BRITISH STANDARD

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772-4:1998

Methods of test for masonry units —

Part 4: Determination of real and bulk density and of total and open porosity for natural stone masonry units

The European Standard EN 772-4:1998 has the status of a British Standard

ICS 91.100.20

National foreword

This British Standard is the English language version of EN 772-4:1998. No existing British Standard is superseded.

The UK participation in its preparation was entrusted by Technical Committee B/519, Masonry and associated testing, to Subcommittee B/519/1, Masonry units, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

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

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

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Summary of pages

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English version

Methods of test for masonry units — Part 4: Determination of real and bulk density and of total and open porosity for natural stone masonry units

Méthodes d'essai des éléments de maçonnerie — Partie 4: Détermination des masses volumiques réelle et apparente et des porosités ouverte et totale pour des éléments de maçonnerie en pierre naturelle

Prüfverfahren für Mauersteine — Teil 4: Bestimmung der Dichte und der Rohdichte sowie der Gesamtporosität und der offenen Porosität von Mauersteinen aus Naturstein

This European Standard was approved by CEN on 2 July 1998.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN 772-4:1998 E

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 125, Masonry, the Secretariat of which is held by BSI.

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 February 1999, and conflicting national standards shall be withdrawn at the latest by February 1999.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Contents

1 Scope

This European Standard specifies a method of determining the real density and the bulk density and the open and total porosity of natural stone masonry units.

2 Normative references

This European Standard incorporates by dated or undated reference, provision from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

prEN 771-6, *Specification for masonry units — Part 6: Natural stone masonry units.*

3 Principle

After drying to constant mass and calculating the bulk and impermeable volume, the bulk and real density of the units are calculated.

4 Symbols

$m_{sat,s}$	is the mass of the saturated specimen (g).
$m_{dry,s}$	is the mass of the dry specimen (g).
$m_{w,s}$	is the apparent mass of the specimen immersed in water (g).
V_b	is the bulk volume (mm^3).
V_p	is the volume of open pores (mm^3).
V_i	is the impermeable volume (mm^3).
$\rho_{r,s}$	is the real density of the specimen (kg/m^3).
$\rho_{b,s}$	is the bulk density of the specimen (kg/m^3).
$m_{c,s}$	is the mass of the crushed portion (g).
$V_{c,s}$	is the volume of liquid displaced by the crushed portion (ml).
P_o	is the open porosity (%).
P	is the total porosity (%).
ρ_w	is the density of water (kg/m^3).

5 Materials

Deionized water

6 Apparatus

6.1 *Ventilated oven*, capable of maintaining a temperature of 70 °C ± 5 °C.

6.2 *Evacuation vessel*, capable of maintaining a pressure of 2,0 kPa ± 0,7 kPa.

6.3 *Weighing instrument*, capable of weighing the specimens to an accuracy of at least 0,01 % of their mass.

6.4 *Linear measuring device*, with an accuracy of 0,1 mm.

6.5 *Le Chatelier type flask*, consisting of a flat-bottomed flask with a tube graduated from 0 ml to 24 ml in 0,1 ml graduations.

6.6 *Sieve*, with a 0,1 mm mesh.

7 Preparation of the specimens

7.1 Sampling

The method of sampling shall be in accordance with prEN 771-6. The minimum number of specimens shall be five, but a larger minimum number may be specified in the product specification, in which case that larger number shall be used.

7.2 Test specimen

The test specimens may have the form of a cylinder, cube or prism and shall be obtained by diamond sawing or coring. Their volume shall be at least 25 cm^3.

In addition, the surface area to volume ratio shall be between 0,1 mm^{-1} and 0,2 mm^{-1}.

7.3 Preparation of specimens

Dry the specimens at a temperature of 70 °C ± 5 °C to constant mass (**6.1**). Constant mass is reached if, during the drying process in subsequent weighings with not less than a 24 h interval, the loss in mass between two determinations is less than 0,1 % of the mass.

8 Procedure

8.1 Open porosity and bulk (apparent) density

Weigh the specimens (m_d), then place them in an evacuation vessel (**6.2**) and lower the pressure gradually to 2,0 kPa ± 0,7 kPa [= (15 ± 5) mm Hg].

Maintain this pressure constant for 24 h in order to eliminate the air contained in the open pores of the specimens.

