BRITISH STANDARD

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Conservation of cultural property — Test methods — Determination of water absorption by capillarity

ICS 97.195

National foreword

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

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Erhaltung des kulturellen Erbes - Prüfverfahren - Bestimmung der Wasserabsorption durch Kapillarität

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Foreword

This document (EN 15801:2009) has been prepared by Technical Committee CEN/TC 346 “Conservation of cultural property”, 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of an identical text or by endorsement, at the latest by June 2010 and conflicting national standards shall be withdrawn at the latest by June 2010.

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Introduction

This test method can be applied if it does not change the value of the cultural property and follows relevant ethical codes of conservation practice.

1 Scope

This European Standard specifies a method for determining the water absorption by capillarity of porous inorganic materials used for and constituting cultural property. The method may be applied to porous inorganic materials either untreated or subjected to any treatment or ageing.

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.

prEN 15898:2009, *Conservation of cultural property — Main general terms and definitions concerning conservation of cultural property*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in prEN 15898:2009 and the following apply.

3.1
porous inorganic materials
materials including natural stones, e.g. sandstone, limestone, marble, as well as artificial materials, such as mortar, plaster, brick and others

4 Principle

Determination of the amount and rate at which a specimen absorbs water by capillarity through the test surface when it is in contact with water.

5 Symbols and abbreviations

For the purposes of this document, the following symbols and abbreviations apply:

m_0 mass of the dry specimen, in kg

m_i mass of the specimen at time t_i, in kg

A area of the specimen in contact with water, in m^2

t_i time elapsed from the beginning of the test, in s

Q_i water absorbed per unit area, in kg/m^2

AC capillary water absorption coefficient, in $kg/(m^2 \cdot s^{1/2})$

H_i height of the front of water, in cm

B capillary water penetration coefficient, in $cm/s^{1/2}$

6 Test equipment

6.1 A vessel with flat base.

6.2 Bedding layer such as filter paper, foam and cotton.

6.3 A chronometer with an accuracy of 1 s.

6.4 A ventilated oven which can maintain a temperature of (60 ± 2) °C.

6.5 An analytical balance with an accuracy of at least 0,01 g.

6.6 A linear measuring device (calliper) with an accuracy of 0,1 mm.

6.7 Climatic chamber with temperature of (23 ± 1) °C.

6.8 Sand paper with grain size of 82 μm (corresponding to grit number P180 according to the FEPA[1)] classification).

6.9 Desiccator filled with desiccant such as self-indicating silica gel or other drying agents.

7 Preparation of test specimens

7.1 Number and dimensions of the test specimens

The test specimens shall have a regular shape such as cubes or cylinders. They shall have dimensions (side or diameter) of at least 10 mm and a height of at least 10 mm.

The number and dimensions of specimens are dependent on the heterogeneity of the material. Each series shall consist of at least 3 specimens. In case of anisotropy, each series shall always be tested according to the same orientation, if any. All dimensions shall have a ± 0,5 mm tolerance.

In case of non homogeneous materials, such as mortars, containing coarse aggregates, the dimensions shall be at least three times (and preferably five times) the largest grain size.

The number and dimensions of the specimens can be different in cases when there could be difficulties in sampling the required amount of material.

7.2 Pre-conditioning of test specimens

The surface chosen for the determination of water absorption by capillarity shall be flat and wet or dry polished with sand paper (6.8). After polishing, the specimens shall be washed with water, gently brushed with a soft brush and immersed in deionised water for 30 min. In case of water-sensitive materials, for example gypsum containing materials, only dry polishing and compressed air shall be used.

The above procedure does not necessarily apply to treated specimens or specimens taken from exposed surfaces.

The test specimens shall be dried to constant mass in a ventilated oven at a temperature of (60 ± 2) °C. If the material is temperature-sensitive, the pre-conditioning shall be conducted in a desiccator filled with desiccant or in a ventilated oven at a temperature of (40 ± 2) °C till constant mass is reached.

1) FEPA – Federation of European Producers of Abrasives

Constant mass is reached when the difference between two successive weighing at an interval of 24 h is not greater than 0,1 % of the mass of the specimen.

Before each weighing and before beginning the test, the specimen shall be kept in a desiccator until temperature of (23 ±1) °C is reached.

8 Test procedure

A dry bedding layer (6.2) (minimum thickness of 5 mm) is placed on the bottom of the vessel (6.1). Water is added until the bedding layer is saturated. The water level should not exceed the upper surface of the bedding layer. Maintain the water level constant throughout the test by adding water as necessary.

Once constant mass has been achieved by drying, each pre-conditioned specimen is weighed (m_0), the surface under investigation is placed on the bedding layer, and the chronometer is started.

For measuring water absorption, the specimen is taken off the medium, any water adhering to the surface is wiped off using a damp cloth, and the specimen is weighed. The time intervals between the weighings depend on the speed of water absorption. The first weighing shall be taken at very short time intervals.

The end of the test is reached when the difference between two successive weighings (24 h) is not greater than 1 % of the mass of water absorbed by the specimen. If this condition is not reached, the test shall be ended after 8 days.

NOTE 1 The choice of time intervals depends on the type of porous inorganic material (porosity, condition, size) and the treatment, if any. It is recommended to conduct preliminary tests in order to establish the time intervals, especially during the first 60 min of the test.

NOTE 2 Regardless of the set of time intervals chosen, it is important to apply the same test procedure (time intervals and number of measurements) both before and after treatment when the determination of water absorption by capillarity test method is used to verify the changes brought about by the treatment itself.

