BRITISH STANDARD

BS EN
1925:1999

# Natural stone test methods — Determination of water absorption coefficient by capillarity

The European Standard EN 1925:1999 has the status of a British Standard

ICS 91.100.15

# National foreword

This British Standard is the English language version of EN 1925:1999.

The UK participation in its preparation was entrusted to Technical Committee B/545, Natural stone, 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 committee can be obtained on request to its secretary.

**Cross-references**

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**Summary of pages**

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 7 and a back cover.

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EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 1925

March 1999

ICS 73.020; 91.100.15

English version

# Natural stone test methods — Determination of water absorption coefficient by capillarity

Méthodes d'essai pour pierres naturelles — Détermination du coefficient d'absorption d'eau par capillarité

Prüfverfahren für Naturstein — Bestimmung des Wasseraufnahmekoeffizienten infolge Kapillarwirkung

This European Standard was approved by CEN on 12 February 1999.



**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 1925:1999 E

## 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of an identical text or by endorsement, at the latest by September 1999, and conflicting national standards shall be withdrawn at the latest by September 1999.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 draft 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 1926, *Natural stone test methods — Determination of compressive strength.*

EN 1936, *Natural stone test methods — Determination of real density and apparent density and of total and open porosity.*

EN 12370, *Natural stone test methods — Determination of resistance to salt crystallization.*

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 EN 1925 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.

This European Standard has an annex A (informative) and an annex B (informative).

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 for determining the water absorption coefficient of natural stone by capillarity.

NOTE This method is not suitable for stones with an open porosity less than 1 % when determined in accordance with EN 1936.

## 2 Normative references

The present 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 below. 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 last edition of the publication referred to applies.

prEN 12670, *Natural stones — Terminology.*

EN 1936, *Natural stone test methods — Determination of real density and apparent density and of total and open porosity.*

prEN 12440, *Denomination of natural stone.*

## 3 Principle

After drying to a constant mass, the specimen is immersed in $(3 \pm 1)$ mm of water on one of its sides (never the worked side) and the increase in mass is measured as a function of time.

## 4 Symbols

$m_d$ mass of the dry specimen, in grams;

$m_i$ successive masses of the specimen during testing, in grams;

$A$ area of the side immersed in water, in square metres;

$t_i$ times elapsed from the beginning of the test until the times at which the successive masses $m_i$ were measured, in seconds;

$C_1$ water absorption coefficient by capillarity perpendicular to the planes of anisotropy of the stone, in grams per square metre per square root of seconds;

$C_2$ water absorption coefficient by capillarity parallel to the planes of anisotropy of the stone, in grams per square metre per square root of seconds.

## 5 Apparatus

**5.1** *Covered tank*, with flat base comprising small non-oxidizing and non-absorbent supports for the specimens.

**5.2** *Device*, able to maintain a constant water level in the tank, described in **5.1**.

**5.3** *Time counter*, with an accuracy of 1 s.

**5.4** *Ventilated oven*, which can maintain a temperature of $(70 \pm 5)$ °C.

**5.5** *Weighing instrument*, with an accuracy of 0,01 g.

**5.6** *Linear measuring device*, with an accuracy of 0,05 mm.

**5.7** *Air conditioned room*, with $(20 \pm 5)$ °C.

## 6 Preparation of the specimens

### 6.1 Sampling

Sampling is not the responsibility of the test laboratory except where especially requested. At least six specimens shall be selected from a homogenous batch and tested for each direction of rise of water in relation to the position of any anisotropy planes (e.g. bedding planes, foliation, etc.) which shall be marked on all specimens by at least two parallel lines.

The specimens shall be rough cut or may have one or two polished or honed faces. These faces are to be placed vertically (the worked face shall never be the immersed face).

### 6.2 Dimensions of the test specimens

The test specimens shall be cubes with $(70 \pm 5)$ mm or $(50 \pm 5)$ mm edge or right circular cylinders whose diameter and height are equal to $(70 \pm 5)$ mm or $(50 \pm 5)$ mm.

