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Agglomerated stone — Test methods

Part 2: Determination of flexural strength (bending)

National foreword

This British Standard is the UK implementation of EN 14617-2:2016. It supersedes BS EN 14617-2:2008 which is withdrawn.

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

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Pierre agglomérée - Méthodes d'essai - Partie 2: Détermination de la résistance à la flexion (traction)

Künstlich hergestellter Stein - Prüfverfahren - Teil 2: Bestimmung der Biegefestigkeit (Schwenkbiegen)

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European foreword

This document (EN 14617-2:2016) 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of an identical text or by endorsement, at the latest by December 2016, and conflicting national standards shall be withdrawn at the latest by December 2016.

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 14617-2:2008.

Clauses 2, 6.1, 6.2.2, 7 and 9 have been modified and old 6.23 "Tolerance" has been deleted since the last edition of this European Standard.

This European Standard is one of a series of standards for test methods for agglomerated stones which includes the following parts:

— *Part 1: Determination of apparent density and water absorption*

— *Part 2: Determination of flexural strength (bending)*

— *Part 4: Determination of the abrasion resistance*

— *Part 5: Determination of freeze and thaw resistance*

— *Part 6: Determination of thermal shock resistance*

— *Part 8: Determination of resistance to fixing (dowel hole)*

— *Part 9: Determination of impact resistance*

— *Part 10: Determination of chemical resistance*

— *Part 11: Determination of linear thermal expansion coefficient*

— *Part 12: Determination of dimensional stability*

— *Part 13: Determination of electrical resistivity*

— *Part 15: Determination of compressive strength*

— *Part 16: Determination of dimensions, geometric characteristics and surface quality of modular tiles*

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1 Scope

This European Standard specifies a method for the determination of flexural strength under a concentrated load (breaking resistance) of agglomerated stone flat products.

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

3 Principle

The principle of this method is to place a specimen on two rollers and progressively load the specimen in the middle. The breaking load is measured and the flexural strength calculated.

4 Symbols

For the purposes of this document, the following symbols apply.

R_{tf} flexural strength, (MPa)

F breaking load, (Newtons)

l distance between the supporting rollers, in millimetres

b width of the specimen adjacent to the plane of fracture, in millimetres

h thickness of the specimen adjacent to the plane of fracture, in millimetres

L total length of the specimen, in millimetres

5 Apparatus

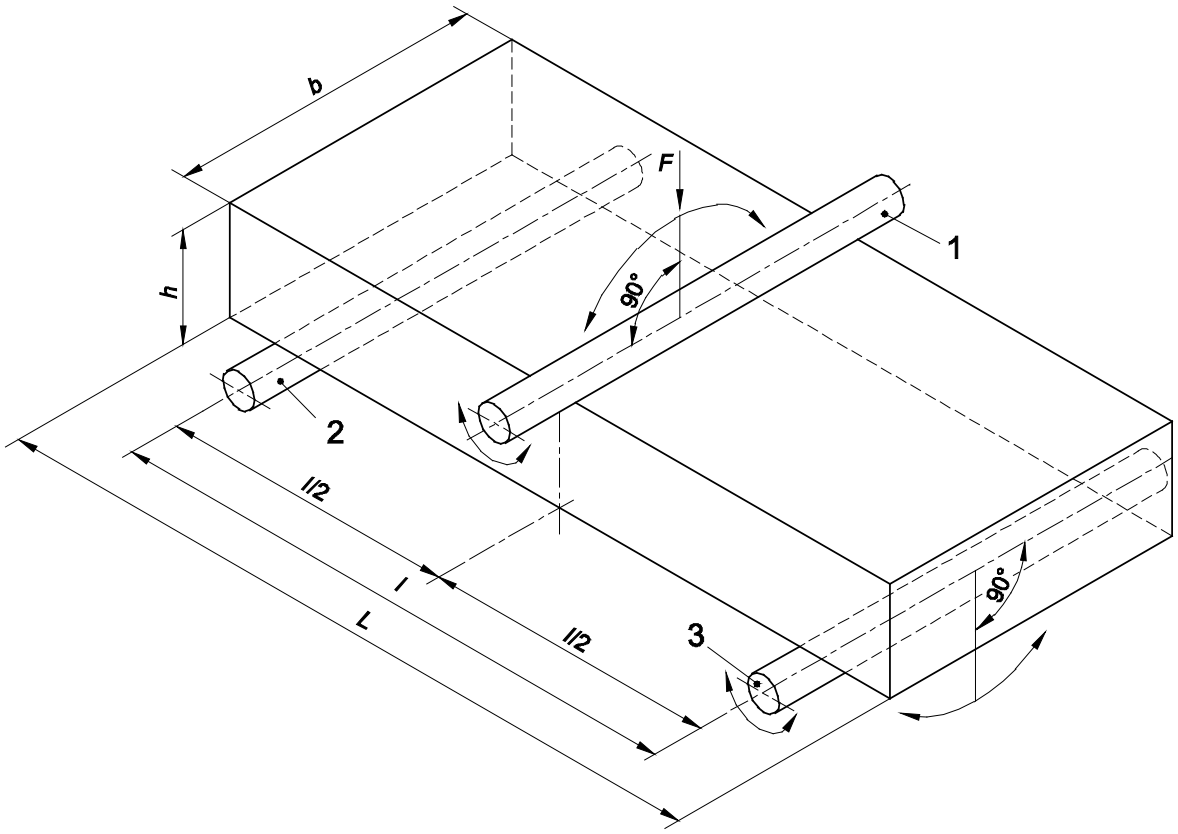
5.1 Balance capable of weighing the specimen with a precision within 0,01 % of the mass of the specimen.

