

Testing concrete —

Part 128. Methods for analysis of fresh concrete

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Committees responsible for this British Standard

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- Association of Lightweight Aggregate Manufacturers
- British Aggregate Construction Materials Industries
- British Cement Association
- British Civil Engineering Test Equipment Manufacturers' Association
- British Precast Concrete Federation Ltd
- Building Employer's Confederation
- Cement Admixtures Association
- Cementitious Slag Makers' Association
- Chartered Institution of Water and Environmental Management
- County Surveyors' Society
- Department of the Environment
- Department of the Environment (Building Research Establishment)
- Federation of Piling Specialists
- Institute of Concrete Technology
- Institution of Structural Engineers
- National House-building Council
- Quality Ash Association
- Sand and Gravel Association Limited
- Society of Chemical Industry

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Foreword

This Part of BS 1881 has been prepared under the direction of Subcommittee B/517/1, Concrete production and testing. It supersedes DD 83 : 1983, which is withdrawn. Three of the five different methods for analysis of fresh concrete described in DD 83 : 1983 which are in common use have been retained in this standard.

All determine the total cement content, but in only two methods can further tests be made to determine the proportions of pulverized-fuel ash (pfa) or ground granulated blastfurnace slag (ggbs) in blended cements. Water content may be obtained by calculation, or more directly on separate samples, by drying them in a microwave oven.

If the results are used to provide a water/cement ratio, it should be realized that the tolerance on accuracy will depend on the combination of the precision data for each test for cement and water contents.

Each test relies for accuracy on calibration using the materials in the concrete mix. The tests are not intended to be used for checks on random samples of concretes with unknown constituents. Although the tests refer to British Standards for sieve sizes, they will still be applicable when European Standards are adopted, however, the size limit between coarse and fine aggregate will change.

Fine aggregate is commonly known as sand in the UK and this term will be used throughout the text of this standard.

Changes to other European Standards for cements are unlikely to affect the tests.

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 26, an inside back cover and a back cover.

Method

1 Scope

This Part of BS 1881 describes the sampling procedures, treatment of samples and test methods to be used on a sample of fresh concrete to determine the cement content, the aggregate content and the water content.

All the procedures described apply to concretes made with Portland cements. Some of the methods can also be used to determine the proportions of pulverized-fuel ash (pfa) and ground granulated blastfurnace slag (ggbfs).

2 References

2.1 Normative references

This Part of BS 1881 incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the publications are listed on the inside back cover. For dated references, only the edition cited applies; any subsequent amendments to, or revisions of the cited publications apply to this Part of BS 1881 only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

2.2 Informative references

This Part of BS 1881 refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definitions

For the purposes of this Part of BS 1881 the definitions in BS 6100 : Sections 6.2 and 6.3 apply, together with the following:

3.1 coarse aggregate

Aggregate retained on a 5 mm test sieve.

3.2 sand

Aggregate passing a 5 mm test sieve.

3.3 batch

Quantity of concrete mixed in one cycle of operations of a batch mixer, or the quantity discharged during 1 min from a continuous mixer, or where this is the greater volume, the quantity conveyed in a truck mixer.

3.4 concrete sample

Sample of concrete of mass sufficient to allow test samples to be extracted.

3.5 test sample

Portion of the concrete sample that is tested.

4 Sampling

4.1 General

For the test results to be valid, it is important that the procedure by which the initial concrete sample is taken from the concrete is as given in this standard. Any deviations from such procedure shall be reported.

4.2 Apparatus

4.2.1 Scoop, of galvanized steel or other suitable non-corrodible material, that when filled will contain about 2.5 kg of concrete.

4.2.2 Sample containers, made of non-corrodible metal or plastics of appropriate size, to contain the mass of concrete given in table 1.

4.3 Procedure

Using the method described in BS 1881 : Part 101, take the required number of scoopfuls of concrete necessary to provide concrete samples of appropriate mass shown in table 1 and transfer them to clean, dry containers (4.2.2).