### 6.3 Drying the specimens

The test specimens are to be dried to constant mass in a ventilated oven at a temperature of $(70 \pm 5)$ °C. Constant mass is reached when the difference between two successive weighings at an interval of $(24 \pm 2)$ h is not greater than 0,1 % of the mass of the specimen.

The specimens shall be kept in a desiccator until room temperature $(20 \pm 5)$ °C is attained.

## 7 Test procedure

Weigh the specimens after drying ($m_d$) to an accuracy of 0,01 g and calculate the area of the base to be immersed by measurement of two medians to the nearest 0,1 mm. Express this area in square metres. Place the specimens in the tank on the thin supports provided such that they only rest partially on their base. Ensure that the position of the planes of anisotropy in relation to the rising water matches the requirements. Immerse the base in the water to a depth of $(3 \pm 1)$ mm. Start the timer device. Maintain the water level constant throughout the test by adding water as necessary, and close the container to avoid evaporation of the damp specimens. At time intervals, initially very short then longer, remove each specimen in succession, lightly dry the immersed part using a damp cloth to remove all water droplets and weigh immediately to the nearest 0,01 g, then replace in the container. Record the time elapsed since the start of the test until the time of each weighing.

NOTE The choice of times depends on the type of stone. For a highly absorbent stone, suitable times $t_1$ are: 1, 3, 5, 10, 15, 30, 60, 480 and 1 440 min. For a low absorption stone, suitable times are: 30, 60, 180, 480, 1 440, 2 880 and 4 320 min. These times will be measured with an accuracy of 5 %. A minimum of 7 measurements is necessary. The end of the test is reached when the differences between two successive weighings is not greater than 1 % of the mass of water absorbed by the specimen.

## 8 Expression of results

Show as a graph the mass of water absorbed in grams divided by the area of the immersed base of the specimen in square metres as a function of the square root of time expressed in seconds.

NOTE 1 In general, graphs are obtained as shown in Figure 1. These can be approximated by two straight lines.

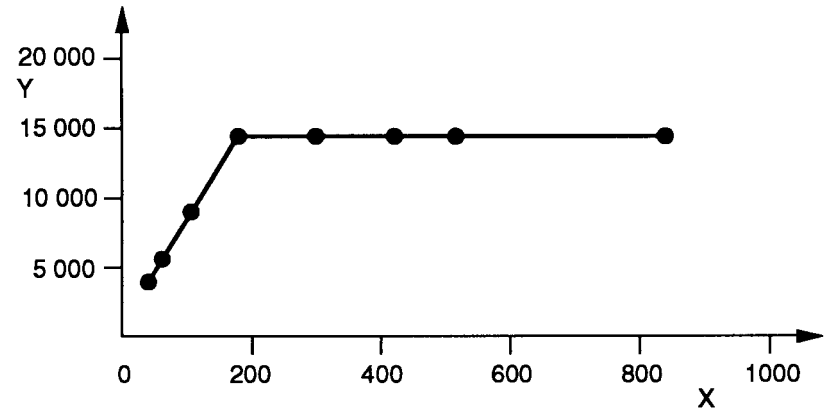
If the correlation coefficient between the measured points of the first part of the graph and the regression straight line of this first part is respectively greater than 0,90 (when at least five measurements were taken in the first part of the graph) or than 0,95 (when only four measurements were taken), the coefficient of water absorption by capillarity $C_1$ or $C_2$ (in grams per square metre per square root of time in seconds) is represented by the slope of the $C_1$ respectively $C_2$ regression line. It can be calculated as the ratio between the ordinate and abscissa of any point of this line using the following formula:

$$C_1 \text{ or } C_2 = \frac{m_i - m_d}{A.\sqrt{t_i}}$$

The obtained values of $C_1$ or $C_2$ are expressed to three significant figures.

NOTE 2 This approximate formula cannot be used if the correlation coefficient between the measured points of the first part of the graph and the regression straight line of this part is not satisfactory (see above).

