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Utgåva 1

Provningsmetoder för natursten – Bestämning av värmeutvidgningskoefficient

Natural stone test methods – Determination of linear thermal expansion coefficient

ICS 73.020; 91.100.15

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EUROPEAN STANDARD

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English version

Natural stone test methods - Determination of linear thermal expansion coefficient

Méthodes d'essai pour pierres naturelles - Détermination du coefficient linéaire de dilatation thermique

Prüfverfahren für Naturstein - Bestimmung des linearen thermischen Ausdehnungskoeffizienten

This European Standard was approved by CEN on 12 November 2004.

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Contents

Foreword

This document (EN 14581:2004) 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of an identical text or by endorsement, at the latest by June 2005, and conflicting national standards shall be withdrawn at the latest by June 2005.

This final draft document is one of the series of documents for tests on natural stone.

Test methods for natural stone consist of the following parts:

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

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 crystallisation*

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 13919, *Natural stone test methods – Determination of resistance to ageing by SO_2 action in the presence of humidity*

EN 14066, *Natural stone test methods – Determination of resistance to ageing by thermal shock*

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

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

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

prEN 14580, *Natural stone test methods – Determination of the 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, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This document specifies two methods to determine the linear thermal expansion coefficient of natural stone, respectively based on mechanical length-change measurements (Method A) or on the use of bonded electric strain gauges (Method B).

2 Normative references

Not applicable.

3 Principle

After drying to constant mass, the specimen is subjected to length measurement in a direction “i” whilst maintaining at least two different temperatures. The linear coefficient of thermal expansion between the extreme temperatures is expressed as the unitary change in length for a change of temperature of 1 °C.

4 Symbols

ℓ_{s20}	Initial length of the specimen at a temperature of (20 ± 0,5) °C in mm.
ℓ_{s80}	Final length of the specimen at a temperature of (80 ± 0,5) °C in mm.
$\Delta\ell_s = (\ell_{s80} - \ell_{s20})$	Change of length of the specimen in mm. If $\Delta\ell_s$ is positive, represents an expansion. If negative, a shrinkage (Note 1).
ℓ_{r20}	Initial length of the reference sample at a temperature of (20 ± 0,5) °C in mm.
ℓ_{r80}	Final length of the reference sample at a temperature of (80 ± 0,5) °C in mm.
$\Delta\ell_r = (\ell_{r80} - \ell_{r20})$	Change of length of the reference sample in millimetres.
ΔT	(60 ± 1) °C, the change in the temperature from (20 ± 0,5) °C to (80 ± 0,5) °C.
ε_r	Unitary linear thermal expansion of the reference sample in 10^{-6} (mm/mm).
$\varepsilon_{si} = \frac{\Delta\ell_s}{\ell_{s20}}$ (mm/mm).	Unitary linear thermal expansion of the specimen in the direction “i” in 10^{-6}
$\varepsilon_{s1}, \varepsilon_{s2}, \varepsilon_{s3}$	Unitary linear thermal expansion of the specimen along three orthogonal directions in 10^{-6} (mm/mm).
α_r	Linear coefficient of thermal expansion of the reference sample in $°C^{-1}$.
α_i	Linear coefficient of thermal expansion of the specimen in the direction "i" in $°C^{-1}$.
$\alpha_1, \alpha_2, \alpha_3$	Linear coefficients of thermal expansion of the specimen along three orthogonal directions, in $°C^{-1}$.

NOTE 1 Due to rock anisotropy, the coefficient of thermal expansion can change with the direction in which the measurement is carried out. In some cases the coefficient of thermal expansion can be negative in some directions and positive in other ones.

NOTE 2 The coefficient of thermal expansion is not linear with the temperatures. The temperature range in this document is (20 to 80) °C, and it will be assumed that α_i is linear in this range. If the linearity of the thermal expansion coefficient need to be evaluated, intermediate measurements at different temperature will need to be made and plotted on a graph.

5 Apparatus

5.1 A ventilated oven capable of raising the temperature from (20 ± 0,2) °C to (80 ± 0,2) °C at a rate of 0,5 °C/min and maintaining temperatures within that range for at least two hours with an accuracy of at least ± 0,5 °C.

5.2 (For Method A) A mechanical measuring device (dilatometer), with an accuracy of at least 1/100 000 of the measuring length (see Figure 1), any other device able to measure length-changes within the given accuracy (e.g. electronic dilatometers).

5.3 (For Method B) A strain gauge measuring device, containing the following parts (see Figure 2):

5.3.1 Strain gauges suitable to be used within the foreseen temperature range.

NOTE Strain gauges should be chosen according to their manufacturer's specifications and test laboratory experience. Strain gauge length should be at least 8 times the maximum grain size of the rock to be tested. In the case of exceptionally large grains, this length could be 3 times the maximum grain size.

5.3.2 A measuring device consisting of an electrical bridge (Wheatstone bridge) and a signal amplifier, with at least four measuring channels. The accuracy of the device shall be at least 5×10^{-6} (mm/mm).

Inner resistances in the electrical bridge shall be fixed to a granite rock or similar one for compensating temperatures.

5.4 A calibrated reference sample, with a known coefficient of thermal expansion within test temperature range (20 to 80) °C.

A reference sample could be made of different materials with low thermal expansion coefficient (invar steel, etc).

It shall have a length twice the length of strain gauges and a minimum cross section of 50 mm x 50 mm.

5.5 A temperature measuring device (e.g. a thermocouple) with an accuracy of at least 0,2 °C.