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Testing aggregates —

Part 112: Methods for determination of aggregate impact value (AIV)

Committees responsible for this British Standard

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Foreword

This Part of BS 812 has been prepared under the direction of the Cement, Gypsum, Aggregate and Quarry Products Standards Policy Committee, and is a revision of clause **6** of BS 812-3:1975 which is withdrawn.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 related tests is revised it will be issued as a separate Part or Section of this standard.

The methods described in this revision have not been changed technically from that given in BS 812-3:1975, but the opportunity has been taken to include a procedure for determining the aggregate impact value of aggregates in a soaked condition. This has been done because some aggregates have a significantly reduced resistance to impact when tested in this condition. With such aggregates, tests on soaked samples give a more reliable indication of their performance in practice.

It is intended that other British Standards should call up BS 812 test methods as the basis for compliance. Nevertheless it is *not* intended that all aggregates should be subjected 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 simpler tests is given, for example, when they can be used for a preliminary sorting of aggregates to see whether more extensive 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 8, 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 methods for the determination of the aggregate impact value (AIV) which gives a relative measure of the resistance of an aggregate to sudden shock or impact.

Two procedures are described, one in which the aggregate is tested in a dry condition, and the other in a soaked condition.

The methods are applicable to aggregates passing at 14.0 mm test sieve and retained on a 10.0 mm test sieve. For smaller size fractions, a recommended method is described in appendix A. Aggregate sizes larger than 14 mm are not appropriate to the aggregate impact value test.

NOTE 1 For the determination of the resistance of an aggregate to a slowly applied compressive load, see BS 812-110.
NOTE 2 The titles of the publications referred to in this standard are listed in 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

A test specimen is compacted, in a standardized manner, into an open steel cup. The specimen is then subjected to a number of standard impacts from a dropping weight. This action breaks the aggregate to a degree which is dependent on the impact resistance of the material. This degree is assessed by a sieving test on the impacted specimen and is taken as the aggregate impact value (AIV).

4 Sampling

The sample used for the test (the laboratory sample) shall be 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 General

5.1.1 *Impact testing machine*

5.1.1.1 *General* The machine shall be of the general form shown in , have a total mass of between 45 kg and 60 kg and shall comprise the parts described in **5.1.1.2** to **5.1.1.6**.

5.1.1.2 *A circular metal base,* with a mass of between 22 kg and 30 kg, with a plane lower surface of not less than 300 mm diameter and shall be supported on a level and plane concrete or stone block floor at least 450 mm thick. The machine shall be prevented from rocking either by fixing it to the block or floor or by supporting it on a level and plane metal plate cast into the surface of the block or floor.

5.1.1.3 *A cylindrical steel cup,* having an internal diameter of 102 ± 0.5 mm and an internal depth of 50 ± 0.25 mm. The walls shall be not less than 6 mm thick and the inner surfaces shall be case hardened. The cup shall be rigidly fastened at the centre of the base and be easily removed for emptying.

5.1.1.4 *A metal hammer,* with a mass of between 13.5 kg and 14.0 kg, the lower end of which shall be cylindrical in shape, 100.0 mm ± 0.5 diameter and 50 ± 0.15 mm long, with a 1.5 mm chamfer at the lower edge, and case hardened. The hammer shall slide freely between vertical guides so arranged that the lower (cylindrical) part of the hammer is above and concentric with the cup.

5.1.1.5 *Means for raising the hammer,* and allowing it to fall freely between the vertical guides from a height of 380 ± 5 mm on to the test sample in the cup, and means for adjusting the height of fall within 5 mm.

5.1.1.6 *Means for supporting the hammer,* whilst fastening or removing the cup.

NOTE Some means for automatically recording the number of blows is desirable.

5.1.2 *Square-hole perforated-plate test sieves,* of sizes 14.0 mm and 10.0 mm and a wovenwire 2.36 mm test sieve. The test sieves shall comply with BS 410.