Table 1. Concrete sample and test sample masses

Method of analysis	Mass of test samples kg
Buoyancy	4 ± 0.5
Constant volume (RAM)	8 ± 1
Pressure filter (Sandberg)	3 ± 0.5
Water content	2.5 ± 0.5

4.4 Certificate of sampling

Each sample shall be accompanied by a certificate of sampling, signed by the person responsible for the sampling, confirming that the sample was taken in accordance with the requirements of BS 1881 : Part 101.

5 Methods of analysis

5.1 General

Each of the three methods of analysis described in this British Standard have been used under site conditions for more than ten years and the test results have been found to be of value in the determination of the composition of fresh concrete.

Each test relies for accuracy on a calibration using the same materials as those in the concrete mix. In order to minimize the risk of an incorrect result due to operator error or apparatus malfunction, all tests shall be carried out twice. Calibrations shall be performed for each combination of constituent materials used and whenever significant changes to the materials occur, in particular the content of material finer than 150 μm .

The flow chart in figure 1 provides guidance on the appropriate method of analysis to be used for the determination of the cement, aggregate and water content.



5.2 Applicability

The methods of analysis described in this British Standard may not be of equal suitability or accuracy over the whole range of concretes that may be encountered in practice. Other factors, such as the number of tests to be carried out within a given time, ease of operation and cost, will also influence the choice of the most appropriate method of analysis for a given job.

5.3 Buoyancy method

In this method, described in annex A, the cement and water contents are determined by difference. The standard procedure does not provide a sample of material passing 150 µm for more detailed analysis.

A 4 kg concrete sample is weighed in air and water and then washed over a nest of sieves to separate the cement and aggregate passing a 150 µm test sieve. The washed aggregate is weighed in water and the proportions of cement, coarse aggregate and sand calculated on the basis of pre-determined values of particle densities.

5.4 Constant volume (RAM) method

In this method, described in annex B, the cement content is determined directly. It is recommended that the water content is determined on a separate sample. The quantity of coarse aggregate is obtained by direct weighing and there is a procedure for determining the sand content.

The operation of the Rapid Analysis Machine (RAM) is controlled automatically by an electronic sequence timer after loading with the test sample. At the end of the timed sequence (6 min) the constant volume vessel is removed from the machine and the cement content of the sample determined from a calibration graph.

5.5 Pressure filter (Sandberg) method

In this method, described in annex C, allowances are made for the aggregate passing 150 µm mixed with the cement and the solubility of the cement. The aggregate is collected from the sieves, dried and weighed. The water content can be determined on a separate sample and the particles passing 150 µm are available for more detailed analysis.

A 3 kg concrete sample is weighed, agitated with water and then washed over a nest of sieves to separate the cement and aggregate passing a 150 µm sieve. The washings are filtered through a filter paper using a pressure filter and then the solids are dried and weighed.

6 Determination of cement content

6.1 General

The analyses are primarily to determine the whole cement content. Further analyses can then be made to determine cement composition as applicable.

6.2 Applicability

The methods of analysis described in this standard use particle size to distinguish cement from aggregate. They give procedures to correct for aggregate particles passing a 125 µm sieve based on the analysis of the raw materials. Provided samples of raw materials are available, the methods are suitable for use on all concretes.

6.3 Procedure

Determine the total content of cement by the method described in annex A, annex B or annex C.

6.4 Pfa content

Determine the pfa content of the mix by the particle density method described in annex D.

NOTE. The measured pfa content will include any incorporated in the cement as a minor additional material

6.5 Ggbs content

Determine the ggbs content of the mix by the chemical method described in annex E.

NOTE 1. Other methods can be used by agreement between the purchaser and supplier of the concrete.

NOTE 2. The measured ggbs content will include any incorporated in the cement as a minor additional material.

