SLOVENSKI STANDARD
SIST EN 1936:2000

01-april-2000

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 method - 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 pour pierres naturelles - Détermination des masses volumiques réelle et apparente et des porosités ouverte et totale

Ta slovenski standard je istoveten z: **EN 1936:1999**

ICS:

73.020	Rudarstvo in kamnolomsko izkopavanje	Mining and quarrying
91.100.15	Mineralni materiali in izdelki	Mineral materials and products

SIST EN 1936:2000 **en**

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 1936

March 1999

ICS 73.020; 91.100.15

English version

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

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This European Standard was approved by CEN on 13 February 1999.

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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.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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

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

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Contents

Foreword

This European Standard 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of an identical text or by endorsement, at the latest by September 1999, and conflicting national standards shall be withdrawn at the latest by September 1999.

This European standard is one of the series of draft standards for tests on natural stone.
Test methods for natural stone consist of the following parts:

EN 1925	Natural stone test methods - Determination of water absorption coefficient by capillarity
EN 1926	Natural stone test methods - Determination of compressive strength
EN 12370	Natural stone test methods - Determination of resistance to salt crystallisation
prEN 12371	Natural stone test methods - Determination of frost resistance
EN 12372	Natural stone test methods - Determination of flexural strength under concentrated load
prEN 12407	Natural stone test methods - Petrographic description
prEN 13161	Natural stone test methods - Determination of flexural strength under constant moment
prEN 13364	Natural stone test methods - Determination of the breaking load at a dowel hole
prEN ....(WI 00246011)	Natural stone test methods - Determination of thermal dilatation coefficient
prEN ....(WI 00246012)	Natural stone test methods - Determination of sound - speed propagation
prEN ....(WI 00246014)	Natural stone test methods - Determination of abrasion resistance
prEN ....(WI 00246015)	Natural stone test methods - Determination of Knoop hardness
prEN ....(WI 00246016)	Natural stone test methods - Determination of thermal shock resistance
prEN ....(WI 00246017)	Natural stone test methods - Determination of slip coefficient
prEN ....(WI 00246018)	Natural stone test methods - Determination of static elastic modulus
prEN ....(WI 00246019)	Natural stone test methods - Determination of rupture energy
prEN ....(WI 00246030)	Natural stone test methods - Determination of surface finishes (rugosity)
prEN 13373	Natural stone test methods - Determination of geometric characteristics on units
prEN ....(WI 00246032)	Natural stone test methods - Determination of resistance to ageing by salt mist
prEN ....(WI 00246033)	Natural stone test methods - Determination of resistance to ageing by humidity, temperature, SO_2 action
prEN ....(WI 00246035)	Natural stone test methods - Determination of dynamic elastic modulus (by fundamental resonance frequency)
prEN ....(WI 00246036)	Natural stone test methods - Determination of water absorption at atmospheric pressure

It is intended that other ENs should call up this EN 1936 as the basis of evaluation of conformity. (Nevertheless it is not intended that all natural stones products should be subjected regularly to all the listed tests. Specifications in other standards should call up only relevant test methods).

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.

1 Scope

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

2 Normative references

This European Standard incorporates by dated or undated reference, provisions 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 12670 Natural stones - Terminology

ISO/DIS 3507 Laboratory glassware - Pyknometers

prEN 12440 Denomination of natural stone

3 Principle

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

4 Definitions

For the purposes of this standard the following definitions and the definitions in accordance with prEN 12670 apply:

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

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

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

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

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

4.6 total porosity: The 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
ρ_r 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 can maintain a temperature of (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 to weigh the specimen in water.

6.4 A linear measuring device with an accuracy of 0,1 mm.

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

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

6.7 A sieve with a 0,063 mm mesh.

6.8 A desiccator with desiccant.

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, which are considered representative of the body of stone being tested, shall be selected.

7.2 Test specimens

The test specimens have the form of a cylinder, cube or prism and shall be obtained by diamond sawing or coring. Their apparent volume calculated by geometrical measurements shall be at least 25 ml.
In addition, the surface area to volume ratio shall be between 0,1 mm^{-1} and 0,2 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 a temperature of (70 ± 5)°C until a constant mass is reached. This is assumed to have been attained when the difference between 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 (24 ± 2) h in order to eliminate the air contained in the open pores of the specimens.

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

After this time 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 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 25 g weighed to an accuracy of ± 0,01 g.
Introduce deionized water into the pycnometer and fill it until 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.
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.

9 Expression of results

9.1 General

The volume of the open pores (in millilitres) is expressed by the equation:

$$V_0 = \frac{m_s - m_d}{\rho_{rh}} \cdot 1000 \tag{1}$$

The apparent volume (in millilitres) is expressed by the equation:

$$V_b = \frac{m - m_h}{\rho_{rh}} \cdot 1000 \tag{2}$$

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

NOTE: The value of the density of water ρ_{rh} at 20 °C is 998 kg/m^3

9.2 Apparent density

The apparent density (in kilograms per cubic metre) is expressed by the ratio of the mass of the dry specimen and its apparent volume, by the equation:

$$\rho_b = \frac{m_d}{m_s - m_h} \cdot \rho_{rh} \tag{3}$$

9.3 Open porosity

The open porosity is expressed by the ratio (as a percentage) of the volume of open pores and the apparent volume of the specimen, by the equation:

$$p_o = \frac{m_s - m_d}{m_s - m_h} \cdot 100 \tag{4}$$