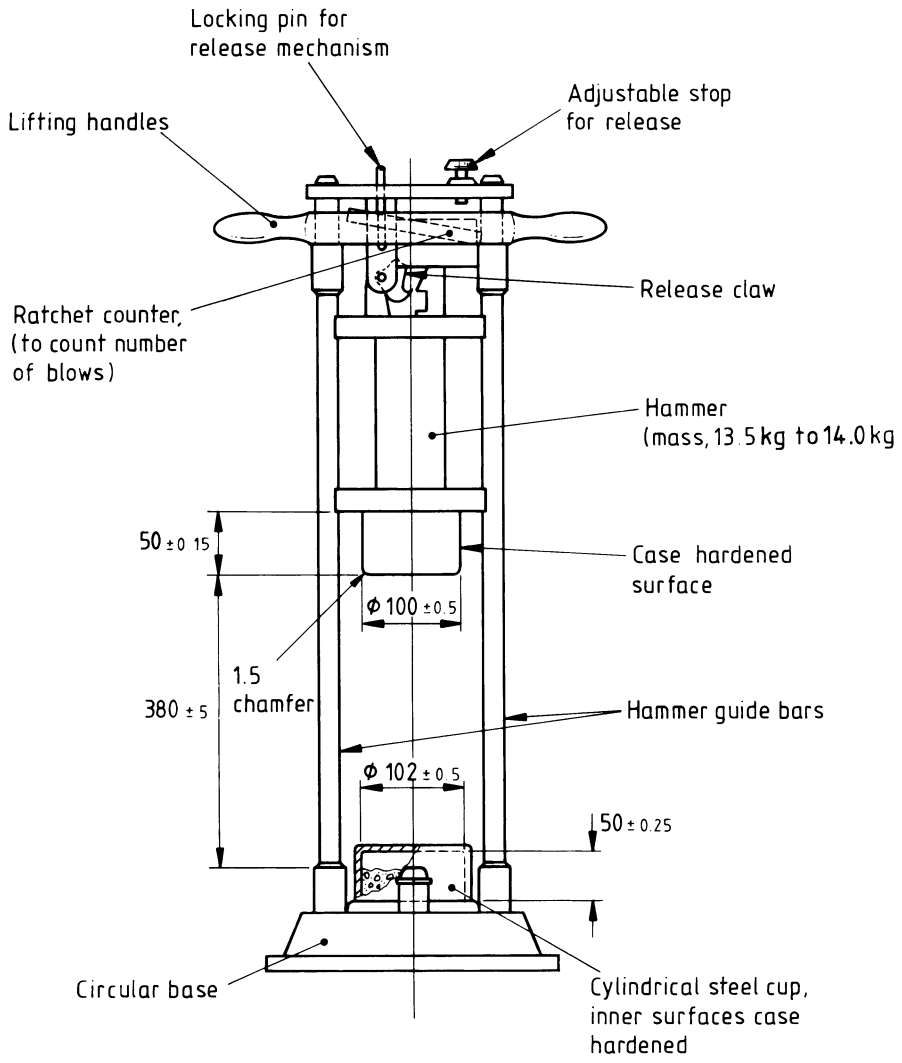
5.1.3 *A cylindrical metal measure,* of sufficient rigidity to retain its form under rough usage and with an internal diameter of 75 ± 1 mm and an internal depth of 50 ± 1 mm.

5.1.4 *A tamping rod,* made out of straight iron or steel bar of circular cross section, 16 ± 1 mm diameter and 600 ± 5 mm long, with both ends hemispherical.

5.1.5 *A balance,* of capacity not less than 500 g readable to 0.1 g.

5.1.6 *A well-ventilated oven,* thermostatically controlled at a temperature of 105 ± 5 °C.

5.1.7 *A rubber mallet.*



All linear dimensions are in millimetres.

Figure 1 — Aggregate impact test machine

5.1.8 *A metal tray,* of known mass large enough to contain 1 kg of aggregate.

5.1.9 *A brush,* with stiff bristles.

5.2 Additional apparatus for testing aggregate in a soaked condition

5.2.1 *Drying cloths or absorbent paper,* for the surface-drying of the aggregate after it has been soaked in water, e.g. two hand-towels of a size not less than 750 mm × 450 mm or rolls of absorbent paper of suitable size and absorbency.