5.2 Ventilated oven capable of maintaining (40 ± 5) °C.

5.3 Linear measuring device with an accuracy of 0,05 mm.

5.4 Testing machine of appropriate force, in accordance with EN 12372 and calibrated according to this standard.

5.5 Device for applying loads on the specimen by a centre-point load. It consists of two lower rollers (supporting rollers) and one upper roller (load-applying roller) which shall be centred exactly in the middle between the two supporting rollers (see Figure 1). The distance between the two supporting rollers shall be reported as requested in 7.



Key

1 loading roller

2 supporting roller

3 supporting roller

Figure 1 — Arrangement of loading of test specimen (centre-point loading)

5.6 Room which can be maintained at (20 ± 5) °C.

6 Preparation of the specimens

6.1 Sampling

The sampling is not the responsibility of the test laboratory except when specially requested. At least ten specimens shall be selected from a homogeneous batch (see also 6.2.3).

6.2 Test specimens

6.2.1 Surface finish

As a standard reference, the surface finish of the faces of the specimens shall be sawn, honed or polished. In case of necessity to test specimens with other surface finishes (e.g. flamed, sandblasted etc.) as required for application, this may be done. The surface intended for use shall be in contact with the two supporting rollers (facing downwards), when the backside face is not perfectly planar. In all other cases the surface intended for use shall be in contact with the upper roller. In any case the kind of surface finish shall be stated in the report.

6.2.2 Dimensions of the specimens for type testing and for factory production control

For type testing and for factory production control:

— the thickness *h* shall be the one forecast for the final product;

— the total length *L* shall be at least (200 ± 0,3) mm;

— the width *b* shall be at least (50 ± 0,3) mm and in no case it shall be less than the thickness.

6.2.3 Conditioning before testing

The specimens shall be conditioned at room temperature (20 ± 5) °C for (24 ± 2) h.

For agglomerated stones with cement or cement and polymer as binder the specimens shall be dried at (40 ± 5) °C to a constant mass.

Constant mass is reached when the difference between two weighings carried out (24 ± 2) h apart is no greater than 0,1 % of the first of the two masses.

After drying and prior to testing the specimens shall be stored at (20 ± 5) °C until the thermal equilibrium is reached. After that the test shall be performed within 24 h.

7 Test procedure

Wipe the surface of the rollers clean and remove any loose grits from the faces of the specimen that will be in contact with the rollers.

The width and the thickness of the specimen are measured and the dimensions are expressed in millimetres to the nearest 0,1 mm.

The specimen is placed centrally on the supporting rollers (see Figure 1). The loading roller is placed in the middle of the specimen.

