British Standard

BRITISH STANDARD

BS 812-113: 1990

Incorporating Amendment No. 1 and 2

Testing aggregates —

Part 113: Method for determination of aggregate abrasion value (AAV)

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Cement, Gypsum, Aggregates and Quarry Products Standards Policy Committee (CAB/-) to Technical Committee CAB/2, upon which the following bodies were represented:

Aggregate Concrete Block Association
Association of Consulting Engineers
Association of Consulting Scientists
Association of Lighweight Aggregate Manufacturers
Brick Development Association
British Aggregate Construction Materials Industries
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Society of Chemical Industry

This British Standard, having been prepared under the direction of the Cement, Gypsum, Aggregates and Quarry Products Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on
29 June 1990

The following BSI references relate to the work on this standard:
Committee reference CAB/2
Draft for comment 84/14034 DC

ISBN 0 580 18828 0

Amendments issued since publication

Amd. No.	Date	Comments
6986	December 1991	
8770	August 1995	Indicated by a sideline in the margin

Contents

Foreword

This Part of BS 812 has been prepared under the direction of the Cement, Gypsum, Aggregates and Quarry Products Standards Policy Committee and is a revision of clause **9** of BS 812-3:1975 which is withdrawn. It forms part of a general revision of the 1975 edition of BS 812. As each of the tests, or collection of tests is revised it is intended to issue it as a separate Part or Section of this standard.

The method described in this revision has not been changed technically from that given in BS 812-3:1975. Most of the changes are editorial and the only major change is that the test sand is no longer allowed to be re-used. Attention is also drawn to the dust hazard that can arise during the course of the test.

It is intended that other British Standards should call up BS 812 test methods as the basis of compliance. Nevertheless, it is *not* intended that all aggregates should be subjected regularly to all the listed tests. Specifications in other standards should call up only relevant test methods.

Some of the tests in other Parts of BS 812 are of limited application, and advice on the use of simple tests is given, for example, when they can be used for a preliminary sorting of aggregates to see whether more expensive testing is justified.

Reference should be made to BS 812-101:1984 for general guidance on testing aggregates, precision of test methods and variance arising from sampling errors.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 4, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Part of BS 812 describes a method for the determination of the aggregate abrasion value (AAV) which gives a measure of the resistance of aggregate to surface wear by abrasion.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this Part of BS 812, the definitions given in BS 812-100, BS 812-101 and BS 812-102 apply.

3 Principle

Two specimens made up from selected and correctly orientated particles from a test portion embedded in resin are fixed in contact with a horizontally rotating lap. The specimens are loaded and an abrasive sand fed continuously through the contacting surfaces of the specimen and lap for a specified number of revolutions. The aggregate abrasion value is determined from the differences in mass of the specimens before and after abrasion.

4 Sampling

The sample used for the test (the laboratory sample) shall have been taken in accordance with clause **5** of BS 812-102:1989.

5 Apparatus

NOTE All apparatus should comply with the general requirements of BS 812-100.

5.1 *Abrasion machine,* consisting essentially of a machined flat circular cast iron or steel grinding lap not less than 600 mm in diameter, which can be rotated in a horizontal plane at a speed of 28 r/min to 30 r/min. The abrasion machine shall be fitted with a revolution counter, and the following accessories:

a) at least two machined metal moulds for preparing specimens, manufactured with removable ends and with internal dimensions of 2.0 ± 0.1 mm × 54.0 ± 0.1 mm × 16.0 ± 0.1 mm, if crystic resin is used, or these dimensions reduced by 0.5 mm if a non-shrinking resin is used (see note 1 to **6.2**);

b) at least two machined metal trays or metal backing plates for holding the prepared specimens. Trays made from 5 mm mild steel plate and of internal dimensions 92.0 ± 0.1 mm × 54.0 ± 0.1 mm × 8.0 ± 0.1 mm are suitable;

c) at least two machined flat plates made from 5 mm mild steel plate of dimensions 115 ± 0.1 mm × 75 ± 0.1 mm;

d) means for locating two of the trays (or specimens with backing plates) with their centre points 260 mm from the centre of the lap diametrically opposite to each other and with their long sides lying in the direction of rotation of the lap. The trays shall be free to move in a vertical plane but restrained from moving in the horizontal plane;

e) two weights, each with a rounded base for pressing the test specimen against the surface of the lap and each having a means for adjusting its mass, including test specimen and tray, to 2 000 ± 10 g (see clause **8**);

f) means for feeding sand continuously on the lap in front of each test specimen at a rate of 700 g/min to 900 g/min, and for removing the sand after it has passed under the test samples.

NOTE Regular testing of very hard aggregates may visibly score the machined surface of the lap. The surface should be inspected between test runs and any such damage should be rectified by machining.

5.2 *A means of reducing the laboratory sample,* e.g. a sample divider, of size appropriate to the maximum particle size to be handled or alternatively a flat shovel and a clean, flat, hard surface, e.g. a metal tray for use in quartering.

