BS EN 14066:2013

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Natural stone test methods — Determination of resistance to ageing by thermal shock

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee B/545, Natural stone.

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

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Natural stone test methods - Determination of resistance to ageing by thermal shock

Méthodes d'essai pour les pierres naturelles - Détermination de la résistance au vieillissement accéléré par choc thermique

Prüfverfahren für Naturstein - Bestimmung des Widerstandes gegen Alterung durch Wärmeschock

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Foreword

This document (EN 14066:2013) 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of an identical text or by endorsement, at the latest by September 2013, and conflicting national standards shall be withdrawn at the latest by September 2013.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 14066:2003.

The following modifications have been made:

— The new standard requires the evaluation of the produced decay through both non-destructive and destructive methods.

— Specimens' dimensions have been modified.

— The normative references have been updated.

Test methods for natural stone consist of the following European Standards:

— EN 1925, *Natural stone test methods – Determination of water absorption coefficient by capillarity*

— EN 1926, *Natural stone test methods – Determination of uniaxial 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 crystallisation*

— EN 12371, *Natural stone test methods – Determination of frost resistance*

— EN 12372, *Natural stone test methods – Determination of flexural strength under concentrated load*

— EN 12407, *Natural stone test methods – Petrographic examination*

— EN 13161, *Natural stone test methods – Determination of flexural strength under constant moment*

— EN 13364, *Natural stone test methods – Determination of the breaking load at dowel hole*

— EN 13373, *Natural stone test methods – Determination of geometric characteristics on units*

— EN 13755, *Natural stone test methods – Determination of water absorption at atmospheric pressure*

— EN 14146, *Natural stone test methods – Determination of the dynamic modulus of elasticity (by measuring the fundamental resonance frequency)*

— EN 14147, *Natural stone test methods – Determination of resistance to ageing by salt mist*

— EN 14157, *Natural stone test methods – Determination of the abrasion resistance*

— EN 14158, *Natural stone test methods – Determination of rupture energy*

— EN 14205, *Natural stone test methods – Determination of Knoop hardness*

— EN 14231, *Natural stone test methods – Determination of the slip resistance by means of the pendulum tester*

— EN 14579, *Natural stone test methods – Determination of sound speed propagation*

— EN 14580, *Natural stone test methods – Determination of static elastic modulus*

— EN 14581, *Natural stone test methods – Determination of linear thermal expansion coefficient*

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

1 Scope

This European Standard specifies a method to assess possible changes of natural stones under the effect of sudden changes in temperature (thermal shock).

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

EN 12372, *Natural stone test methods – Determination of flexural strength under concentrated load*

EN 12670:2001, *Natural stone – Terminology*

EN 14146, *Natural stone test methods – Determination of the dynamic modulus of elasticity (by measuring the fundamental resonance frequency)*

EN 14579, *Natural stone test methods – Determination of sound speed propagation*

3 Terms and definitions

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

4 Symbols and abbreviations

F_r Flexural strength tested on the reference specimens, in MPa

F_f Flexural strength tested on the specimens subjected to thermal cycles, in MPa

ΔF Change in flexural strength between reference and exposed specimens, in %

E_0 Dynamic elastic modulus of the specimens before the thermal cycles, in MPa

E_f Dynamic elastic modulus of the specimens after the thermal cycles, in MPa

ΔE Change in dynamic elastic modulus of the specimen, in %

ρ_0 Open porosity before the test, in %

ρ_f Open porosity after the test, in %

$\Delta\rho$ - Change in open porosity of the specimen, in %

v_0 Ultrasound pulse velocity (UPV) before the test, in km/s

v_f Ultrasound pulse velocity (UPV) after the test, in km/s

Δv Change in Ultrasound pulse velocity of the specimen, in %

5 Principle

After drying at (40 ± 5) °C for a week, the specimens are subjected to successive cycles, each formed by drying at (70 ± 5) °C followed by immediate immersion in water at (20 ± 5) °C.

The potential strength loss is measured according to EN 12372. Exposed specimens and, when relevant, changes in other physical and mechanical properties are measured by one or more of the following non-destructive tests: dynamic elastic modulus (E_0) according to EN 14146, UPV (v_0) according to EN 14579, and open porosity (ρ_0) according to EN 1936, performed on specimens before and after the thermal cycles.

6 Apparatus

6.1 A ventilated oven capable of maintaining a temperature of (70 ± 5) °C.

6.2 A covered tank with a flat base, comprising small non-oxidising and non-absorbent supports for the specimens.

6.3 A weighing instrument with an accuracy of at least 0,01 % of the mass to be weighed.

7 Preparation of specimens

7.1 Sampling

The sampling is not the responsibility of the test laboratory except where specially requested.

At least 20 specimens shall be selected from a homogeneous batch: a set of 10 specimens as references for flexural strength measurement of fresh material and the other set for the thermal cycles.