Introduce deionized water at 20 °C ± 5 °C slowly into the vessel. The rate at which the water rises shall be such that the samples are completely immersed in not less than 15 min. Maintain the pressure of 2,0 kPa ± 0,7 kPa during introduction of the water and for 24 h afterwards.

At the end of this period return the vessel to atmospheric pressure and leave the specimens under water for another 24 h at atmospheric pressure.

Record the apparent mass in water ($m_{w,s}$) for each specimen and quickly wipe with a damp cloth and determine the mass ($m_{sat,s}$) of the specimen saturated with water.

In the case of natural stones with visible cavities (e.g. travertine) the apparent volume is determined by measuring their dimensions to the nearest 1 mm.

8.2 Real density

Having determined the apparent density and the open porosity, crush each specimen separately until the particles pass through the sieve (**6.6**).

Dry the crushed specimen to a constant mass and set apart a portion ($m_{c,s}$) of approximately 50 g (weighed to an accuracy of $\pm$0,1 g).

Introduce deionized water into the Le Chatelier flask (**6.5**) until the level is up to the zero graduation. Then add the weighed portion of each specimen into the flask in five fractions each of approximately 10 g, ensuring that all of each fraction falls into the liquid. After the introduction of each fraction, agitate the liquid to disperse the crushed specimen. Read the graduation to determine the volume ($V_{c,s}$) (in ml to the nearest 0,1 ml) of liquid displaced by the mass ($m_{c,s}$) of crushed portion.

Before taking the initial and final volume readings make sure that the ambient air temperature is 20 °C $\pm$ 5 °C.

9 Calculation and expression of results

9.1 General

The volume of the open pores (in mm^3) is expressed to the nearest 1 mm^3 by equation (1):

$$V_p = \frac{m_{sat,s} - m_{dry,s}}{\rho_w} \quad (1)$$

The bulk volume (in mm^3) is expressed to the nearest 1 mm^3 by equation (2):

$$V_b = \frac{m_{sat,s} - m_{w,s}}{\rho_w} \quad (2)$$

which can alternatively be calculated on the basis of the dimensions of the specimen.

NOTE The value of the density of water (ρ_w) at 20 °C is 0,998 g/ml.

9.2 Bulk (apparent) density

The bulk density is expressed to the nearest 10 kg/m^3 by the ratio of the mass of the dry specimen and its bulk volume, by equation (3):

$$\rho_{b,s} = \frac{m_{dry,s} \times \rho_w \times 1\,000}{m_{sat,s} - m_{w,s}} \quad (3)$$

9.3 Open porosity

The open porosity is expressed by the ratio to the nearest 0,1 % of the volume of open pores and its bulk volume, by equation (4):

$$P_o = \frac{V_p}{V_b} \times 100 \quad (4)$$

9.4 Real density

The real density (in kg/m^3) is expressed by the ratio of the mass of the crushed dry specimen ($m_{c,s}$) to the volume of liquid displaced by the mass ($V_{c,s}$) by equation (5):

$$\rho_{r,s} = \frac{m_{c,s} \times 1\,000}{V_{c,s}} \quad (5)$$

9.5 Total porosity

The total porosity (P) is expressed by the ratio (as a percentage) of the volume of pores (open and closed) and the bulk volume of the specimen, by equation (6):

$$P = \left(1 - \frac{\rho_{b,s}}{\rho_{r,s}}\right) \times 100 \quad (6)$$

10 Evaluation of test results

Calculate the mean value for bulk (apparent density) to the nearest 10 kg/m^3 and for the total porosity to the nearest 0,1 %.

11 Test report

The test report shall contain the following information:

a) the number, title and date of issue of this European Standard;

b) a description of the specimens to prEN 771-6, the name and address of the client, and:

- — the type of stone;
- — the commercial name of the stone;
- — the country and region of extraction;
- — the name of the supplier;

c) the method of sampling and by which organization;

d) the direction of any bedding or anisotropic features, to be clearly indicated on the samples by means of two parallel lines;

e) the date of delivery of the specimens;

f) the date of testing;

