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Conservation of cultural heritage — Test methods — Measurement of water absorption by pipe method

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The UK participation in its preparation was entrusted to Technical Committee B/560, Conservation of tangible cultural heritage.

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

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Foreword

This document (EN 16302:2013) has been prepared by Technical Committee CEN/TC 346 “Conservation of cultural heritage”, 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of an identical text or by endorsement, at the latest by August 2013, and conflicting national standards shall be withdrawn at the latest by August 2013.

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Introduction

This test method can be applied if it does not change the value of the cultural property following the ethical code of conservation practice.

This test aims to measure water penetration under pressure analogous to incident rainfall.

1 Scope

This European Standard specifies a method to measure water absorption of porous inorganic materials used for and constituting cultural property by pipe method.

The method may be used on porous inorganic materials which are untreated or have been subjected to any treatment or ageing.

The method may be used both in the laboratory and in situ due to its non destructive nature.

2 Normative references

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

EN 15898:2011, *Conservation of cultural property — Main general terms and definitions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 15898:2011 and the following apply.

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

Note 1 to entry: See EN 15801.

3.2
water absorption by pipe method
amount of water (ml) transferred from the pipe through a defined test area (cm^2) after a fixed time, expressed as ml/cm^2

3.3
specimen
part considered representative of the material constituting an object

Note 1 to entry: The specimen can have different origins and can be taken from:

— materials similar to those constituting the object under study (e.g. stone quarries);

— specifically prepared comparative materials e.g. reference materials;

— available materials from the object.

Note 2 to entry: The number and dimension of the specimens can be different depending on constraints encountered in sampling the required amount of material.

4 Principle

Determination of the amount and rate at which water is absorbed through the test surface that is in contact with water.

5 Symbols and abbreviations

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

h is the height of the water column measured from the centre of the testing area, in mm

d is the internal diameter of the water column, in mm

D is the diameter of the testing area, in cm

t_i is the time to an intermediate i-measurement, in min

t_f is the time to the final measurement, in min

Q_i is the amount of water absorbed at the time t_i , in ml

Q_5 is the amount of water absorbed after 5 minutes, in ml

Q_f is the amount of water absorbed at the final time t_f , in ml

A is the test area, in cm^2

W_i is the amount of absorbed water (ml/cm^2) per unit of surface area, at the time t_i

W_t is the total amount of absorbed water (ml/cm^2) at the time to the final measurement t_f

T is the average ambient temperature, in °C

RH is the relative humidity, in %

6 Test equipment

6.1 General

Typical pipes are made of glass or other transparent material.

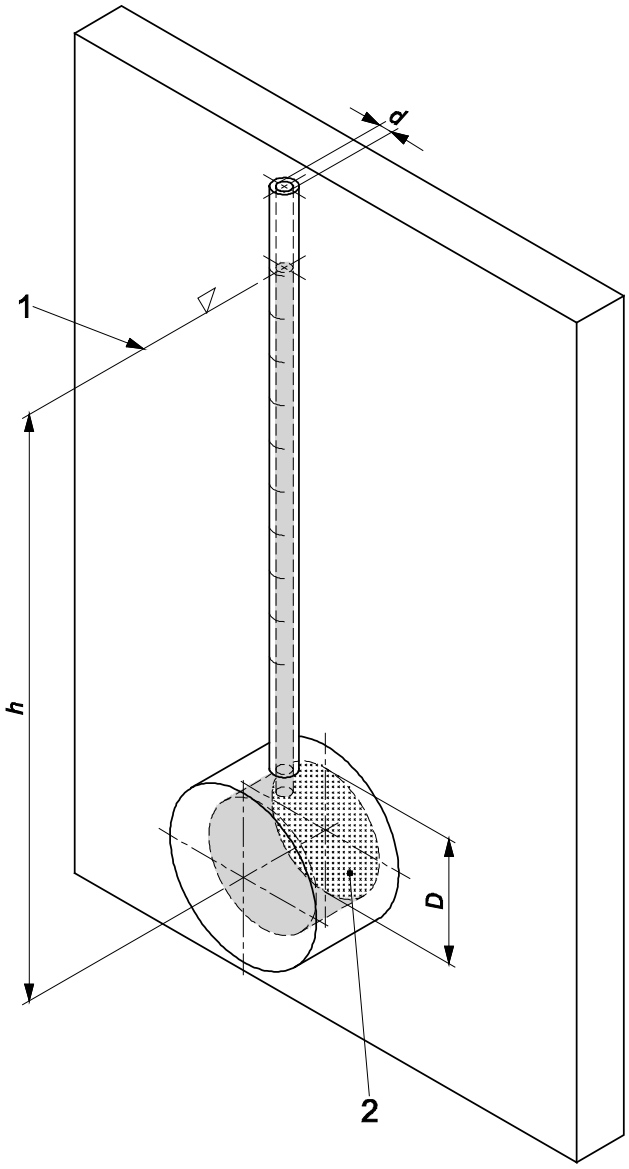
The most common types of pipes are described in Annex A.

