BRITISH STANDARD

BS 1438:2004

Aggregates — Single-sized aggregates for use as a medium in biological percolating filters

ICS 91.100.25

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BSI British Standards

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee B/502, Aggregates, upon which the following bodies were represented:

Association of Consulting Engineers

Association of Lightweight Aggregate Manufacturers

British Geological Survey

British Precast Concrete Federation Ltd

County Surveyors' Society

Department for Transport – Highways Agency

Department of Trade and Industry – represented by the Building Research Establishment

Electricity Association

Institution of Civil Engineers

Institution of Structural Engineers

Quarry Products Association

Society of Chemical Industry

UK Steel Association

Co-opted members

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The following BSI references relate to the work on this British Standard:
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Contents

Foreword

This British Standard has been prepared by Technical Committee B/502.
It supersedes BS 1438:1971, which is withdrawn.

This new edition represents a full revision of the standard, and introduces the following principal changes:

a) implementation of new standards for aggregates, including the aggregate size requirements in BS EN 13242, the revised sieving test in BS EN 933-1 and a new method to determine aggregate shape in BS EN 933-3;

b) deletion of a number of aspects of the old edition that are outside the scope of current British Standards, including background information about the use of biological percolating filters, notes on the use of the standard and references to independent testing.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 7 and a back cover.

1 Scope

This British Standard specifies the properties of single-sized aggregates for use as a medium in biological percolating filters.

NOTE Suitable aggregates include crushed natural aggregate, metallurgical slags, selected bottom ashes, sintered pulverized fuel ash and other similar materials.

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.

BS EN 932-1, Tests for general properties of aggregates — Part 1: Methods for sampling.

BS EN 932-2, Tests for general properties of aggregates — Part 2: Methods for reducing laboratory samples.

BS EN 932-3, Tests for general properties of aggregates — Part 3: Procedure and terminology for simplified petrographic description.

BS EN 932-5, Tests for general properties of aggregates — Part 5: Common equipment and calibration.

BS EN 933-1, Tests for geometric properties of aggregates — Part 1: Determination of particle size distribution – Sieving method.

BS EN 933-2, Tests for geometric properties of aggregates — Part 2: Determination of particle size distribution — Test sieves, nominal size of apertures.

BS EN 933-3, Tests for geometric properties of aggregates — Part 3: Flakiness index.

BS EN 13242, Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction.

3 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in BS EN 13242 and the following apply.

3.1
laboratory sample
sample submitted to a laboratory for testing

3.2
test portion
sample used in a single test

4 Geometrical requirements

4.1 Particle size distribution

The particle size distribution of aggregate for use as a medium in biological percolating filters shall be determined using sieving, as specified in BS EN 933-1, and shall conform to the requirements specified in Table 1 for the relevant aggregate size d/D. The laboratory sample used for the test shall be taken in accordance with BS EN 932-1.

Table 1 — Particle size distribution and aggregate size

Test sieve, mm	**Mass fraction of aggregate passing sieve,** %					
	40/63[a]	**32/50**[a]	**20/40**[a]	**14/32**[a]	**10/20**[a]	**6/14**[a]
75	100	—	—	—	—	—
63	85 to 100	100	—	—	—	—
50	0 to 35	85 to 100	100	—	—	—
40	0 to 5	0 to 30	85 to 100	100	—	—
31.5	—	0 to 5	0 to 40	85 to 100	100	—
20	—	—	0 to 5	0 to 40	85 to 100	100
14	—	—	—	0 to 7	0 to 40	85 to 100
10	—	—	—	—	0 to 7	0 to 40
6.3	—	—	—	—	—	0 to 7
2	0 to 3	0 to 3	0 to 3	0 to 3	0 to 3	0 to 3
0.063	0 to 1	0 to 1	0 to 1	0 to 1	0 to 1	0 to 1

[a] Aggregate size d/D, where d is the lower sieve size and D is the upper sieve size.

4.2 Shape of aggregate

The shape of aggregate for use as a medium in biological percolating filters shall be determined in terms of the flakiness index, as specified in BS EN 933-3. The flakiness index of the aggregate, when determined in accordance with BS EN 933-3, shall be not greater than 30. The laboratory sample used for the test shall be taken in accordance with BS EN 932-1.