7.2 Dimensions of the test specimens

The dimensions of the specimens shall be in accordance with EN 12372, i.e. determined by their thickness.

— the thickness shall be between 25 mm and 100 mm and shall be greater than twice the size of the largest grain in the stone;

— the total length shall be equal to six times the thickness;

— the distance between the supporting rollers shall be equal to five times the thickness;

— the width shall be between 50 mm and three times the thickness and in no case shall it be less than the thickness.

7.3 Putting reference marks on the specimens

To ensure that the measurements of the dynamic elastic modulus or of the ultrasound pulse velocity performed before and after the thermal shock test are done at the same points, indelible marks in the form of points are made on the relevant faces of the specimens, to show the location of emitter and receiver.

Indelible lines are traced to show the location of the axis of the two supports on which the specimens will be placed during the determination of the dynamic elastic modulus and the UPV.

7.4 Drying the specimens

The specimens are dried in a ventilated oven at (40 ± 5) °C for one week and then cooled to ambient temperature (20 ± 5) °C before start of the cycles.

8 Test procedure

8.1 Control measurements before cycling

Before cycling, depending on the test chosen to evaluate the change in performance, the specimens subjected to cycles are measured according to one or more of the non-destructive tests: dynamic elastic modulus (E_0) according to EN 14146, UPV (v_0) according to EN 14579, and open porosity (ρ_0) according to EN 1936.

8.2 Description of the cycles

The dried specimens are subjected to changes of temperature according to the following procedure: (18 ± 1) h in a ventilated oven at (70 ± 5) °C; immediately followed by (6 ± 0,5) h completely submerged in tap water, whose temperature before the immersion of the specimens is (20 ± 5) °C.

Both in the oven and in the water container, the specimens are placed on the supports at a distance of at least 50 mm from one another and from the wall. In the water container, the specimens are placed on supports located at the bottom of the container which has been filled with tap water to such a height that the water level above the specimens is (60 ± 10) mm. The procedure described above constitutes one cycle. If the test is to be interrupted at any time, other than for testing, then the specimens are to be immersed in water at (20 ± 5) °C.

8.3 Control measurements after cycling

After the 20th cycle the specimens are dried to constant mass at (70 ± 5) °C. Constant mass is reached when the difference between two weighing at an interval of (24 ± 2) h is not greater than 0,1 % of the first of the two masses. Then they are visually inspected and compared with the reference specimens. All alterations are recorded.

One or more of the non-destructive tests are performed: the dynamic elastic modulus (E_f) according to EN 14146, the UPV (v_f) according to EN 14579, and/or the open porosity (ρ_f) according to EN 1936.

Finally, the flexural strength test is performed according to EN 12372, on the dried references specimens and on the specimens subjected to thermal cycles.

9 Expression of results

9.1 Visual appearance

Describe the modifications observed visually by comparison with the reference specimen, such as:

— cracking;

— scaling or exfoliation.

9.2 Modulus of elasticity

Calculate the change in dynamic elastic modulus to the nearest 0,1 % according to Formula (1):

$$\Delta E = \frac{E_f - E_0}{E_0} \times 100 \quad (1)$$

9.3 Open porosity

Calculate the change in open porosity to the nearest 0,1 % according to Formula (2):

$$\Delta \rho = \frac{\rho_f - \rho_0}{\rho_0} \times 100 \quad (2)$$

9.4 Ultrasound pulse velocity

Calculate the change in ultrasound pulse velocity to the nearest 0,1 % according to Formula (3):

$$\Delta v = \frac{v_f - v_0}{v_0} \times 100 \quad (3)$$

9.5 Flexural strength

Measure the flexural strength on dried reference and exposed specimens. The percentage change in flexural strength (ΔF) is calculated as follows:

$$\Delta F = \frac{F_f - F_r}{F_r} \times 100 \quad (4)$$

10 Test report

The test report shall contain the following information:

a) unique identification number of this report, i.e. EN 14066:2013;

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 it is different from the test laboratory;

d) the name and address of the client;

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

   1) the petrographic name of the stone;

   2) the commercial name of the stone;

   3) the country and region of extraction;

   4) the name of the supplier;

   5) 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;

   6) the name of the person or organisation which carried out the sampling;

7) 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) any observed alteration for each specimen;

k) the percentage change in dynamic elastic modulus for each specimen and the mean percentage change in dynamic elastic modulus (if performed);

l) the percentage change in UPV for each specimen and the mean (if performed);

m) the percentage change in open porosity for each specimen and the mean (if performed);

n) the mean percentage change in flexural strength;

o) a statement on measurement uncertainty (where appropriate);

p) any deviations from the standard and their justification;

q) 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.

Bibliography

[1] EN 12407, *Natural stone test methods – Petrographic examination*

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