, $y \leq 20$ cm, $a = 20$ cm (within 1 cm)

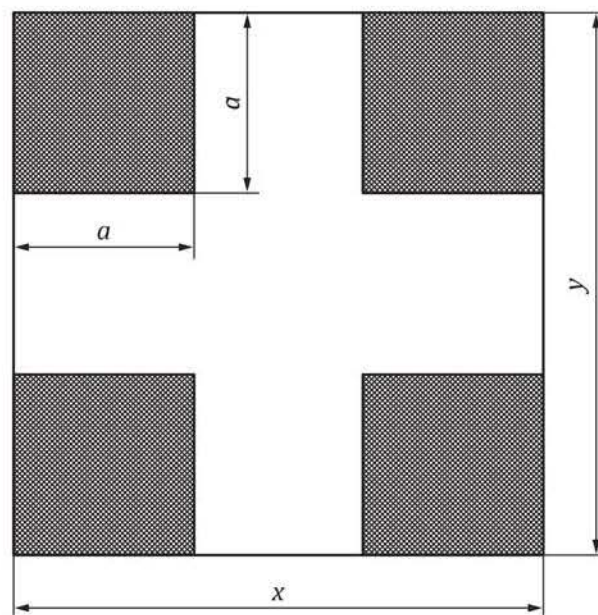
NOTE [Figure 3 b\)](#) also applies for tiles $>3\,600$ cm².

Figure 3 — Scheme of cuts for tiles greater than 400 cm² and less than or equal to $3\,600$ cm² where $y \leq 20$ cm

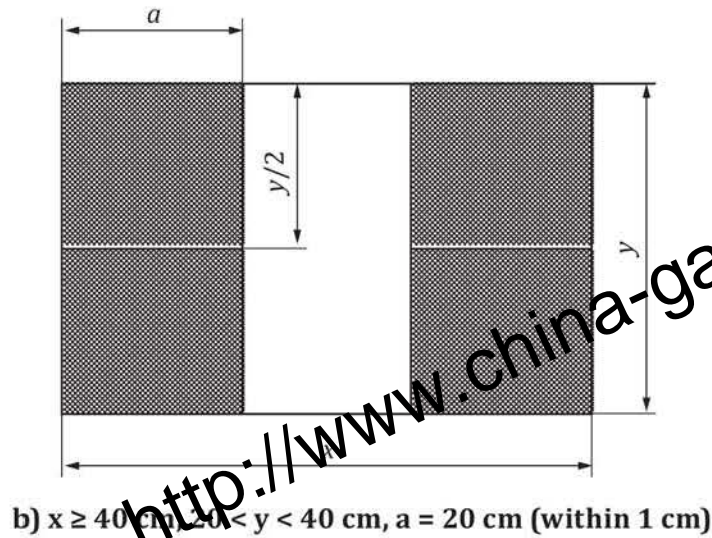
6.2.5 Tiles greater than $3\,600$ cm²

Proceed as follows:

- if $y \geq 40$ cm, a 20×20 cm portion, within 1 cm, shall be cut from four corners of each specimen for testing (see [Figure 4 a\)](#)).
- if $20 < y < 40$ cm, a portion $20 \text{ cm} \times y/2$ cm, within 1 cm, shall be cut from four corners of each specimen for testing (see [Figure 4 b\)](#)).
- if $y \leq 20$ cm, two portions where one dimension is equal to y and the other dimension is equal to 20 cm, within 1 cm, shall be cut of each specimen for testing (see [Figure 3 b\)](#)).



a) $x \geq 40$ cm, $y \geq 40$ cm, $a = 20$ cm (within 1 cm)



NOTE See also [Figure 3 b](#)).

Figure 4 — Scheme of cuts for tiles greater than 3 600 cm²

7 Procedure

7.1 Sample preparation

Dry the test specimens to constant mass (see NOTE) in the oven (5.1) adjusted to a minimum of 110 °C, not to exceed 160 °C for a minimum of 24 h (or such other time as has been established for the oven in use and the mass of tiles being dried). The drying of the specimens and the determination of their masses may be done either before or after the specimens have been impregnated with water. Usually the dry mass is determined before impregnation. However, if the specimens are friable or evidence indicates that particles have broken loose during the impregnation, the specimens shall be dried and weighed after the suspended mass and the saturated mass have been determined. In this case, the second dry mass shall be used in all appropriate calculations.

NOTE Constant mass is reached when after two subsequent weightings, the final weight does not change more than 0.1 %. Specimens being tested directly following their manufacture can be considered fully dried so long as they have not been subjected to any process that wets the specimen post firing (such as can occur in cutting and polishing operations), and they are placed in a desiccator sufficiently quickly (usually within no more than 30 min of exiting the kiln) that no moisture has been absorbed from ambient air, as can be confirmed by weighing to constant mass after impregnation.