Annex A (informative) gives an equation more appropriate for this kind of test result.




Legend

Y is the water absorption in g/m$^2$

X is the square root of time in s$^{0,5}$

**Figure 1 — Water absorption by capillarity perpendicular to the planes of anisotropy as a function of the square root of time for a specimen with a low water absorption coefficient ($C_1$ = 86,0 g/m$^2$.s$^{0,5}$)**

## 9 Test report

The test report shall contain the following information:

a) unique identification number of the report;

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

c) the name and address of the test laboratory and the address where the test was carried out if different from the test laboratory;

d) the name and address of the client;

e) it is the responsibility of the client to supply the following information:

— the petrographic name of the stone;

— the commercial name of the stone in accordance with prEN 12440;

— the country and region of extraction;

— the name of the supplier;

— the direction of any existing plane of anisotropy (if relevant to the test) to be clearly indicated on the sample or on each specimen by means of two parallel lines;

— the name of the person or organization which carried out the sampling;

— the surface finish of the specimen (if relevant to the test);

f) the date of delivery of the sample or of the specimens;

g) the date when the specimens were prepared (if relevant) and the date of testing;

h) the number of specimens in the sample;

i) the dimensions of the specimens;

j) for each specimen the water absorption coefficient by capillarity $C_1$ perpendicular to or $C_2$ parallel to the planes of anisotropy, expressed to the three significant figures;

k) the arithmetic mean of the water absorption coefficients $C_1$ and/or $C_2$ expressed to the three significant figures;

l) all deviations from the standard and their justification;

m) remarks.

The test report shall contain the signature(s) and role(s) of the responsible(s) for the testing and the date of issue of the report. It shall also state that the report shall not be partially reproduced without the written consent of the test laboratory.

# Annex A (informative)
# Calculation of water absorption coefficient by capillarity by means of a non-linear regression function

## A.1 Scope

The annex presents a more appropriate equation for determining the water absorption coefficient by capillarity when the approximate formula given in clause **8** cannot be used.

## A.2 Symbols

$y_i \left(= \frac{m_i - m_d}{A}\right)$ is the mass of water related to surface area of the immersed base and absorbed up to time $t_i$, in grams per square metre;

$m_f$ is the final mass of the specimen at the end of the test, in grams;

$a \left(= \frac{m_f - m_d}{A}\right)$ is the maximum mass of water related to surface area of the immersed base, in grams per square metre;

$b$ is the length-related water penetration coefficient, that is the reciprocal of the square root of the time $t_i$ in seconds.

NOTE The other symbols have already been defined in clause **4**.

## A.3 Expression of results

The equation given below applies, when, in a test for determining the water absorption coefficient by capillarity, the graph showing the mass of absorbed water related to the surface area of the immersed base of the specimen as a function of the square root of time cannot be satisfactorily approximated by two straight lines, that is, when the correlation coefficient between the measured points of the first part of the graph and the corresponding regression straight line is not greater than 0,90 (for at least five measurements) or 0,95 (for four measurements).

In the case of graph as shown in Figure A.1 a more appropriate equation to describe the link between the mass of absorbed water related to the surface area ($y_i$) and the square root of the time ($\sqrt{t_i}$) is as follows:

