BRITISH STANDARD

BS EN
14617-11:2005

Agglomerated stone — Test methods —

Part 11: Determination of linear thermal expansion coefficient

The European Standard EN 14617-11:2005 has the status of a British Standard

ICS 91.100.15

BSI
British Standards

National foreword

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The UK participation in its preparation was entrusted to Technical Committee B/545, Natural stone, which has the responsibility to:

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English version

Agglomerated stone - Test methods - Part 11: Determination of linear thermal expansion coefficient

Pierre agglomérée - Méthodes d'essai - Partie 11: Détermination du coefficient linéaire de dilatation thermique

Künstlich hergestellter Stein - Prüfverfahren - Teil 11: Bestimmung des linearen thermischen Ausdehnungskoeffizienten

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Contents

Foreword

This document (EN 14617-11:2005) 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of an identical text or by endorsement, at the latest by September 2005, and conflicting national standards shall be withdrawn at the latest by September 2005.

Test methods for agglomerated stones consist of the following:

EN 14617-1, *Agglomerated stone - Test methods – Part 1: Determination of apparent density and water absorption*

EN 14617-2, *Agglomerated stone – Test methods – Part 2: Determination of flexural strength (bending)*

prEN 14617-3, *Agglomerated stone - Test methods – Part 3: Determination of slipperiness*

EN 14617-4, *Agglomerated stone - Test methods – Part 4: Determination of the abrasion resistance*

EN 14617-5, *Agglomerated stone - Test methods – Part 5: Determination of freeze and thaw resistance*

N 14617-6, *Agglomerated stone - Test methods – Part 6: Determination of thermal shock resistance*

prEN 14617-7, *Agglomerated stone – Test methods – Part 7: Determination of ageing*

prEN 14617-8, *Agglomerated stone – Test methods – Part 8: Determination of resistance to fixing (dowel hole)*

EN 14617-9, *Agglomerated stone - Test methods – Part 9: Determination of impact resistance*

EN 14617-10, *Agglomerated stone – Test methods – Part 10: Determination of chemical resistance*

EN 14617-11, *Agglomerated stone – Test methods – Part 11: Determination of linear thermal expansion coefficient*

EN 14617-12, *Agglomerated stone – Test methods – Part 12: Determination of dimensional stability*

EN 14617-13, *Agglomerated stone – Test methods – Part 13: Determination of electrical resistivity*

prEN 14617-14, *Agglomerated stone – Test methods – Part 14: Determination of surface hardness*

EN 14617-15, *Agglomerated stone – Test methods – Part 15: Determination of compressive strength*

EN 14617-16, *Agglomerated stone – Test methods – Part 16: Determination of dimensions, geometric characteristics and surface quality of modular tiles*

prEN 14617-17, *Agglomerated stone – Test methods – Part 17: Determination of biological resistance*

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1 Scope

The present document specifies a test method to determine the linear thermal expansion coefficient of agglomerated stones used for internal/external flooring or walling in building.

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.

Not applicable.

3 Principle

The principle of the determination of the linear thermal expansion coefficient consists of measuring the variation in length of a sample of agglomerated stone during a temperature change. The temperature change is achieved by heating or cooling the sample through a programmed cycle. A suitable dilatometer measures the expansion or the shrinkage of the sample, relatively to the initial length.

4 Symbols and definitions

α = linear thermal expansion coefficient of the material ($°C^{-1}$)

L_o = length of the test sample at any initial temperature (mm)

ΔL = expansion or shrinkage of the sample during heating/cooling in a temperature range (mm)

ΔT = temperature range over which the change in length of the sample is measured (°C)

5 Apparatus

5.1 A dilatometer consisting of a frame holding the expansion sensor, the sample holder and the moving slide for the furnace shift.

5.2 A furnace, compatible with the moving slide of the dilatometer and governed by a personal computer, able to cover a temperature range between room temperature and at least +150 °C.

5.3 A measuring system consisting of a sample holder and a push rod, used to transfer the length change of the material out of the heated zone to the connected measuring device.

5.4 A temperature sensor that measures the temperature directly in contact with the sample.

5.5 A personal computer connected to the instrument for the data acquisition and elaboration.

5.6 A manual linear measuring device with an accuracy of 0,05 mm.

6 Dimensions of the specimens

The shape and dimensions of the test specimen must be suitable for the dimensions of the dilatation sample holders. A length of the specimen not smaller than 10 mm is necessary to get sufficient representativeness for agglomerated stones with maximum grit size up to 6 mm. For samples of agglomerated stone materials with maximum grit size between 2 mm and 6 mm the measure has to be repeated on at least three different samples in

order to guarantee the reproducibility of the specimen for the full size mass. For samples of agglomerated stone materials with maximum grit size over 6 mm see Annex A (Theoretical determination).