7 Determination of water content

7.1 General

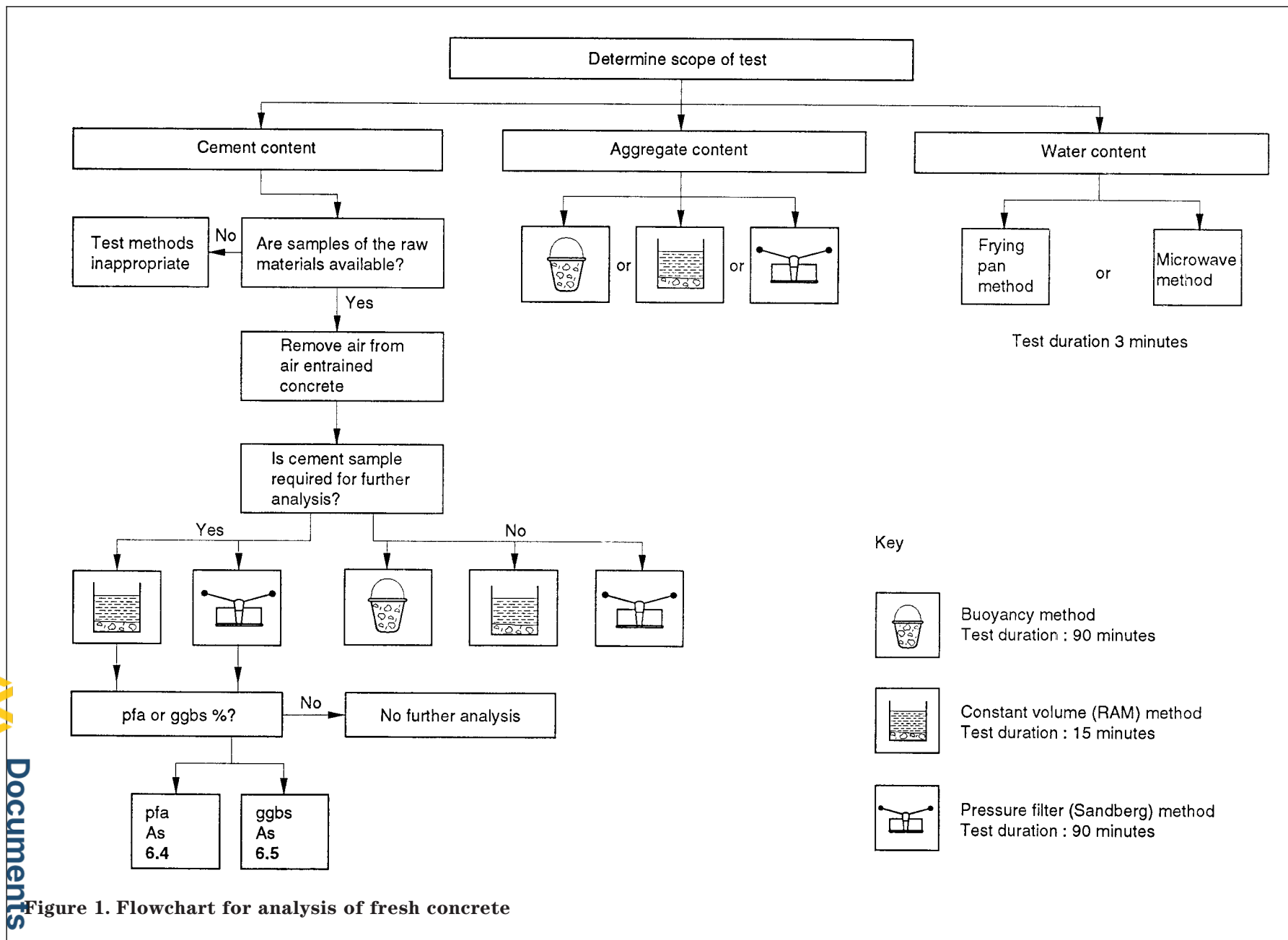
The determination of the water/cement ratio of concrete is normally based on the free water content of the concrete at the time of mixing, where the free water content equals the total water content less the water absorption of the fine and coarse aggregates.