Only values obtained with the same type of pipe (identical h, d, D values) can directly be compared.

6.2 Pipe for vertical surfaces (type V)

This type is suitable for measuring the absorption of water through vertical surfaces.

The pipe consists of a graduated tube welded at its lower part on a cylinder cell; it shall be designed so that the graduated tube shows divisions each not greater than 1/50th of the volume of the tube (Figure 1).



Key

1 water level

2 test surface

d internal diameter of the water column, in mm

D diameter of the testing area, in cm

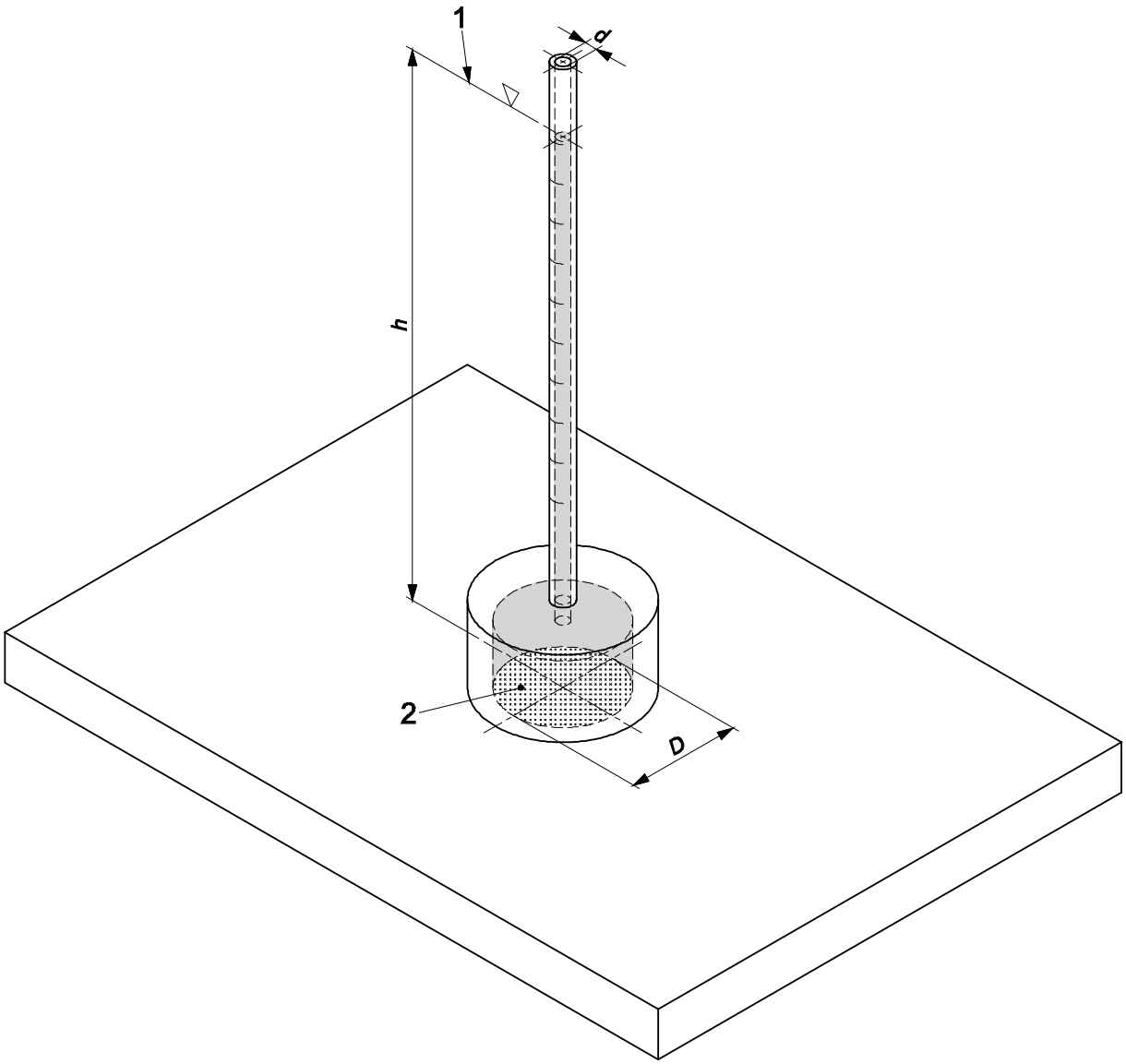
h height of the water column measured from the centre of the testing area, in mm