Cool the tiles in the desiccator (5.4) over silica gel or another suitable desiccant but not an acid.

Weigh each tile and determine with an accuracy of 0,01 % of the mass, the mass, m_1 , of each specimen.

7.2 Impregnation with water

Place the tiles vertically with one of the cut side facing the bottom, with no contact between the specimens and the chamber (5.8). Evacuate to a pressure of 10 ± 5 kPa (91 ± 5 kPa below standard atmospheric pressure of 101 kPa) and maintain it for 30 ± 2 min. Then, while maintaining the vacuum, slowly admit sufficient water, taking no longer than 10 min to cover the tiles by at least 5 cm. Release the vacuum and allow the tiles to remain submerged for 15 ± 2 min. Determine the suspended mass according to 7.3. After the determination of the suspended mass, or directly after the 15 ± 2 min soak, if the suspended mass is not determined, blot each specimen lightly with a damp microfibre cloth to remove all visible water droplets from the surface, and determine the saturated mass m_2 , of each specimen, with an accuracy of 0,01 % of the mass. A dry microfibre cloth shall be saturated with water

equal to two times its dry weight (for example, a 50 g cloth is saturated with 100 g of water). This may be achieved by placing the cloth in a bowl, adding the required amount of water, and squeezing the cloth to ensure all of the water is absorbed and that the cloth is evenly saturated without any dry areas. The facial area of the microfibre cloth shall be at least 65 % of the total facial area of specimens tested (for example, five 20 × 20 cm specimens require a microfibre cloth surface area of 1 300 cm² or greater). Multiple microfibre cloths may be used to meet the required minimum cloth facial area. The blotting process shall involve patting the specimen lightly on all edges and surfaces with the damp microfibre cloth. Take care not to blot excessively as this could introduce error by withdrawing water from the pores of the specimen. Weight determination shall be performed immediately after the blotting process to avoid errors due to evaporation of water from the test specimen.

Repeat as necessary until all required specimens have been tested.

7.3 Suspended weight

After impregnation under vacuum of the test specimens, determine, with an accuracy of 0,01 % of the mass, the mass, m_3 , of each specimen while suspended in water. Carry out weighing by placing the specimen in a wire loop, halter, or basket (5.6) that is suspended from one arm of the balance (5.2). Before actually weighing, counterbalance the scale with the wire loop, halter, or basket in place and immerse in water to the same depth as is used when the specimens are in place.

8 Expression of results

8.1 Water absorption

In the following calculations, the assumption is made that 1 cm³ of water weighs 1 g, where

m_1 is the mass of the dry tile;

m_2 is the mass of the tile impregnated by immersion under vacuum;

m_3 is the mass of the suspended tile impregnated by immersion under vacuum.

For each tile, the water absorption, E_v , expressed as a percentage of the dry mass, is calculated using [Formula 1](#):

$$E_v = 100 \times \frac{(m_2 - m_1)}{m_1} \quad (1)$$

8.2 Apparent porosity

8.2.1 The external volume, V , expressed in cubic centimetres is calculated using [Formula 2](#):

$$V = m_2 - m_3 \quad (2)$$

8.2.2 The volume of open pores, V_0 , and the volume of the impervious portion, V_1 , expressed in cubic centimetres, are given by [Formulae 3](#) and [4](#):

$$V_0 = m_2 - m_1 \quad (3)$$

$$V_1 = m_1 - m_3 \quad (4)$$

8.2.3 The apparent porosity, P , expressed as a percentage, is the relationship of the volume of the open pores of the test specimen to its exterior volume. The apparent porosity is calculated using [Formula 5](#):

$$P = 100 \times \frac{(m_2 - m_1)}{V} \quad (5)$$

8.3 Apparent relative density

Apparent relative density, T , of the impervious portion of the test specimen, is calculated using [Formula 6](#):

$$T = m_1 / (m_1 - m_3) \quad (6)$$

8.4 Bulk density

Bulk density, B , expressed in gram per cubic centimetre, of a specimen is the quotient of its dry mass divided by the exterior volume, including pores. The bulk density is calculated using [Formula 7](#):

$$B = \frac{m_1}{V} \quad (7)$$

9 Test report

The test report shall include the following information:

- a) reference to this document (ISO 10545-3);
- b) a description of the tiles, including dimensions before and after test specimen preparation;
- c) for each property determined, report the results for each individual tested specimen;
- d) for each property determined, report the average value.

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