BS 812 : Part 109 describes three methods for the determination of the moisture content of aggregates which can be used, with minor modifications, to determine the total water content of fresh concrete:

- a) oven-drying method, see annex F;
- b) high temperature method, see annex G;
- c) microwave oven method, see annex H.

Table 2. Applicability of test methods				
Method of analysis	Cement content	Aggregate content	Water content	Recovery of fraction finer than 150 µm
Buoyancy	Yes	Yes	1)	No
Constant volume (RAM)	Yes	Yes	1)	Yes
Pressure filter (Sandberg)	Yes	Yes	1)	Yes
Water content	No	No	Yes	No

1) Water content can be calculated by difference, but the accuracy of the result will reflect any errors in the determination of the cement and aggregate contents.



8 Determination of aggregate content

8.1 General

All of the test methods outlined in clause 5 separate the total aggregate content into coarse, fine and passing 150 μm fractions which can be recovered and analysed in accordance with BS 812 : Section 103.1. The procedure for recovering the aggregate is specific to each test method.

8.2 Buoyancy method

Recover the total aggregate content of the concrete test sample retained on the 5 mm and 150 μm sieves for grading after weighing in water. Determine the mass of the particles passing the 150 μm sieve from the grading correction factor.

8.3 Constant volume (RAM) method

Recover the sand retained on the sieve and determine its grading. From these values calculate the total mass of sand carried away in the slurry using the RAM sampling factor. Recover the aggregate from the elutriation column of the RAM and sieve to obtain a sample grading. Determine the mass of material passing the 150 μm sieve using the fines correction factor.

8.4 Pressure filter (Sandberg) method

Collect the aggregates from the sieves and determine the mass of the material passing the 150 μm sieve to obtain the fines content.

9 Other constituents

9.1 General

The fresh concrete sample obtained as described in clause 4 may also be used for the determination of chloride, sulfate and alkali contents but details of these chemical analysis methods are outside the present scope of this standard.

9.2 Entrained air

When air-entrained concrete is being analysed, the density and air content of the batch shall be determined.

The amount of air entrained by admixtures other than air-entraining admixtures is normally insignificant (0.5 % to 1.0 %). In cases of doubt, the concrete should be treated as being air-entrained.

NOTE. When calculating the mass of each constituent in a sample in kilograms per cubic metre (kg/m^3), use the density determined on the air-entrained concrete.

10 Report

10.1 General

The report shall affirm that the analysis was made in accordance with this Part of BS 1881. If alternative procedures are used, these should be described with the reason for their use.

A copy of the certificate of sampling shall be provided with the report.

The following information shall be included in the report:

- a) method of analysis used;
- b) method of determining water content;
- c) density of fresh concrete used in calculation of results as determined by BS 1881 : Part 107;
- d) the determined contents of constituents, in kg/m^3 ;
- e) date and time of sampling to provide materials for the calibration tests;
- f) date and time of last calibration tests for the test method used;
- g) the assessment of the accuracy of the test, in accordance with annex J.

Annex A (normative)

Buoyancy method

A.1 Test principle

A.1.1 General

A test sample, obtained in accordance with clause 4, is weighed in air and in water and then washed over a nest of sieves to separate the material passing a 150 μm test sieve from the aggregate. The washed aggregate is weighed in water and the proportions of cement, coarse aggregate, sand and water are then calculated. The addition of a chemical substance to disperse air is used when air-entrained concrete is to be analysed.

A.1.2 Samples of raw materials required

Samples of coarse aggregates and sand, typical of those used in the concrete to be analysed, are required for the determination of the proportion of the aggregate that passes a 150 μm test sieve, and for the determination of their particle densities. A sample of the cement, typical of that used in the concrete to be analysed, is required for the determination of its density.