$$y_i = a\ (1 - e^{-b\sqrt{t_i}}) \qquad [A.1]$$

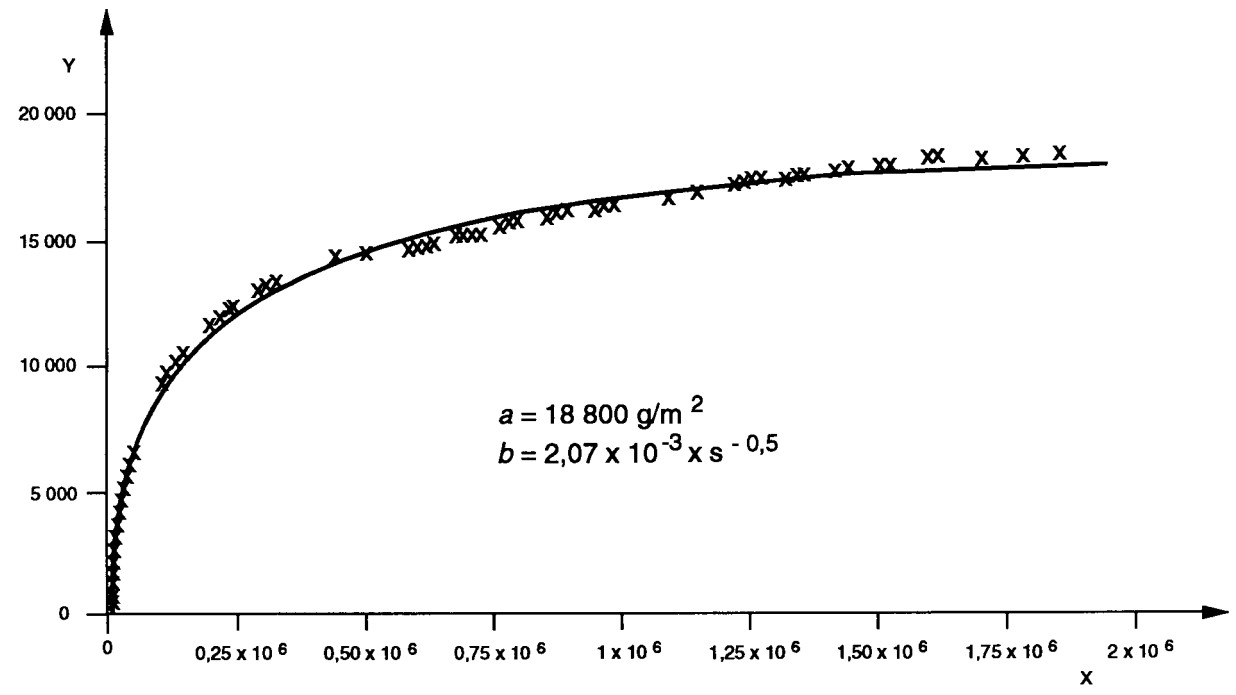
By linearising the exponential function [for small values of $t_i$ is $e^{-b\sqrt{t_i}} \cong (1 - b{\cdot}\sqrt{t_i})$], the equation [A.1] becomes:

$$y_i = a{\cdot}b\sqrt{t_i} \qquad [A.2]$$

and

$C_1$ or $C_2 = a{\cdot}b$

The obtained values of $C_1$ or $C_2$ are expressed to three significant figures.




Legend

Y is the water absorption in g/m$^2$

X is the time in s

**Figure A.1 — Water absorption by capillarity perpendicular to the planes of anisotropy according to the regression function (equation A.2) for a specimen with a low water absorption coefficient ($C_i$ = 38,9 g/m$^2$ s$^{0,5}$)**

## Annex B (informative)

## Bibliography related to annex A

More information on the subject treated in annex A can be found in the following papers.

[1] Hotfmann, D.; Niesel, K.: Quantifying capillary rise in columns of porous material. Amer. Ceram. Soc. Bull. 67 (1988) No. 8, 1418.

[2] Hoffmann, D.; Niesel, K.: Zur rechnerischen Erfassung des Kapillaraufstiegs in Säulen poröser Baustoffe. Bautenschutz und Bausanierung 10 (1987) No. 5, 69–70.

[3[ Niesel, K.: Détermination de l'ascension capillaire de liquide dans des matériaux poreux de construction. in: Actes de la journée ICOMOS/Direction du Patrimoine "Les remontées d'eau du sol dans les maçonneries", Paris: Musée des Monuments Français 25/01/1994, Paris: 1994, 21 pp.

[4] Hoffmann, D.; Niesel K.: Quantifying the effect of air pollutants on rendering and also moisture-transport phenomena in masonry including its constituents. http://www.bam.de/a_vii/moisture/transport.html

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