

INTERNATIONAL  
STANDARD

ISO  
10545-4

عنوان

Third edition  
2014-07-15

---

**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 10545-4:2014(E)

© ISO 2014



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2014

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
Case postale 56 • CH-1211 Geneva 20  
Tel. +41 22 719 01 11  
Fax +41 22 719 09 47  
E-mail [copyright@iso.org](mailto:copyright@iso.org)  
Web [www.iso.org](http://www.iso.org)

Published in Switzerland

## Contents

	Page
Foreword	iv
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Principle	2
5 Apparatus	2
6 Test specimens	2
7 Procedure	3
8 Calculation	3
9 Test report	4

## 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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 189, *Ceramic Tiles*, Subcommittee SC 1.

This third edition cancels and replaces the second edition (ISO 10545-4:2004), which has been technically revised.

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*
- 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: Determination of lead and cadmium given off by glazed tiles

Part 16: Determination of small colour differences



# Ceramic tiles —

## Part 4:

# Determination of modulus of rupture and breaking strength

### 1 Scope

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

NOTE — ISO 13006 provides property requirements for tiles and other useful information on these products.

### 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 43:2010, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

ISO 13006, *Ceramic tiles — Definitions, classification, characteristics and marking*

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

#### 3.1

##### breaking load

force necessary to cause the test specimen to break, as read from the pressure gauge

Note 1 to entry: See 7.5 and Figure 1.

Note 2 to entry: The breaking load is expressed in newtons.

#### 3.2

##### breaking strength

force obtained by multiplying the breaking load by the ratio (span between support rods)/(width of the test specimen)

Note 1 to entry: See Formula (1) in Clause 8.

Note 2 to entry: The breaking strength is expressed in newtons.

#### 3.3

##### modulus of rupture

quantity obtained by dividing the calculated breaking strength by the square of the minimum thickness along the broken edge

Note 1 to entry: See Formula (2) in Clause 8.

6mm. The modulus of rupture is expressed in newtons per square millimetre.

#### 4 Principle

Determination of the breaking load, breaking strength, and modulus of rupture of a tile by applying a force at a specified 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  $(110 \pm 5)^\circ\text{C}$ .

Microwave, infrared or other drying systems can 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  $(50 \pm 5)$  IRHD, measured in accordance with ISO 48.

One rod shall be slightly pivotable (see Figure 2) and the other shall be slightly rotatable about its own axis. See Table 1 for relevant dimensions.

5.4 **Central cylindrical rod**, of the same diameter as the support rods (5.3) and covered with the same rubber, for transmission of the load.

This rod shall also be slightly pivotable (see Figure 2). See Table 1 for relevant dimensions.

Table 1 — Diameter of rods,  $d$ , thickness of rubber,  $t$ , and overlap of tile beyond the edge supports,  $l_1$

Dimensions of tile, $l$	Diameter of rod, $d$	Thickness of rubber, $t$	Overlap of tile beyond the edge supports, $l_1$
mm	mm	mm	mm
100–300	$5 \pm 1$	$1 \pm 0,2$	2
100–1 000	$10 \pm 1$	$2,5 \pm 0,5$	5
1 000–	$20 \pm 1$	$5 \pm 1$	10

#### 6 Test specimens

6.1 Select the specimens at random from the lot to be tested. Whenever possible, whole tiles shall be used. However, it might be necessary to cut exceptionally large tiles (that is, those greater than 600 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 using cut tiles. If cut tiles are used, it shall be noted in the test report.

6.1.1 Tiles up to 600 mm are tested as is. If the tile is greater than 600 mm, the tile is cut and the dimensional ratio of the original tile is maintained in the cut piece.

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



Table 2 — Minimum number of test specimens

Dimension of tile <i>L</i> mm	Minimum number of test specimens
$18 < L \leq 48$	10
$48 < L < 1000$	7
$L > 1000$	5

## 7 Procedure

7.1 Remove any loosely adhering particles from the back of all test specimens with a stiff brush. Dry each test specimens in the drying oven (5.1) maintained over 105 °C during at least 24 h, and let them cool 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  $l_1$  (see Table 1 and Figure 1) 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 rectangular tiles, place the test specimens so that the longer side,  $l$ , 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 in stress of  $(1 \pm 0,2)$  N/mm<sup>2</sup> per second; the actual rate per second can be calculated by Formula (2) given in Clause 8. Record the breaking load  $F$ .

## 8 Calculation

Use only the results for test specimens that break within a central portion of length equivalent to one third of the distance between the supporting rods to calculate the mean breaking strength and the mean modulus of rupture. A minimum of five acceptable results is necessary to calculate the mean 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 Formula (1):

$$S = \frac{Fl_1}{b} \quad (1)$$

where

$F$  is the breaking load, expressed in newtons;

$l_1$  is the span between the support rods (see Figure 1), in mm;

$b$  is the width of the test specimen, in mm.



The modulus of rupture,  $R$ , expressed in newtons per square millimetre, is calculated by means of Formula (2).

$$R = \frac{3Fl_2}{2bh^2} = \frac{3S}{2h^2} \quad (2)$$

where

- $F$  is the breaking load, expressed in newtons;
- $l_2$  is the span between the support rods (see Figure 1), in mm;
- $b$  is the width of the test specimen, in mm;
- $h$  is the minimum thickness of the test specimen measured after the test along the broken edge, in mm.

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.

Record all individual results.