The load is increased uniformly at a rate of (0,25 ± 0,05) MPa/s until the specimen breaks. Note the breaking load at least to the nearest 10 N and also the place where the fracture occurs**.**

Where the loading rate (*V*) is needed in N/s the following formula can be used to determine the required rate in N/s:

$$V = 2 \times a \times b \times h^2 / 3l \left(N/s\right) \tag{1}$$

where

a is the rate, in MPa/s;

h is the thickness forecast for the final product;

L is the total length, at least (200 ± 0,3) mm;

l is the distance between the supporting rollers, which is always (20 ± 1) mm shorter than the total length *L*;

b is the width, at least (50 ± 0,3) mm and in no case it is less than the thickness.

8 Expression of the results

The flexural strength R_{tf} of each specimen is calculated using the formula:

$$R_{tf} = \frac{3FI}{2bh^2} \tag{2}$$

The result shall be expressed in Megapascals to the nearest 0,1 MPa.

If the fracture is situated more than 15 % of the distance between the supporting rollers from the middle of the specimen and/or flaws are present (veins, fissures, etc.) the test shall be repeated.

9 Test report

The test report shall contain the following information:

a) unique identification number of the report;

b) number, title and date of issue of this European Standard;

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

d) commercial name of the product;

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

f) date of delivery of the sample 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) the result expressed as the mean value $\overline{R}_{tf}$ of the flexural strength and the standard deviations, in Megapascal to the nearest 0,1 MPa;

k) all deviations from the standard and their justification;

l) remarks.

The test report shall contain the signature(s) and the 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 written consent of the test laboratory.

Annex A
(normative)

Statistical evaluation of tests results

A.1 Scope

This annex establishes a method for the statistical treatment of test results obtained following the agglomerated stone test method described in this standard.

A.2 Symbols and definitions

Measured values $x_1, x_2, .. x_i .., x_n$

Number of measured values n

Mean value $\bar{x} = \frac{1}{n}\sum_i x_i$

Standard deviation $s = \pm\sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$

Coefficient of variation $v = \frac{s}{x}$ (for individual values)

Logarithmic Mean $\bar{x}_{\ln} = \frac{1}{n}\sum_i \ln x_i$

Logarithmic Standard deviation $s_{\ln} = \pm\sqrt{\frac{\sum(\ln x_i - \bar{x}_{\ln})^2}{n-1}}$

Maximum value Max

Minimum value Min

Lower expected value $E = e^{\bar{x}_{\ln} - k_s \cdot s_{\ln}}$ where k_S (quantile factor) is given in Table A.1.

Quantile factor k_S see Table A.1

A.3 Statistical evaluation of test results

From the calculation of the mean value $\left(\bar{x}\right)$, the standard deviation (s) and the coefficient of variation (v) a normal distribution is assumed.

For the calculation of the lower expected value (E) a logarithmic normal distribution is assumed. The lower expected value (E) corresponds to the 5 % quantile of a logarithmic normal distribution for a confidence level of 75 %.

Table A.1 — Quantile factor (*ks*) in dependence on the number of measured values (*n*) in correspondence to the 5 % quantile for a confidence level of 75 %

n	k_S
3	3,15
4	2,68
5	2,46
6	2,34
7	2,25
8	2,19
9	2,14
10	2,10
15	1,99
20	1,93
30	1,87
40	1,83
50	1,81
8	1,64

The following examples should help to clarify the method:

EXAMPLE 1

Calculation of mean value, standard deviation, maximum value and minimum value of 6 measured values

Measurement no.	Measured value x
1	2 000
2	2 150
3	2 200
4	2 300
5	2 350
6	2 400
Mean value	2 233
Standard deviation	147
Maximum value	2 400
Minimum value	2 000

EXAMPLE 2

Calculation of mean value, standard deviation, coefficient of variation and lower expected value of 10 measured values

Measurement no.	Measured value x	(ln x)
1	2 000	(7,60)
2	2 150	(7,67)
3	2 200	(7,70)
4	2 300	(7,74)
5	2 350	(7,76)
6	2 400	(7,78)
7	2 600	(7,86)
8	2 750	(7,92)
9	2 900	(7,97)
10	3 150	(8,06)
Mean value	2 480	(7,807)
Standard deviation	363	(0,143)
Variation coefficient	0,15	

From Table A.1 for: n=10 k_s=2,1

lower expected value1819

Bibliography

[1] EN 14618, *Agglomerated stone — Terminology and classification*

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