NOTE The BS EN 933-3 test to determine flakiness index is different to the method described in BS 812-105.1, which will be withdrawn in June 2004. The value of 30 is nominally equivalent to a flakiness index of 40 using the BS 812-105.1 test.

5 Impurities

Aggregate for use as a medium in biological percolating filters shall not contain a mass fraction of clay or other cohesive material that is greater than 0.5 %. The aggregate shall not contain wood or other organic matter.

NOTE This is to minimize the risk of clogging the filter.

6 Durability

When tested in accordance with Annex A, using the soundness criteria specified in **A.8.2**, aggregate for use as a medium in biological percolating filters shall be sound.

7 Designation and description

7.1 Designation

The designation for aggregate for use as a medium in biological percolating filters shall include at least the following information:

a) source and manufacturer (if the material has been rehandled in a depot, both source and depot shall be stated);

b) type of aggregate, using the procedures specified in BS EN 932-3;

c) aggregate size, using the appropriate designation d/D as given in Table 1.

7.2 Additional information for the description of an aggregate

When required by the purchaser, the following information shall also be supplied:

a) shape and surface texture of the aggregate, using the procedures specified in BS EN 932-3;

b) any additional information needed to identify the particular aggregate.

8 Marking and labelling

The delivery ticket shall contain at least the following information:

a) designation (see **7.1**);

b) date of despatch;

c) serial number of the ticket;

d) number and date of this British Standard, i.e. BS 1438:2004[1)].

[1)] Marking BS 1438:2004 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification of conformity.

Annex A (normative)
Method for the determination of soundness (sodium sulfate soundness test)

A.1 Principle

A dried test portion consisting of at least 40 pieces of aggregate in the size range 6.3 mm to 63 mm is subjected to 20 cycles of immersion in a saturated solution of sodium sulfate followed by oven drying. This subjects each piece of aggregate to the disruptive effects of the repeated crystallization and rehydration within the pores of the aggregate.

The extent of the degradation of the aggregate is assessed.

A.2 Sampling

The laboratory sample used for the test shall be taken in accordance with BS EN 932-1.

A.3 Apparatus

A.3.1 Unless otherwise stated, all apparatus shall conform to the general requirements of BS EN 932-5.

A.3.2 *Test sieves,* conforming to BS EN 933-2, of 6.3 mm and 63 mm size.

A.3.3 *Balance*, of capacity suitable for weighing each piece of aggregate to an accuracy of 0.1 g.

A.3.4 *Density hydrometer*, graduated at 20 °C to measure density in the range 1.150 g/ml to 1.175 g/ml.

A.3.5 *Aluminium or stainless steel mesh basket(s) or tray(s*), of suitable size to allow free circulation of the solution around each piece of aggregate. The base of the basket(s) or tray(s) shall be perforated to allow free access of the solution to the test portion and subsequent drainage without loss of material.

A.3.6 *Container(s)* of sufficient size to hold the basket(s) or tray(s) listed in **A.3.5** with a minimum clearance of 20 mm in all directions. The container(s) shall have a volume at least five times the volume of the test portion.

A.3.7 *Waterbath*, thermostatically controlled, or other suitable means of maintaining the temperature of the solution in the container(s) at (20 ± 2) °C.

A.3.8 *Ventilated drying oven*, thermostatically controlled to maintain a temperature of (110 ± 5) °C.

A.4 Reagents

A.4.1 *Sodium sulfate solution*. Dissolve sodium sulfate in hot water to give a concentration of 250 g of the anhydrous salt per litre of solution. Allow the solution to cool to (20 ± 2) °C with periodic stirring and keep within this temperature range during storage and use.

A.5 Preparation of the test portion

A.5.1 Reduce the laboratory sample in accordance with BS EN 932-2 to produce a test portion containing at least 40 pieces of aggregate retained in the 6.3 mm sieve (**A.3.2**) and passing the 63 mm sieve (**A.3.2**).

A.5.2 Examine the test pieces for incipient cracks or other obvious weaknesses brought about by their production, and remove any such pieces before carrying out the test.

A.5.3 Wash or scrub each test piece to remove loose dirt or dust. Dry the entire test portion at (110 ± 5) °C for 4 h and allow to cool. Using the balance (**A.3.3**), weigh each piece to the nearest 0.1 g and give it an identifying number.

A.5.4 Record the masses of the individual test pieces. Calculate and record the mean mass of the pieces.