5.2.2 *One or more wire-mesh baskets,* having apertures not larger than 6.5 mm or a perforated container of convenient size with hangers for lifting purposes.

5.2.3 *A stout watertight container,* in which the basket(s) may be immersed.

5.2.4 *A supply of clean water,* of drinking quality.

6 Preparation of test portions and specimens

6.1 Test portions

Reduce the laboratory sample by the procedures described in clause **6** of BS 812-102:1989 to produce a test portion of sufficient mass to produce three test specimens of 14 mm to 10 mm size fraction.

NOTE A single test specimen is that quantity of material required to fill the cup (see **7.1.1**. and Table 1).

Table 1 — Guide to minimum mass of test portions required to obtain a suitable mass of material to determine aggregate impact value

Grade of the aggregate	Minimum mass of the test portion[a]
mm	kg
All-in aggregate 40 max. size	20
All-in aggregate 20 max. size	15
Graded aggregate 40 to 5	12
Graded aggregate 20 to 5	8
Graded aggregate 14 to 5	5

[a] For normal density aggregates.

6.2 Test specimens in a dry condition

6.2.1 Thoroughly sieve the entire dried test portion on the 14 mm and 10 mm test sieves to remove the oversize and undersize fraction. Divide the resulting 14 mm to 10 mm size fractions to produce three test specimens each of sufficient mass to fill the measure (see **5.1.3**) when it is filled by the procedure described in **6.2.3**.

NOTE Mechanical sieving should only be used for aggregates which do not degrade under its action.

6.2.2 Dry the test specimens by heating at a temperature of 105 ± 5 °C for a period of not more than 4 h. Cool to room temperature before testing.

6.2.3 Fill the measure to overflowing with the aggregate comprising the test specimen by means of a scoop. Tamp the aggregate with 25 blows of the rounded end of the tamping rod, each blow being given by allowing the tamping rod to fall freely from a height of about 50 mm above the surface of the aggregate and the blows being evenly distributed over the surface.

Remove the surplus aggregate by rolling the tamping rod across, and in contact with, the top of the container. Remove by hand any aggregate which impedes its progress and fill any obvious depressions with added aggregate. Record the net mass of aggregate in the measure and use the same mass for the second test specimen.

6.3 For test specimens in a soaked condition

6.3.1 Prepare the test portion using the procedure described in **6.1** except that the test portion is tested in the as-received condition and not oven-dried. Place each test specimen (see note to **7.2.1**) in the wire basket and immerse it in the water in the container with a cover of at least 50 mm of water above the top of the basket. Immediately after immersion remove the entrapped air from the specimen by lifting the basket 25 mm above the base of the container and allowing it to drop 25 times at a rate of about once a second. Keep the basket and aggregate completely immersed during the operation and for a subsequent period of 24 ± 2 h and maintain the water temperature at 20 ± 5 °C.

6.3.2 After soaking, remove the specimen of aggregate from the basket and blot the free water from the surface with the absorbent cloths. Carry out the completion of preparation and testing as described in **7.2** immediately after this operation.

7 Procedure

7.1 Test specimens in a dry condition

7.1.1 Rest the impact machine, without wedging or packing, upon the level plate, block or floor, so that it is rigid and the hammer guide columns are vertical. Before fixing the cup to the impact machine, place the whole of the test specimen in the cup and then compact by 25 strokes of the tamping rod (see **6.2.3**). With the minimum of disturbance to the test specimen, fix the cup firmly in position on the base of the machine. Adjust the height of the hammer so that its lower face is 380 ± 5 mm above the upper surface of the aggregate in the cup and then allow it to fall freely on to the aggregate. Subject the test specimen to a total of 15 such blows, each being delivered at an interval of not less than 1 s.

NOTE No adjustment for hammer height is required after the first blow.

7.1.2 Remove the crushed aggregate by holding the cup over a clean tray and hammering on the outside with the rubber mallet until the particles are sufficiently disturbed to enable the mass of the specimen to fall freely on to the tray.

