BRITISH STANDARD

BS EN
14617-15:2005

Agglomerated stone — Test methods —

Part 15: Determination of compressive strength

The European Standard EN 14617-15:2005 has the status of a British Standard

ICS 91.100.15

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Foreword

This document (EN 14617-15:2005) 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of an identical text or by endorsement, at the latest by September 2005, and conflicting national standards shall be withdrawn at the latest by September 2005.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*

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

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*

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

This document specifies a method for determining the compressive strength of agglomerated stones.

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.

EN 197-1, *Cement - Part 1: Composition, specifications and conformity criteria for common cements*

EN 12390, *Testing hardened concrete*

EN 14618:2003, *Agglomerated stone- Terminology and classification*

3 Principle

The specimens, after mechanical preparation of the surfaces or, if needed, after capping, are laid and centred on the plate of a testing machine. A uniformly distributed load is applied and increased continuously until failure occurs.

4 Terms and definitions

For the purposes of this standard, the terms and definitions given in EN 14618:2003 apply.

5 Symbols

h height of the specimen, in millimetres;

$\bar{l}$ mean value of the lateral dimension, i.e. the distance between opposite vertical faces of the specimen (if cubic), in millimetres;

$\bar{d}$ mean value of the diameter of the specimen (if cylindrical), in millimetres;

A cross-sectional area of the specimen before testing, in square millimetres;

F failure load, in newtons;

R uniaxial compressive strength of the specimen, in MPa;

$\bar{R}$ mean value of the uniaxial compressive strength, in MPa;

s standard deviation;

v coefficient of variation.

6 Apparatus

6.1 A surface grinder.

6.2 A lapping machine if final preparation of the specimens is needed.

6.3 A test machine of appropriated force, in accordance with EN 12390 and calibrated according to this standard, and provided with a system for controlling the strain rate.

6.4 A time counter accurate to 1 s.

6.5 A ventilated oven which can maintain a temperature of (70 ± 5) °C.

6.6 A weighing instrument with an accuracy of 0,1g.

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

6.8 Air conditioned room with a temperature of (20 ± 5) °C.

7 Preparation of specimens

7.1 Sampling

The sampling is not the responsibility of the testing laboratory except where it is especially requested to undertake this.

At least six specimens are to be tested.

7.2 Test specimens

Test specimens shall be cubes with (70 ± 5) mm or (50 ± 5) mm edge or right circular cylinders whose diameter and height are equal to (70 ± 5) mm or (50 ± 5) mm.

The height of the specimen can be reached also gluing, using suitable adhesives, different samples of minimum 6,5 mm of thickness.

If the maximum observed dimension of the grains exceeds 7 mm, it is recommended to have a larger number of specimens in order to obtain representative results.

7.3 Surface preparation

7.3.1 General

The faces through which the load is to be applied shall be flat to a tolerance of 0,1 mm and shall not depart from perpendicularity to the axis of the specimen by more than 0,01 radian or 1 mm in 100 mm. The sides of the specimen shall be smooth and free of abrupt irregularities and straight to within 0,3 mm over the full length of the specimen.

To meet the above requirements the specimens shall be finished on either a lathe or surface grinder, with final preparation on a lapping machine if needed.

Capping with paste according to the procedures indicated in 7.3.2 is to be used only if the indicated tolerances are not obtainable with the prescribed mechanical preparation. This condition shall be clearly indicated in the test report.

7.3.2 Capping with paste

If the specimen height indicated in 7.2 cannot be reached by the available samples, it is possible to cap the specimen at the required height using a paste made up with water and cement CEM I 52,5 R according to EN 197-1, water/cement ratio of (0,6 ± 0,1), curing in room condition according to EN 197-1 for one week ± 4 hours.

7.4 Conditioning of specimen before testing

Specimens, whether capped or uncapped, shall be dried at (70 ± 5) °C to constant mass, i.e. the difference between two weighings is no greater than 0,1% of the mass of the specimen in (24 ± 2) h. After drying and prior to testing the specimens shall be stored at (20 ± 5) °C until the thermal equilibrium is reached. After that, the tests shall be performed within 24 h.

8 Procedure

8.1 Measuring the specimen

The cross-sectional dimensions of the test specimen (lateral dimension for cubic, diameter for cylindrical test specimens) shall be measured to the nearest 0,1 mm by averaging two measures taken at right angles to each other at about the upper-height and two about the lower-height *h* of the specimen. The average lateral dimension $\bar{l}$ or the average diameter $\bar{d}$ shall be used for calculating the cross-sectional area. The height of the specimen shall be determined to the nearest 1,0 mm.

8.2 Placing the specimen in the testing machine

Wipe the bearing surfaces of the testing machine clean and remove any loose grit from the bed faces of the specimen. Align the specimen carefully with the centre of the ball-seated platen, so that a uniform seating is obtained. Do not use any packing material.

8.3 Loading

Load on the specimen shall be applied continuously at a constant stress rate of (1 ± 0,5) MPa/s. The failure load on the specimen shall be measured to the nearest 1kN and recorded.

9 Expression of results

The uniaxial compressive strength *R* of each specimen is expressed by the ratio of the failure load of the specimen and its cross-sectional area before testing, by the equation:

$$R = \frac{F}{A}$$

stating the type of specimen by Rc and Rcyl in the case of cube and cylinder respectively.

The result shall be expressed in MPa with at least one significant figure. The mean value *R* shall be calculated to the nearest 1 MPa.

10 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 document;

c) name and address of the test laboratory and the address where the test was carried out if different from the testing 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 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 $\bar{l}$ (or $\bar{d}$) and *h* in millimetres and the failure load *F* of each specimen, in newtons;

j) surface preparation of the specimens and their conditioning before testing;

k) orientation of the axis of loading with respect to the existing planes of anisotropy;

l) compressive strength *R* of each specimen, in Megapascals with at least two significant figures;

m) mean value $\overline{R}$ of compressive strength, in Megapascals to the nearest 1 MPa;

n) standard deviation *s* , in Megapascals to the nearest 1 MPa, and the variation coefficient *v*;

o) all deviations from the standard and their justification;

p) 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 testing laboratory.

NOTE Comparison between test results should be only made for specimens of the same shape.

Annex A
(normative)

Statistical evaluation of test 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 document.

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

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

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

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

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

For the calculation of the mean value $(\bar{x})$, 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 (k_S) 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
∞	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	2000
2	2150
3	2200
4	2300
5	2350
6	2400

Mean value	2333
Standard deviation	147
Maximum value	2400
Minimum value	2000

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	2000	(7,60)
2	2150	(7,67)
3	2200	(7,70)
4	2300	(7,74)
5	2350	(7,76)
6	2400	(7,78)
7	2600	(7,86)
8	2750	(7,92)
9	2900	(7,97)
10	3150	(8,06)
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Mean value	2480	(7,807
Standard deviation	363	(0,143)
Variation coefficient	0,15	

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

Lower expected value 1819

Bibliography

[1] EN 12440, *Natural stone - Denomination criteria*

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