NOTE A suitable divider is the riffle box illustrated in BS 812-102.

5.3 *Test sieves* with an aperture size of 14.0 mm in square-hole perforated-plate and of 850 μm, 600 μm, 425 μm, 300 μm and 212 μm in woven wire. The test sieves shall comply with BS 410.

5.4 *Slotted flake-sorting sieve,* of size 20.0 mm to 14.0 mm having a slot width of 10.2 ± 0.15 mm complying with BS 812-105.1.

5.5 *A well-ventilated oven,* thermostatically controlled to maintain a temperature of 105 ± 5 °C.

NOTE This is only required if the test portion is to be oven-dried rather than air-dried.

5.6 *A balance* of at least 1 kg capacity, readable to 0.1 g.

5.7 *Two fine-haired brushes,* about 3 mm diameter.

5.8 *A brush with stiff bristles.*

5.9 *A clamp,* such as a 200 mm G-clamp.

5.10 *A thermometer,* complying with BS 593, and stamped as such, that covers the range 100 °C to 110 °C.

5.11 *A balance,* of at least 2.5 kg capacity, readable to 1 g.

6 Materials

6.1 *Abrasive,* consisting of Leighton Buzzard silica sand at least 75 % of which shall pass the 600 μm test sieve (**5.3**) and be retained on the 425 μm sieve and all of which shall pass the 850 μm sieve and be retained on the 300 μm sieve. The sand shall be dry and shall not have been previously used.
About 30 kg is required for each test.

6.2 *Polyester resin and hardener,* (see note 1) together with a release agent such as liquid car polish, a cleaning solvent or a mixture of 90 % (*V*/*V*) acetone 10 % (*V*/*V*) kerosene, and disposable cups suitable for mixing the resin (see note 2).

NOTE 1 Crystic resin is suitable and gives about 0.5 mm shrinkage on the length and width of the specimen; if a non-shrinking resin is used the appropriate mould dimensions should be decreased by 0.5 mm.

NOTE 2 Paper, polypropylene or resin-making cups are suitable but some plastics cups may dissolve in the cleaning solvent.

6.3 *Fine sand,* (passing the 212 μm test sieve), to prevent the polyester resin from squeezing up between the individual pieces of aggregate.

7 Preparation of test portions and specimens

7.1 Test portions

Reduce the laboratory sample using the procedures described in clause **6** of BS 812-102:1989 and sieve to produce a test portion consisting of aggregate passing a 14.0 mm sieve (**5.3**) and retained on the 20.0 mm to 14.0 mm flake-sorting sieve (**5.4**). The mass of the test portion shall be sufficient to allow two test specimens to be prepared as described in **7.2**. After sieving the aggregate wash to remove surface dust and allow to dry in air or oven dry for a period not exceeding 4 h at a temperature not exceeding 110 °C. The aggregate shall be tested in a surface-dry condition and shall be at room temperature before the preparation of the test portion as described in **7.2**.

7.2 Specimens

7.2.1 Prepare two specimens for each test.

7.2.2 Lightly coat the internal faces and top edges of the mould with release agent with one fine-haired brush.

7.2.3 From the test portion prepared as described in **7.1** select as many particles as possible and in any case not less than 24 and place them in the mould in a single layer with their flattest surface lying on the bottom of the mould.

NOTE The particles may be selected from the test portion as required but care should be taken to ensure that they are representative of the test portion.

7.2.4 Fill the interstices between the pieces of aggregate to approximately three-quarters of their depth with the fine sand (see **6.3**) and level with the other fine-haired brush. Mix sufficient resin and hardener in a disposable cup and use to fill the mould to overflowing.

NOTE Approximately equal proportions of resin and hardener have been found to be suitable when using crystic resin.

7.2.5 Coat one side of the flat plate with the release agent and place it firmly on the mould, coated side down, and hold in position by the clamp. When the resin has hardened (usually after 30 min), remove the plate and trim off the excess resin with a knife or spatula.

7.2.6 Remove the specimen from the mould, remove the loose sand with the stiff brush and weigh the specimen to the nearest 0.1 g (mass *A*).

NOTE The solvent should be used to clean moulds, tools, etc., as required.

8 Procedure

WARNING. The abrasion of the aggregate during the course of the operations described in this clause may generate particles that could be injurious to health. It is essential therefore that, in addition to ensuring that the test equipment is properly guarded, appropriate precautions are taken such as by the use of dust masks or dust containing and/or extracting facilities.

8.1 Fit each specimen into one of the machined metal trays or metal backing plates, taking care to ensure a tight fit. Weigh each specimen in its tray with one of the weights and adjust the mass until the total is between 2 000 ± 10 g.