NOTE 1 If this fails to remove the compacted aggregate other methods should be used but take care not to cause further crushing of the particles.

NOTE 2 Mechanical sieving should only be used for aggregates which do not degrade under its action.

Transfer fine particles adhering to the inside of the cup and the underside of the hammer to the tray by means of the stiff bristle brush. Weigh the tray and the aggregate and record the mass of aggregate used (M_1) to the nearest 0.1 g.

7.1.3 Sieve the whole of the specimen in the tray on the 2.36 mm test sieve until no further significant amount passes during a further period of 1 min. Weigh and record the masses of the fractions passing and retained on the sieve to the nearest 0.1 g (M_2 and M_3 respectively), and if the total mass ($M_2 + M_3$) differs from the initial mass (M_1) by more than 1 g, discard the result and test a further specimen.

7.1.4 Repeat the procedure as described in **7.1.1** to **7.1.3** inclusive using a second specimen of the same mass as the first specimen.

7.2 Aggregate in a soaked condition

7.2.1 Follow the test procedure described in **7.1**, except that the number of blows of the hammer to which the aggregate is subjected, is the number of blows which will yield between 5 % and 20 % of fines when this value is calculated by the procedure given in clause **8**.

NOTE The number of blows will usually be less than 15, but the actual number has to be ascertained by a process of trial and error. For this reason, more than two test specimens will almost invariably be required and due allowance should be made for this when preparing the specimen by the procedure given in **6.3**. Once the number of blows required has been determined, the procedure is repeated on a second test specimen which is subjected to the same number of blows.

7.2.2 Remove the crushed specimen from the cup and dry it in the oven at a temperature of 105 ± 5 °C either to constant mass or for a minimum period of 12 h. Allow the dried material to cool and weigh to the nearest gram and record the mass of the test specimen (M_1). Complete the procedure as described in **7.1.2** starting at the stage where the specimen is sieved on the 2.36 mm test sieve.

8 Calculations and expression of results

8.1 Aggregate in the dry condition

Calculate the aggregate impact value (AIV) expressed as a percentage to the first decimal place for each test specimen from the following equation:

$$(AIV) = \frac{M_2}{M_1} \times 100$$

where

M_1 is the mass of the test specimen(in g);

M_2 is the mass of the material passing the 2.36 mm test sieve (in g).

8.2 Aggregate in the soaked condition

8.2.1 Calculate the mass of fines m expressed as a percentage of the total mass for each test specimen from the following equation:

$$m = \frac{M_2}{M_1} \times 100$$

where

M_1 is the mass of oven-dried test specimen (in g);

M_2 is the mass of oven-dried material passing the 2.36 mm test sieve (in g).

8.2.2 Calculate the aggregate impact value (AIV) expressed as a percentage to the first decimal place for each test specimen from the equation:

$$(AIV) = \frac{15m}{n}$$

where

n is the number of hammer blows to which the specimen is subjected.

8.3 Results

Calculate the mean of the two values determined in **8.1** or **8.2** to the nearest whole number. Report the mean as the aggregate impact value, unless the individual results differ by more than 0.15 times the mean value. In this case repeat the test on two further specimens, calculate the median of the four results to the nearest whole number, and report the median as the aggregate impact value.

In the case of tests on aggregate in the soaked condition report the number of hammer blows.

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.

9 Precision

9.1 A precision experiment was carried out involving 15 laboratories. Details of the experiment and the precision data are given in appendix B.

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

10 Test report

The report shall affirm that the aggregate impact value of the dry aggregate and/or soaked aggregate 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 shall be provided. The test report shall contain the following additional information:

a) sample identification and sample description;

b) the condition in which the aggregate was tested, i.e. dry or soaked condition;

c) the aggregate impact value (AIV) of the dry aggregate;

d) the aggregate impact value of the aggregate in a soaked condition and the number of blows of the hammer that was used in the determination;

e) if the AIV is greater than 30 %, a statement that the results obtained should be treated with caution.