7 Test procedure

7.1 Definition of the temperature range

The linear thermal expansion coefficient of a material is an average value and must be determined in a linear region. Agglomerated stones bound by resins and cement/resin mixture, due to the fact that most of the polymers used in the manufacture of agglomerated stones shows a glass transition temperature in the range of 55-75 °C (information available from the suppliers), do not exhibit a linear thermal expansion behaviour in this glass transition range, the linear thermal expansion coefficient of such agglomerated stones shall be therefore evaluated in the temperature ranges respectively below and/or above this transition temperature.

A practical linear thermal expansion coefficient of the material inside the whole tested temperature interval (20-130) °C can be considered as the average of the two values experimentally determined in the proper temperature ranges.

7.2 Definition of the temperature change program

The rate of the temperature increase or decrease does not affect the linear thermal expansion coefficient, within the limits usually supported by the manufacturer of the dilatometer. Normally the cooling rate can not be guaranteed by the instrument due to the different testing conditions.

7.3 Determination of the α value

The value of α shall be determined during both the heating and cooling phases. If also after several cycles these values do not coincide (due to resin cross-linking after-effects), the two different values must be specified in the test report with the information concerning the phase where they have been determined.

7.4 Preparation of the specimens

Cut the specimen in the suitable length and assure that the bearing surfaces be perfectly planar, in case treating them with an abrasive paper. Make a measurement of the length of the specimen by a manual linear measuring device with an accuracy of 0,05 mm. Put the sample in the holder and locate the temperature sensor in contact with the sample.

7.5 Setting of the instrument

Follow the calibrating operation of the instrument (zero point) according to the procedure specified by the instrument manufacturer. Move the furnace on the moving slide until the centre of the furnace corresponds to the position of the sample.

7.6 Heating program

7.6.1 Give the start up to the program previously prepared in the PC. When the heating program is concluded it is possible to remove the furnace from the sample in order to speed up the cooling phase. The recommended operative conditions are:

7.6.2 Heating phase from room temperature up to 130 °C at 3 °C/min.

7.6.3 Cooling phase from 130 °C down to room temperature with a speed rate depending from the testing conditions.

7.6.4 These operations must be repeated until the PC registration shows the starting lengths of the sample and the final length (at the same temperature) coincide.

7.7 Determination of α

The determination of α shall be made when the sample final length is equal to the starting length: the temperature range normally used for the determination of α is 30 to 60 °C.

8 Expression of the results

The linear thermal expansion coefficient of a material is obtained by the following formula:

$$\alpha = \Delta L / (L_o \times \Delta T)$$

and is usually expressed in $10^{-6}°C^{-1}$ to the first decimal.

9 Test report

The test report shall contain the following information:

a) unique identification number for the report;

b) number, title and date of issue of this document;

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

d) name and address of the client;

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

- name of the supplier;
- name of the person or organization which carried out the sampling;
- surface finish of the specimens (if relevant to the test);
- nature of the binders

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

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

h) number of specimens in the sample;

i) dimensions of the specimens;

j) heating/cooling rates used;

k) results of the measurements and if they have been obtained experimentally or theoretically;

l) interval of temperature where the measure has been determined;

m) if the measure has been obtained in the heating or in the cooling phase if they are different from each other;

n) all deviations from this standard and their justification;

o) remarks.

The test report shall contain the signature(s) and role(s) of those 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 written agreement of the test laboratory.

Annex A
(normative)

Theoretical determination of α

A.1 Principle

This test is a reference method to be used to calculate theoretically the linear thermal expansion coefficient of agglomerated stones containing big size grits (> 6 mm).

A.2 Theoretical determination of α

When the size grits is > 6 mm the small size of the sample for the experimental determination of α by common dilatometers cannot ensure the reproducibility of the test specimen respect to the whole agglomerated stone batch.

In this case it is possible to calculate with a reliable accuracy the linear thermal expansion coefficient of the material through the following equation:

$$\alpha = \alpha_f \times V_f + \alpha_p \times V_p$$

where

α_f and α_p are the expansion coefficients of the fillers and grits contained in the agglomerated stone material and of the binders respectively

V_f and V_p are the average volume fraction of aggregates and fillers and of the binders respectively.

The values of α_f and α_p are available from either specific literature or technical data sheets of the agglomerated stone manufacturer. The values of V_f and V_p are available from the manufacturers of the agglomerated stones (or experimentally in the case of pure resin as binder by a mass loss determination at 600 °C in air).

A.3 Test report

The test report shall contain the following information:

a) unique identification number for the report;

b) number, title and date of issue of this document;

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

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- name of the supplier;

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

- surface finish of the specimens (if relevant to the test);

- nature of the binders

- remarks

The test report shall contain the signature(s) and role(s) of those 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 written agreement of the test laboratory.

Bibliography

EN 12440, *Natural stone - Denomination criteria*

EN 14618 *Agglomerated stone- Terminology and classification*

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