Calculate the mean breaking strength and the mean modulus of rupture of the sample as the mean 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  $d$ ,  $t$ ,  $l_1$ , and  $l_2$  (see Figure 1);
- e) the breaking load,  $F$ , of each test specimen;
- f) the mean breaking load;
- g) the breaking strength,  $S$ , of each test specimen;
- h) the mean value of the breaking strength;
- i) the modulus of rupture,  $R$ , of each test specimen;
- j) the mean value of the modulus of rupture;
- k) the note "test performed on cut tiles" when applicable.

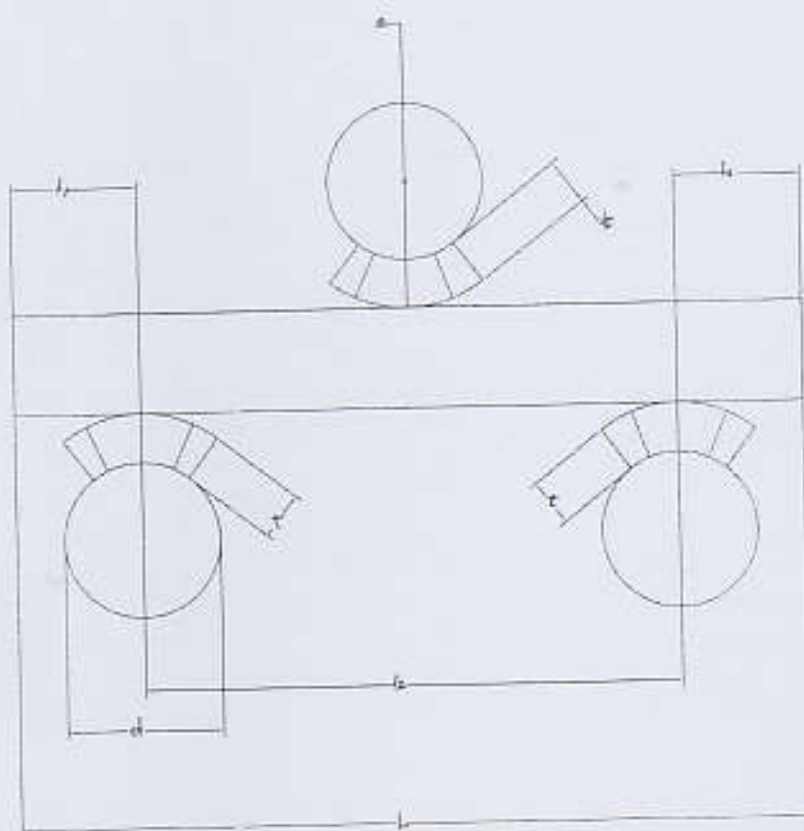


Figure 1 — Application of load to test specimen

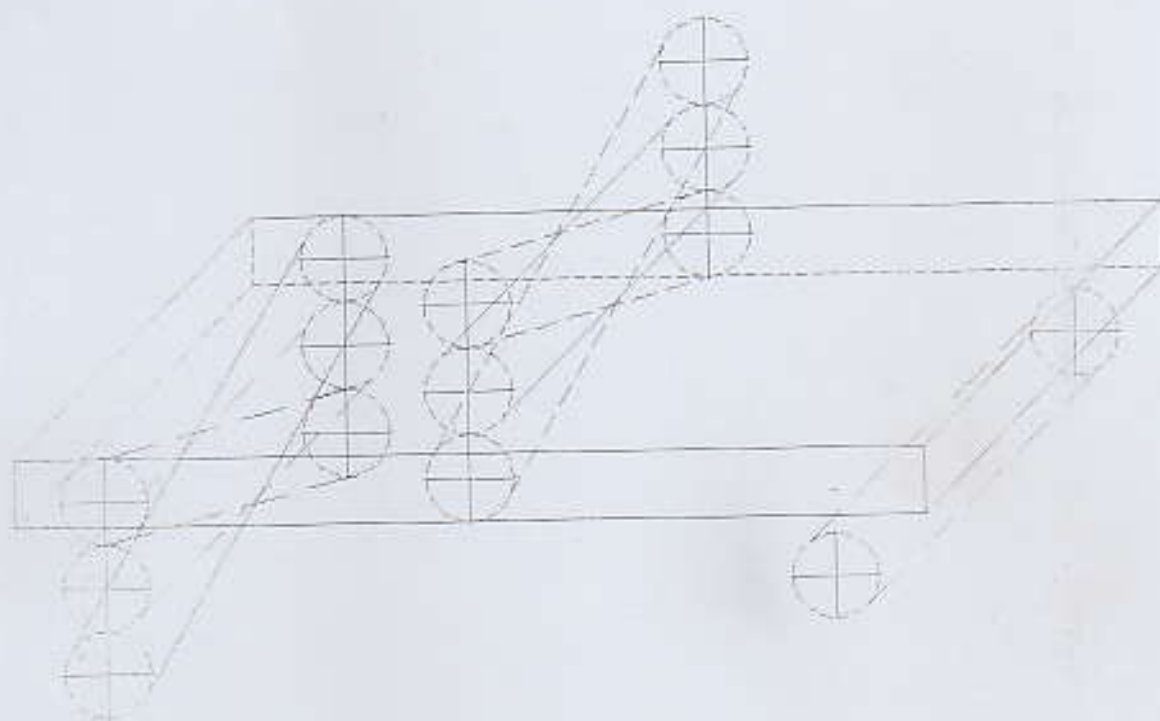


Figure 2 — Allowable movement of rods