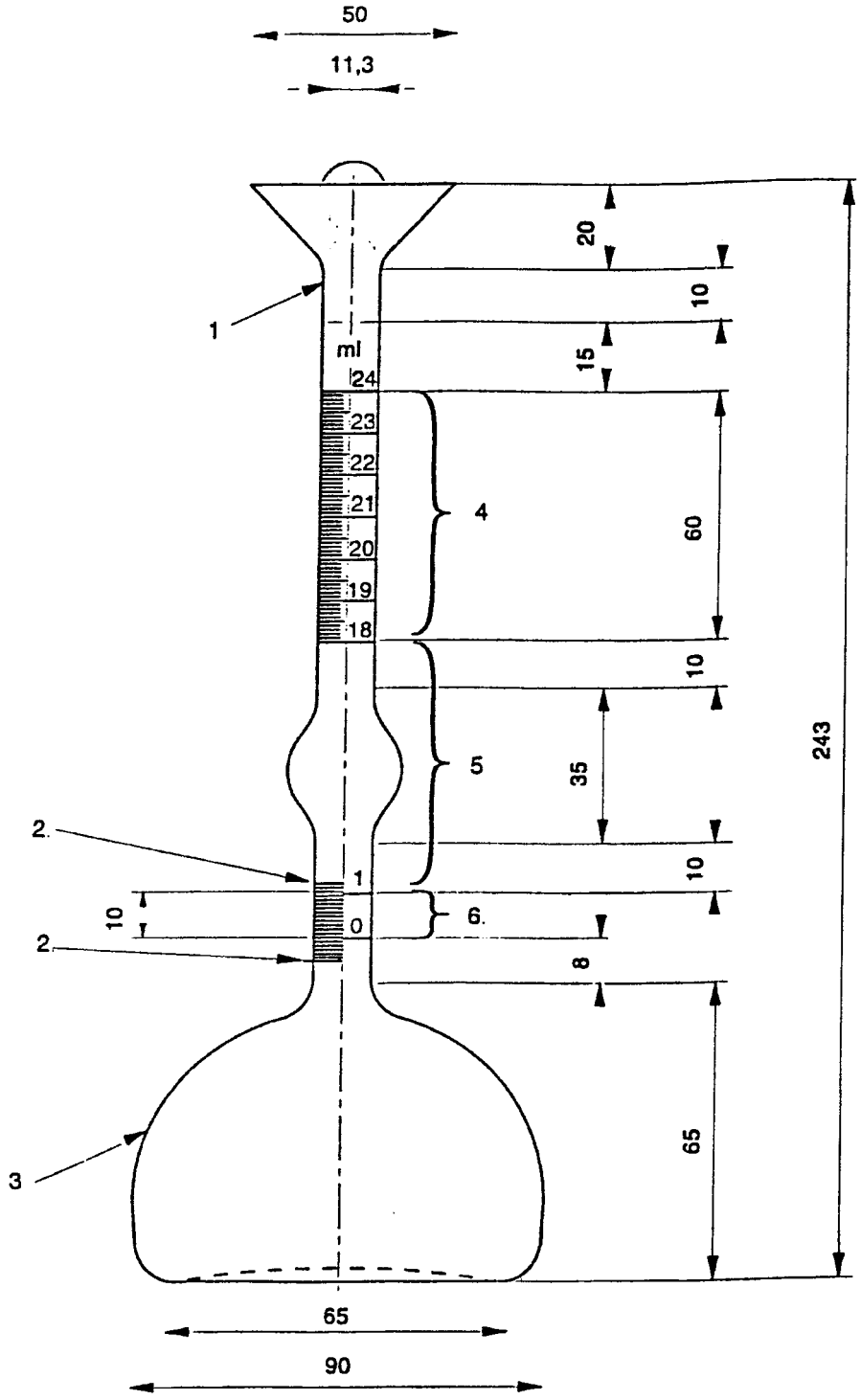
g) the number of specimens in the sample;

h) for each sample: the real density and the bulk (apparent) density to the nearest 10 kg/m^3, the open porosity and the total porosity to the nearest 0,1 %;

i) the arithmetic mean of the individual values for the real density and for the bulk (apparent) density (to the nearest 10 kg/m^3), for the open porosity and for the total porosity (to the nearest 0,1 %);

j) remarks, if any.

Dimensions in millimetres



1 Ground glass stopper
2 Have two 0,1 ml graduations extend above 1 and below 0 mark
3 Capacity of bulk approx 250 ml
4 6 ml capacity at 20 °C
5 17 ml capacity at 20 °C
6 1 ml capacity at 20 °C

NOTE Variations of a few millimetres in such dimensions as total height of flask, diameter of base, etc., are to be expected and should not be considered sufficient cause for rejection.

Figure 1 — Le Chatelier flask for measurement of real density

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