A.6 Procedure

A.6.1 Prior to each use of the sodium sulfate solution, break up any salt cake in the container, stir the solution thoroughly and determine the specific gravity of the solution using the hydrometer (**A.3.4**). The solution shall have a specific gravity of not less than 1.151 and not more than 1.174 and the solution in the vessel shall be saturated at all times as indicated by the presence of crystals of sodium sulfate.

A.6.2 Place the dried test pieces in the basket(s) or tray(s) (**A.3.5**) and immerse in the sodium sulfate solution (**A.4.1**) in the container(s) (**A.3.6**). Ensure that the pieces are covered completely with solution. Immerse the container(s) in the waterbath (**A.3.7**).

A.6.3 After the test pieces have been immersed for 19 h, remove the basket(s) or tray(s) containing them from the solution and allow to drain for 2 min to 3 min, then place the pieces for 4 h in the drying oven (**A.3.8**) maintained at (110 ± 5) °C.

A.6.4 At the end of the 4 h drying period, remove the test pieces from the oven and allow them to cool, then test the pieces individually by twisting between the fingers. Record the incidence of incipient cracks, fractures (including spontaneous fractures), and disintegration, and the cycle number at which they occur. After 1 h of cooling, immerse the pieces again in the sodium sulfate solution.

A.6.5 Withdraw from the test any pieces which undergo disintegration (see Note) before the end of 20 cycles.

NOTE A piece is deemed to have suffered disintegration if it has fractured into four or more smaller pieces none of which has a mass greater than one half of the original mass of the piece.

A.6.6 Repeat the procedure in **A.6.1** to **A.6.5** a further 19 times. If for any reason the continuity of the test has to be interrupted, as for example over weekends, keep the sample in the solution.

NOTE One immersion, one drying and one cooling period constitutes a cycle. The treatment is applied for 20 cycles.

A.6.7 At the end of 20 cycles, wash the test pieces by allowing them to stand in running water for 24 h, then place the pieces for 4 h in the drying oven (**A.3.8**) maintained at (110 ± 5) °C. After cooling, weigh the pieces that have remained in the test.

A.7 Calculation and expression of results

A.7.1 Record:

a) the final mass of each test piece;

b) the difference between the final mass and the original mass of each test piece;

c) the change in mass of each test piece, expressed as a percentage of the original mean mass of all the pieces tested (see **A.5.4**);

d) the total loss in mass of all the test pieces, expressed as a percentage of the original total mass of all the test pieces.

A.7.2 When recording the results (**A.7.1**):

a) any test piece withdrawn from the test because it disintegrates before completion of the 20th cycle (see **A.6.5**) shall be deemed to have lost the whole of its mass;

b) any test piece which is fractured or so cracked that it is easily broken with the fingers, but is not disintegrated (see **A.6.5**), shall be ignored when calculating both the original total mass and final total mass of all the test pieces [see **A.7.1** d)]. The test piece is still considered as having failed [see **A.8.1** a)];

c) any increase in mass (such as might be caused by the retention of sodium sulfate in the pores) shall be ignored, the change in mass being recorded as zero.

A.8 Evaluation of results

A.8.1 *Pass/failure criteria for individual aggregate pieces*

A test piece shall be deemed to have failed the test:

a) if the test piece is fractured or so cracked that it is easily broken by the fingers; or

b) if the test piece has a loss in mass greater than 10 % of the original mean mass (**A.5.4**) of the pieces tested.

A.8.2 *Soundness criteria for the test portion*

A test portion shall be deemed to be unsound:

a) if the number of pieces which fail (see **A.8.1**) is equal to or greater than one tenth of the number of pieces tested; or

b) if the total loss in mass of all the test pieces [see **A.7.1** d)] is greater than 3 %.

A.9 Test report

The test report shall include the following information:

a) number and date of this British Standard, i.e. BS 1438:2004[2)];

b) source and description of the sample;

c) aggregate size submitted to the laboratory;

d) number of pieces of aggregate tested;

e) number of pieces that failed the criteria in **A.8.1**;

f) whether or not the test portion is sound, as defined in **A.8.2**;

g) a copy of the certificate of sampling, if available.

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Bibliography

BS 812-105.1:1989, *Testing aggregates — Part 105: Methods for determination of particle shape — Section 105.1: Flakiness index.*

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