After the determination of capillary water absorption, an additional test, following the same procedure shall be performed to measure the front of water on lateral surfaces of the specimen.

For geometrical specimens (e.g. cubic, cylindrical form) the dynamic migration of the water front (capillary fringe) can be measured on the lateral surfaces.

In case of a homogeneous and linear front, the height of the fringe corresponding to the border between the dry and the wet zone is measured with a graduated line drawn on the lateral surface of the specimen or with a ruler, starting from the bottom of the specimen.

In case of a heterogeneous front, the height of the fringe corresponds to the average of the four heights measured in the central part of each face (case of a cubic specimen) or with the average of three recorded heights according to the three graduated vertical lines, each 120° from each other (case of a cylindrical specimen).

Alternatively, the minimum and maximum height of the fringe on the lateral surfaces can be recorded with a ruler.

9 Expression of results

9.1 Capillary water absorption curve and coefficient (AC)

The amount of water absorbed by the specimen per unit area Q_i (kg/m^2) at time t_i (s) is calculated as follows:

$Q_i = [(m_i – m_0)/A]$

For the determination of the capillary water absorption curve the calculated values of Q_i are reported in a graph as a function of the square root of time ($t_i^{1/2}$).

The capillary water absorption coefficient (AC) is the slope of the linear section of the curve obtained plotting the mass change per area (Q_i) versus the square root of time ($t_i^{1/2}$), and shall be calculated by linear regression, using at least 5 successive aligned points.

Graphs reporting the water absorbed for untreated and treated specimens per unit area (Qi) versus the square root of time ($t_i^{1/2}$) are reported in Annex A as examples (Figure A.1).

9.2 Capillary water penetration coefficient (B)

The capillary water penetration coefficient B is represented by the slope of the curve obtained reporting the height of the water front migration (H_i) versus the square root of time ($t_i^{1/2}$), and shall be calculated by linear regression.

10 Test report

The test report shall include the following information:

a) reference to this European Standard;

b) the name and address of the test laboratory in which the test was carried out;

c) date of testing (yy-mm-dd);

d) type, name, provenance, description of the porous inorganic material including chemical, petrographical, mineralogical and physical characteristics (if available), in accordance with existing standards;

e) number, shape, dimensions and orientation of anisotropy present, if any;

f) description of pre-conditioning;

g) description of the test surface of the specimens, the date when the specimens were prepared, type and date of the treatment applied, if any;

h) type of water used for the test (e.g. tap water, deionised or distilled);

i) set of time intervals chosen and the duration of the test;

j) for each specimen the following data shall be reported:

   1) Q_i values and the time intervals t_i

   2) Hi values and the time intervals t_i

   3) the graphs of Q_i values as a function of square root of time ($t_i^{1/2}$)

   4) the graphs of Hi values as a function of square root of time ($t_i^{1/2}$)

5) capillary water absorption coefficient AC and the correlation coefficient of the regression line used for the calculation

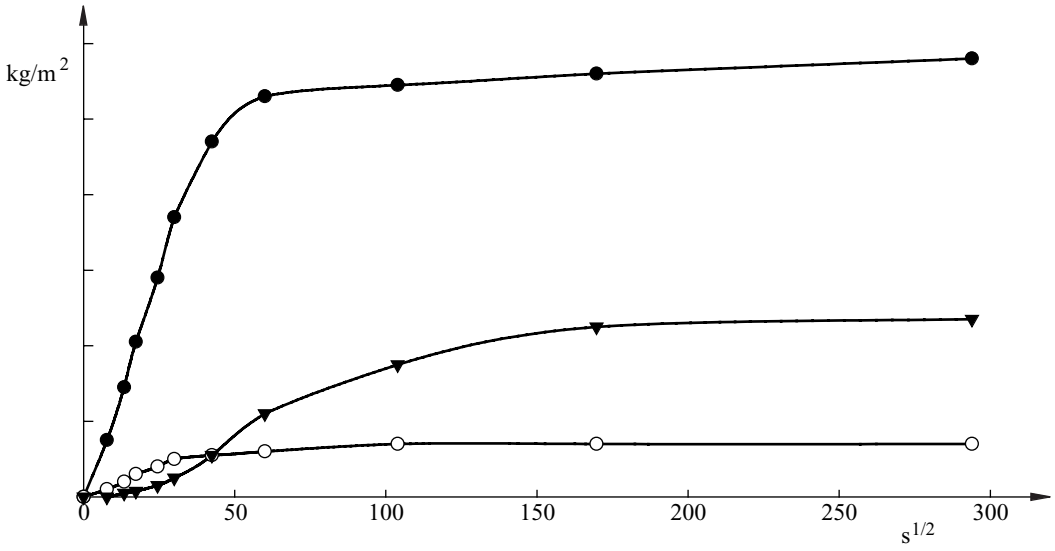
6) capillary water penetration coefficient B and the correlation coefficient of the regression line used for the calculation

k) all deviations from this European Standard and their justification;

l) any additional remarks.

Annex A
(informative)

Example of capillarity curves



Key

untreated
with treatment A
with treatment B

Figure A.1 — Example of curves of capillary water absorption for untreated and treated specimens

NOTE In case of treatment B the calculation of AC is not possible due to the not linear behaviour of the first part of the curve.

Bibliography

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

[2] EN 12440, *Natural stone — Denomination criteria*

[3] EN 12670, *Natural stones — Terminology*

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