Appendix A Recommended method for determining the aggregate impact value for other size fractions of aggregate

A.1 General

When required, or if the definitive size fraction passing the 14 mm test sieve and retained on a l0 mm test sieve is not available, tests may be made on aggregates of other sizes which pass a 14.0 mm test sieve and are retained on 2.36 mm test sieve. Because of the lack of experience of testing sizes other than the definitive size fraction, it has not been possible to give any positive indication as to how the results obtained on non-standard sizes would compare with those obtained by the standard test procedures. In general the smaller sizes of aggregate will give a lower value, but the relationship between the values obtained with different sizes may vary from one aggregate to another.

A.2 Apparatus

The apparatus shall be as described in clause **5** together with such additional test sieves that may be necessary to prepare the test portions (see Table 2).

Table 2 — Particulars of test sieves for testing other size fractions of aggregates

Size fraction	Nominal aperture size of test sieve complying with BS 410			
	For preparation of test specimens		For separating fines	
	Passing	Retained		
	mm	mm	mm	μm
Larger than 14.0 mm	NA[a]	NA[a]	NA[a]	NA[a]
Standard	14.0	10.0	2.36	—
Smaller than standard	10.0	6.30	1.70	—
	6.30	5.00	1.18	—
	5.00	3.35	—	850
	3.35	2.36	—	600

[a] The test is not applicable (NA).

A.3 Preparation of test portions and specimens

Follow the procedure described in clause **6**, using the appropriate sieves as described in Table 2, according to the size of the fraction under test. For a grading of test portions of less than 10 mm maximum size, a minimum mass of 1 kg is required.

A.4 Procedure

Follow the procedure described in clause **7** using the appropriate separating sieves given in Table 2.

A.5 Calculation and expression of results

Follow the general procedure described in clause **8**.

A.6 Test report

The test report shall contain the information specified in clause **10**, with additionally the size of aggregate tested.

Appendix B Details of the evaulation of precision data

B.1 The precision data given in Table 3 and Table 4 were determined from an experiment conducted in 1989/90 involving 15 laboratories. The experiment was designed, and the data analysed, following the principles set out in BS 5497-1. The materials used were from 4 t stockpiles. Laboratory samples of approximately 125 kg were taken 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 impact value. (The same materials were also used for the precision experiments recorded in BS 812-110 and BS 812-111.)

B.2 The test for outliers given in BS 5497-1 were applied to the data. No data were found to be outliers.

B.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 3 and Table 4 apply when a test result is obtained as the average of two determinations of the aggregate impact value on sub-samples of the same test portion, when both determinations comply with the check on the masses given in **7.1.3** of this Part, and with the check on the percent fines in **7.2.1** (in the case of tests on soaked materials).

Table 3 — Precision values for the determination of aggregate impact value using materials in the dry condition

Material	Mean value of the data	Repeatability r_1	Reproducibility R_2	$\sqrt{V_{r1}}$	$\sqrt{(V_L + V_S)}$
Argillaceous limestone (A)	28	1.7	6.7	0.6	2.3
Blast-furnace slag (B)	32	1.9	8.7	0.7	3.0
Carboniferous limestone (C)	19	2.0	6.8	0.7	2.3
Igneous rock (I)	15	2.1	5.7	0.7	1.9
Mixed gravel (M)	26	2.4	9.4	0.9	3.2

Table 4 — Precision values for the determination of aggregate impact value using materials in the soaked condition

Material	Mean value of the data	Repeatability r_1	Reproducibility R_2	$\sqrt{V_{r1}}$	$\sqrt{(V_L + V_S)}$
Argillaceous limestone (A)	49	5.7	26.1	2.0	9.1
Blast-furnace slag (B)	40	4.8	17.6	1.7	6.1
Carboniferous limestone (C)	18	2.4	6.4	0.8	2.1
Igneous rock (I)	17	2.9	6.9	1.0	2.2
Mixed gravel (M)	32	3.9	14.2	1.4	4.9

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Publications referred to

BS 410, *Specifications for test sieves.*

BS 812, *Testing aggregates.*

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

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

BS 812-102, *Methods of sampling.*

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

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

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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