Figure 1 — Scheme of pipe type for vertical surface

6.3 Pipe for horizontal surfaces (type H)

This type is suitable for measurement of absorption of water through horizontal surfaces.

The pipe consists of a graduated tube welded to its lower part on a cylinder cell; it shall be designed so that the graduated tube shows divisions each not greater than 1/50th of the volume of the tube (Figure 2).



Key

1 water level

2 test surface

d internal diameter of the water column, in mm

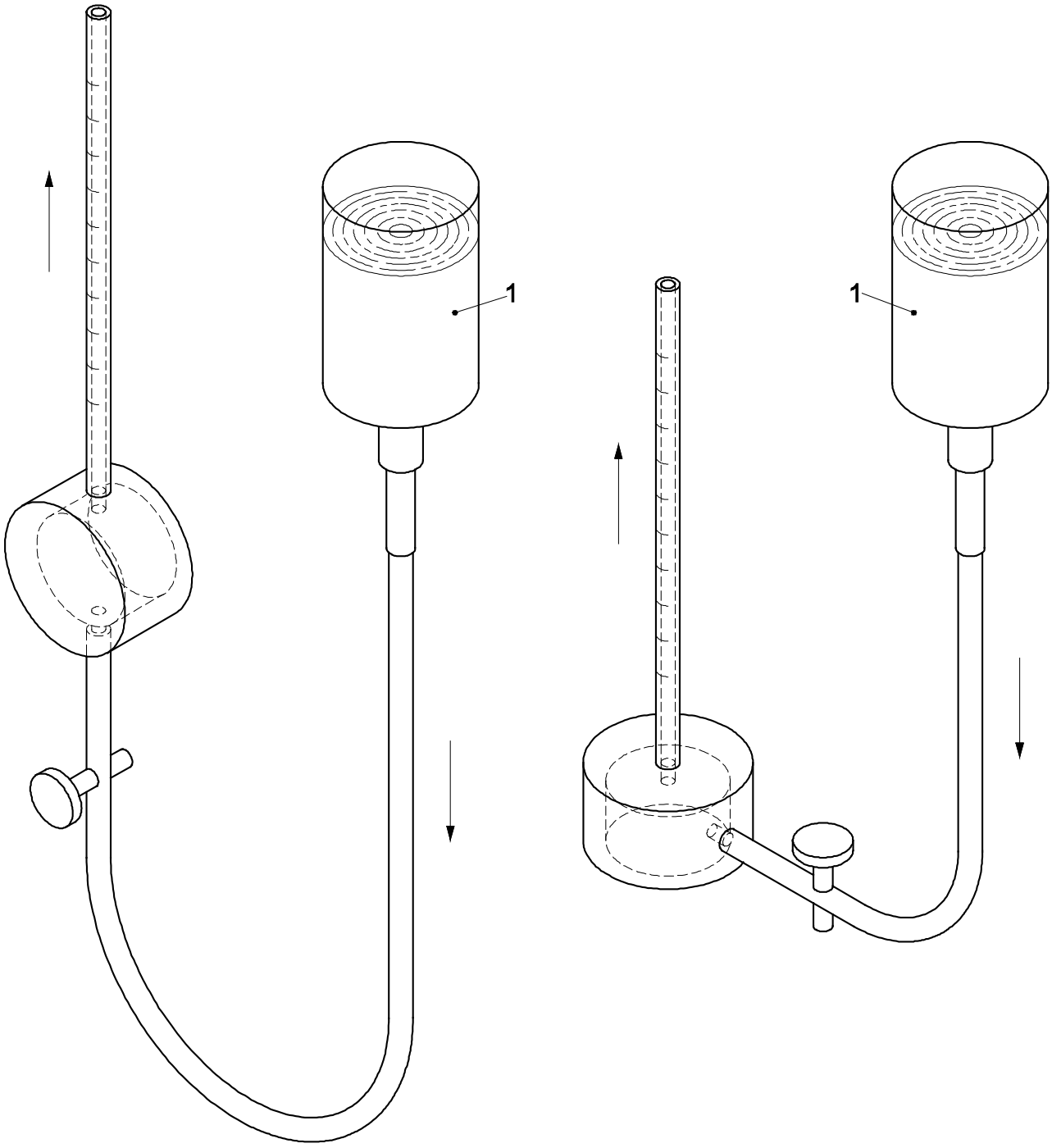
D diameter of the testing area, in cm

h height of the water column measured from the centre of the testing area, in mm

Figure 2 — Scheme of pipe type for horizontal surface

6.4 Water reservoir

The reservoir is connected to the water inlet on the bottom (type V) or on lateral side (type H) of the cell; the connection is secured by a transparent polymeric tube that can be closed by a Hoffman clamp (Figure 3).



Key

1 water

Figure 3 — Scheme of the water supply for types V and H

6.5 Sealing material

This shall be capable of preventing water leakage from the edge of the cell. The sealing materials should not cause any kind of damage/ alteration i.e. staining of the substrate.

6.6 Chronometer

It shall have an accuracy of one second.

7 Experimental conditions

7.1 General

The test surface shall be sufficiently flat and homogeneous, without visible cracks, to assure adhesion without leaks. The surface area of the specimen should not be less than D (Annex A).

The number and dimensions of test surfaces are dependent on the heterogeneity of the material. Each series shall consist of measurements on at least 3 specimens or 3 different surface areas.

In case of anisotropy, each series shall always be tested according to the same orientation.

In case of non homogeneous materials such as mortars containing coarse aggregates, the diameter of the measurement area should be at least three times (and preferably five times) larger than the size of the largest grain.

7.2 “In situ” measurements

The experimental surface should be flat, dry and it should not be exposed to direct solar light or rain during the test. It is recommended to record temperature (T) and relative humidity (RH) close to the test surface.

7.3 Laboratory measurements — Specimen pre-conditioning

The pre-conditioning procedure does not apply to treated specimens, to specimens taken from exposed surfaces, or to in situ measurements.

For laboratory specimens the surface chosen for the determination of water absorption by pipe method shall be flat and wet polished with sand paper. 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 examples gypsum containing materials, only compressed air shall be used.

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 until constant mass is reached.

Constant mass is reached when the difference between two successive weighing at an interval of 24 hours 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 room temperature (23 ±1) °C is reached.