A.2 Reagent

Tri-n-butyl phosphate, general purpose reagent grade (required for air-entrained concrete only).

A.3 Apparatus (see figure A.1)

A.3.1 Balance, of a suitable type for weighing the containers (A.3.3) in both air and water. The balance shall have a minimum capacity of 5 kg and be readable to within 0.5 g.

A.3.2 Stirrup assembly, such that the containers (A.3.3) can be suspended from the balance. The stirrup shall be marked in such a way as to ensure that the container when suspended on the stirrup can be fully immersed to a constant depth.

A.3.3 Eight bucket shaped containers, of corrosion-resisting metal, each of (200 ± 5) mm diameter at the top and (180 ± 5) mm deep, having smooth sloping sides and a rounded bottom to prevent the trapping of air during immersion. The eight containers shall have the same known mass in air to within ± 0.25 g

A.3.4 Water tank, of sufficient size to allow a container (A.3.3) on the stirrup (A.3.2) to be fully immersed to a constant depth.

A.3.5 Two nesting sieves, conforming to BS 410, approximately 450 mm in diameter and 300 mm deep, the upper sieve being fitted with a perforated plate of 5 mm square aperture size, and the lower sieve being fitted with woven wire cloth of 150 μm aperture size. The 150 μm sieve shall be provided with a wire support below the mesh.

A.3.6 Funnel and support frame, a typical design of which is shown in figure A.1.

A.3.7 Hose, fitted with a nozzle that, when fed with water at normal mains pressure, gives a fine spray strong enough to move the particles of sand over the surface of the 150 μm mesh sieve.

A.3.8 Tamping rod, as described in 3.5 of BS 1881 : Part 102.

A.4 Calibration tests

A.4.1 General

Determine the density of the cement, and the particle densities of the coarse aggregates and sand. Determine also a fines correction factor to allow for that fraction of the coarse aggregate and sand used in the concrete that passes a 150 μm sieve.

NOTE. The accuracy of the results depends to a great extent on the reliability of the estimates obtained from the above determinations. It cannot be assumed that the results of the calibration tests will remain constant.

A.4.2 Density of the cement

Determine the density of the cement by the method described in BS EN 196-6.

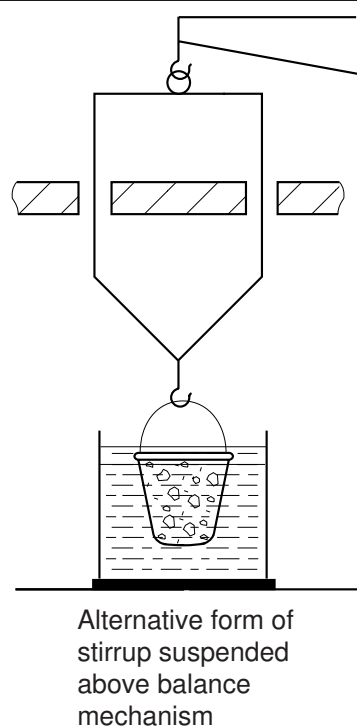
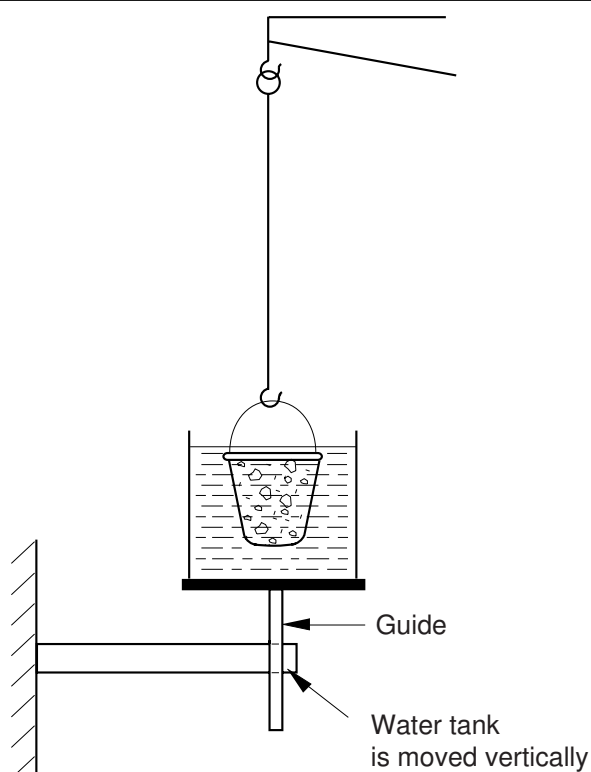
A.4.3 Determination of the particle densities of the aggregates