8.2 Place the two specimens in the abrasion machine diametrically opposite to each other with their centre points 260 mm from the centre of the lap and so that the 92 mm × 54 mm face of exposed aggregate particles rests on the lap over the whole face area and then place the appropriate weights centrally on the specimens.

8.3 Turn the lap through 500 revolutions at a speed of 28 r/min to 30 r/min, the abrasive sand (see **6.1**) being fed continuously on to it across the full width of the specimen immediately in front of each test specimen at a rate of 700 g/min to 900 g/min per specimen.

NOTE A slot of about 1.3 mm is suitable.

To ensure that the sand is fed beneath each specimen lift them clear of the lap for one revolution before the start of abrasion and at every hundredth revolution thereafter. Remove the sand with a rubber-edged blade, mounted so that the rubber edge rests lightly on the lap for its full width, and discard the sand.

8.4 If it becomes apparent that, because of the nature of the aggregate, it has abraded away to the level of the resin backing discontinue the test and report the number of revolutions.

8.5 On completion of 500 revolutions, remove the test specimens from the machine, remove the trays or backing plates and the weights and weigh the specimens to the nearest 0.1 g (mass *B*).

9 Calculation and expression of results

9.1 Calculate the aggregate abrasion value (AAV) of each test specimen, to three significant figures, from the following equation:

$$\text{AAV} = \frac{3(A - B)}{d}$$

where

A is the mass of specimen before abrasion (in g);

B is the mass of specimen after abrasion (in g);

d is the particle density of the aggregate (on saturated surface dried basis in Mg/m^3) determined in accordance with clause **5** of BS 812-2:1995.

NOTE The calculation is based on the percentage loss in mass of an assumed 33 ml volume of aggregate.

9.2 Calculate the mean of the two results to two significant figures. Report the mean as the aggregate abrasion value, unless the individual results differ by more than 0.2 times the mean value. In this case repeat the test on two further specimens, calculate the median of the four results to two significant figures, and report the median as the aggregate abrasion value.

NOTE The median of four results is calculated by excluding the highest and the lowest result and calculating the mean of the two middle results.

10 Precision

10.1 A precision experiment was carried out involving 13 laboratories. Details of the experiment and the precision data are given in appendix A.

10.2 Uses of precision data are described in clause **5** of BS 812-101:1984.

11 Test report

The test report shall affirm that the aggregate abrasion value was determined in accordance with this Part of BS 812 and whether or not a certificate of sampling is available. If available a copy of the certificate of sampling shall be provided. The test report shall include the following information:

a) sample identification;

b) mean aggregate abrasion value.

Appendix A Details of the evaluation of precision data

A.1 The precision data given in Table 1 were determined from an experiment conducted in 1989/90 involving 13 laboratories. The experiment was designed, and the data analysed, following the principles set out in BS 5497-1. A 4 t stockpile of material B was used, and a 1 t stockpile of material G. Laboratory samples of approximately 125 kg were taken of material B, and of approximately 25 kg of material G, in accordance with BS 812-102, and one laboratory sample of each material was sent to each laboratory. Two test portions were prepared from each laboratory sample for the determination of the aggregate abrasion value. (Material B was also used for the precision experiments recorded in BS 812-110, BS 812-111 and BS 812-112.)

A.2 The tests for outliers given in BS 5497-1:1987 were applied to the data. No data were found to be outliers.

A.3 Variation due to the preparation of the samples (V_s) in the precision trial may be assumed to be small so that R_1 will be similar to R_2. The definitions of repeatability r_1 and reproducibility R_1 and R_2 and of the variances V_{r1}, V_s and V_L are given in BS 812-101. The values given in Table 1 apply when a test result is obtained as the average of the determinations of the aggregate abrasion value on two specimens made using the same test portion and run at the same time.

Table 1 — Precision values for the determination of aggregate abrasion value.

Material	Mean value of the data	Repeatability r_1	Reproducibility R_2	$\sqrt{V_{r1}}$	$\sqrt{(V_L + V_S)}$
Blast-furnace slag (B)	16	2.5	3.5	0.9	0.9
Gritstone (G)	4	0.7	1.5	0.3	0.5

Publications referred to

BS 410, *Specification for test sieves.*

BS 593, *Specification for laboratory thermometers.*

BS 812, *Testing aggregates.*

BS 812-2, *Methods for determination of physical properties.*

BS 812-100, *General requirements for apparatus and calibration.*

BS 812-101, *Guide to sampling and testing aggregates.*

BS 812-102, *Methods for sampling.*

BS 812-105, *Methods for determination of particle shape.*

BS 812-105.1, *Flakiness index.*

BS 812-110, *Methods for determination of aggregate crushing value (ACV).*

BS 812-111, *Methods for determination of the ten percent fines value (TFV).*

BS 812-112, *Methods for determination of the aggregate impact value (AIV).*

BS 5497, *Precision of test methods.*

BS 5497-1, *Guide for the determination of repeatability and reproducibility for a standard test method by inter-laboratory tests.*

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