SLOVENSKI STANDARD
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Preskušanje naravnega kamna - Ugotavljanje prostorninske mase brez por in votlin in prostorninske mase s porami in votlinami ter skupne in odprte poroznosti

Natural stone test methods - Determination of real density and apparent density, and of total and open porosity

Prüfverfahren für Naturstein - Bestimmung der Reindichte, der Rohdichte, der offenen Porosität und der Gesamtporosität

Méthodes d'essai des pierres naturelles - Détermination des masses volumiques réelle et apparente et des porosités ouverte et totale

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

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Foreword

This document (EN 1936:2006) has been prepared by Technical Committee CEN/TC 246 “Natural stones”, 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of an identical text or by endorsement, at the latest by June 2007, and conflicting national standards shall be withdrawn at the latest by June 2007.

This document supersedes EN 1936:1999.

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

1 Scope

This European standard specifies methods for determining the real density, apparent density, and open and total porosity of natural stone.

2 Normative references

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

EN 12670:2001, *Natural stone - Terminology*

ISO 3507, *Laboratory glassware - Pyknometers*

3 Principle

After drying to constant mass, the apparent density and open porosity are determined by vacuum assisted water absorption and submerged weighing of specimens. The real density and total porosity require the specimen to be pulverised.

4 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12670:2001 and the following apply.

4.1
apparent density (ρ_b)
ratio between the mass of the dry specimen and its apparent volume

4.2
apparent volume
volume limited by the external surface of the specimen, including any voids

4.3
volume of the solid part
difference between the apparent volume of the specimen and the volume of the voids (open and closed pores)

4.4
real density (ρ_r)
ratio between the mass of the dry specimen and the volume of its solid part

4.5
open porosity
ratio (as a percentage) between the volume of the open pores and the apparent volume of the specimen

4.6
total porosity
ratio (as a percentage) between the volume of pores (open and closed) and the apparent volume of the specimen

5 Symbols

m_d mass of the dry specimen, in grams;

m_h mass of the specimen immersed in water, in grams;

m_s mass of the saturated specimen, in grams;

m_e mass of the specimen ground and dried (for the tests using the pycnometer or the volumenometer), in grams;

m_1 mass of the pycnometer filled with water and the ground specimen, in grams;

m_2 mass of the pycnometer filled with water, in grams;

V_b apparent volume of the specimen, in millilitres;

V_o volume of open pores of the specimen, in millilitres;

V_s volume of liquid displaced by the mass m_e (volumenometer test);

ρ_b apparent density of the specimen, in kilograms per cubic metre;

ρr real density of the specimen, in kilograms per cubic metre;

ρ_{rh} density of water, in kilograms per cubic metre;

p_o open porosity of the specimen, as a percentage;

p total porosity of the specimen, as a percentage.

6 Apparatus

6.1 A ventilated oven which maintain a temperature (70 ± 5) °C.

6.2 An evacuation vessel which can maintain a pressure of (2,0 ± 0,7) kPa = (15 ± 5) mm Hg and allow gradual immersion of the contained specimens.

6.3 A weighing instrument which has an accuracy of at least 0,01% of the mass to be weighed, also capable of weighing the specimen in water.

6.4 A linear measuring device with an accuracy of at least 0,01%.

6.5 An ISO 3507 type 3 pycnometer having a nominal capacity of 50 ml.

6.6 A La Chatelier type volumenometer consisting of a flat-bottomed flask with a tube graduated form 0 ml to 24 ml in 0,1 ml graduations.

6.7 A sieve with a 0,063 mm mesh.

6.8 A dessicator with dessicant.

7 Preparation of the specimens

7.1 Sampling

The sampling is not the responsibility of the test laboratory except where specially requested. At least six test specimens, representing the body of stone being tested, shall be selected.

7.2 Test specimens

The test specimens can be in the form of a cylinder, cube or prism and must be obtained by diamond sawing or coring. Their apparent volume calculated by geometrical measurements shall be at least 60 ml.

In addition, the surface area to volume ratio shall be between 0,08 mm-1 and 0,20 mm-1.