A.4.3.1 Aggregate samples

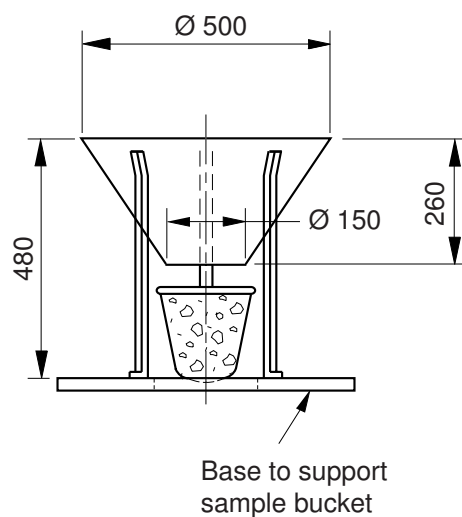
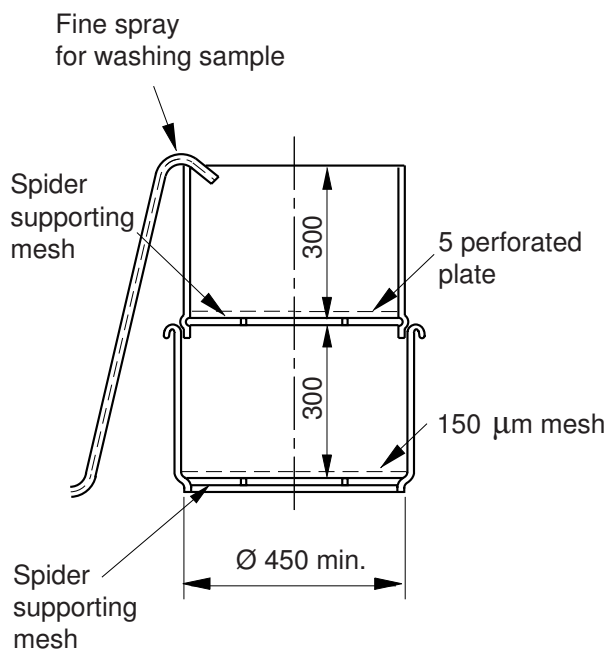
Obtain representative samples of the coarse aggregate and sand to be used in the concrete to be analysed, by the appropriate method described in BS 812 : Part 102.

A.4.3.2 Sub-samples of aggregates

Assuming a concrete test sample mass of 4 kg, calculate from the expected mix proportions the saturated surface dry (SSD) mass of the coarse aggregate and sand in such a sample. Then reduce each bulk sample of aggregate by the methods described in BS 812 : Part 102 to provide a sub-sample containing aggregate of between one and two times the appropriate calculated SSD mass. Take sub-samples of the coarse aggregate fractions, making any necessary allowance for the free water in the aggregate, to provide a composite coarse aggregate sample of the mass previously calculated for a 4 kg sample of concrete. Then, separately, repeat this operation for the sand.



a) Typical balance and support methods



b) Funnel and support method

All dimensions in millimetres, unless otherwise stated.

Figure A.1 Apparatus for buoyancy method