7.4 Test procedure

The pipe is fixed to the test surface by applying a force to the cell (by means of mechanical devices) or by using an appropriate and removable sealing material. Potential staining effects of the sealing shall be tested prior to the measurement procedure.

The pipe is carefully filled with water through the water inlet by opening the Hoffman clamp until “ZERO” level is reached. The absence of air bubbles or leakage must be verified.

Tap water, deionised or distilled water may be used for the test.

The chronometer is then started and the change of water level in the graduated column are recorded over time intervals of between ten seconds and one minute (the interval appropriate depends on the porosity of the measured material).

Subsequent readings should be taken every 5 min until a constant value is reached. If constant value is not reached the experiment shall be stopped after 1 h

8 Expression of the results

8.1 General

Results of the test measurements are presented in the form of a water absorption graph with the volume of water absorbed (Q_i) as a function of time (t_i).

8.2 Calculation of water absorption per unit of surface area W_i, at the time t_i

The amount of water absorbed by the test area (expressed in ml per square centimetre) at time t_i is calculated as follows:

$$W_i = \frac{Q_i}{A}$$

8.3 Calculation of total water absorption per unit of surface area W_f, at time t_f

Total water absorption is the total amount of absorbed water at the time to the final measurement (t_f) per unit area, expressed in ml per square centimetre, calculated as follows:

$$W_i = \frac{Q_f}{A}$$

9 Test report

The test report shall contain 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) for on site measurements the exact location (coordinates) at which the test was carried out;

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

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

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

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

i) the type of pipe used and the diameter of the measurement area;

j) the set of time intervals and the duration of the test;

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

1) Q_i values and the time intervals t_i;

2) the graph of W_i as a function of t_i;

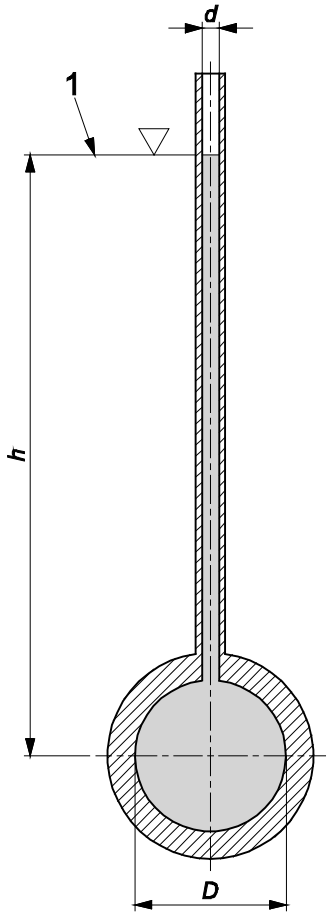
3) the total water absorption W_f;

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

m) any additional remarks (including T and RH during measurement).

Annex A
(informative)

Common types of pipes



Key

1 water level

d internal diameter of the water column, in mm

D diameter of the testing area, in cm

h height of the water column measured from the centre of the testing area, in mm

Figure A.1 — Common types of pipes

A.1 TYPE “V1” - KARSTEN TUBE

D = 27 ± 1 mm

d = 8 ± 0,5 mm

h = 98 ± 1 mm

Test Area: 5,7 cm^2

A.2 TYPE "V2" - "Large surface for heterogeneous materials"

D = 47 ± 1 mm

d = 8 ± 0,5 mm

h = 138 ± 1 mm

Test Area: 17,35 cm^2

A.3 TYPE "V3" - "Italian pipe"

D = 35 ± 1 mm

d = depending on the volume of the column (made with standard laboratory pipettes):

— 0,2 ml (subdivision 0,001) i.d. 1,1 mm

— 1,0 ml (subdivision 0,01) i.d. 2,5 mm

— 5,0 ml (subdivision 0,1) i.d. 5,5 mm

— 10,0 ml (subdivision 0,1) i.d. 7,8 mm

h = 210 ± 1 mm

Test Area: 9,6 cm^2

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