NOTE The specimens prepared for the determination of compressive or flexural strength can be used if they satisfy the surface/volume ratio.

7.3 Drying the specimens

The specimens are to be dried at (70 ± 5)°C until a constant mass is reached. This is assumed to have been attained when the difference between the two weighings at an interval of (24 ± 2) h is not greater than 0,1 % of the mass of the specimen.

The specimens shall be kept in a desiccator until room temperature is attained.

8 Test procedure

8.1 Open porosity and apparent density

Weigh each specimen (m_d), then put the specimens into an evacuation vessel and lower the pressure gradually to (2,0 ± 0,7) kPa = (15 ± 5) mm Hg.

Maintain this pressure for (2 ± 0,2) h in order to eliminate the air contained in the open pores of the specimens.

Slowly introduce demineralized water at (20 ± 5)°C into the vessel (the rate at which the water rises shall be such that the specimens are completely immersed not less than 15 min).

Maintain the pressure of (2,0 ± 0,7) kPa during the introduction of water.

When all the specimens are immersed, return the vessel to atmospheric pressure and leave the specimens under water for another (24 ± 2) h at atmospheric pressure.

Then, for each specimen:

— weigh the specimen under water and record the mass in water: m_h;

— quickly wipe the specimen with a dampened cloth and determine the mass m_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 the dimensions of the specimens to the nearest millimetre.

8.2 Real density

8.2.1 General

For dense, low porosity stones the differences between real and apparent density, as well as between open porosity and total porosity, are very small. For these stones it is sufficient to determine the apparent density and the open porosity. In the case of control of supplies the decision of omitting the determination of the real density shall be agreed upon between the parties.

In this standard two methods for the determination of real density are described: the pycnometer (Method A) and Le Chatelier volumenometer (Method B).

The first method is more accurate but requires a very long time. It is suggested to use it as a reference method in the case of controversy. Le Chatelier volumenometer method is less accurate but easy and rapid to perform and can be used for production control.

8.2.2 Method A (pycnometer)

For each specimen, after having determined the apparent density and the open porosity, grind each specimen separately until the particles pass through a sieve with 0,063 mm mesh.

Dry the ground specimen to a constant mass and set apart a mass, m_e of approximately 10 g weighed to an accuracy of ± 0,01 g.

Introduce deionized water into the pycnometer and fill it approximately half full. Then add the weighed mass, m_e of the ground specimen into the pycnometer and agitate the liquid to disperse the solid matter.

NOTE Ethanol or other liquids may be used instead of deionised water if required. In this case the density of this liquid shall be used instead of density of water in the equation (5a).

Expose the pycnometer to a vacuum of (2 ± 0,7) kPa until no further air bubbles rise, then fill it with deionized water almost to the top and leave the solid matter to settle until the water above the residue is clear.

Next, carefully top up the pycnometer with deionized water, fit the ground stopper and gently wipe off any overflow. Finally weigh the pycnometer to an accuracy of ± 0,01 g (m_1).

Empty and wash the pycnometer, fill it with deionized water only and weigh to an accuracy of ± 0,01 g (m_2).

Before each weighing make sure that the ambient air temperature is (20 ± 5)°C.

8.2.3 Method B (Le Chatelier volumenometer)

For each specimen, after having determined the apparent density and the open porosity, grind each specimen separately until the particles will pass through a sieve with 0,063 mm mesh.

Dry the ground specimen to a constant mass and set apart a mass, m_e of approximately 50 g weighed to an accuracy of ± 0,1 g.

Introduce deionized water into Le Chatelier volumenometer until the level is up to the 0 graduation. Then add the weighed mass, m_e of the ground specimen into the volumenometer in five fractions in the region of 10 g each, ensuring that all of each fraction falls into the liquid. After the introduction of each fraction, agitate the liquid to disperse the ground specimen. Read the graduations to determine the V_s in millilitres to the nearest 0,1 ml of liquid displaced by the mass m_e of the ground specimen.

Before taking the initial at 0 level and final volume readings make sure that the ambient air temperature is (20 ± 5)°C.