British Standard

BS 1881 :
Part 129 : 1992

Testing concrete

Part 129. Method for determination of density of partially compacted semi-dry fresh concrete

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Technical Sector Board for Building and Civil Engineering (B/-) to Technical Committee CAW4, upon which the following bodies were represented:

Association of Lightweight Aggregate Manufacturers.
Association of Metropolitan Authorities
Association of Quality Pulverised Fuel Ash Suppliers
British Aggregate Construction Materials Industries
British Cement Association
British Civil Engineering Test Equipment Manufacturers Association
British Precast Concrete Federation
British Ready Mixed Concrete Association
Building Employers Confederation
Cement Admixtures Association
Cementitious Slag Makers Association
Concrete Society
County Surveyors' Society
Department of the Environment (Building Research Establishment)
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Department of Transport
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National House-building Council
Sand and Gravel Association
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The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

Association of Consulting Scientists
Department of Trade and Industry (National Measurement Accreditation Service)

This British Standard, having been prepared under the direction of the Technical Sector Board for Building and Civil Engineering, was published under the authority of the Standards Board and comes into effect on 28 February 1992

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Contents

Foreword

This Part of BS 1881 has been prepared under the direction of the Technical Sector Board for Building and Civil Engineering. It describes a method of test for determining the density of partially compacted semi-dry fresh concrete, primarily to establish the correct yield when this type of concrete is produced by a ready mixed concrete plant for applications such as kerb backing and Minding.

The density of compacted fresh concrete can be measured by the method described in BS 1881 : Part 107 but that method is not applicable to concrete that cannot be compacted by vibration alone. Semi-dry concrete has a very low workability, with a slump generally not more than 6 mm when measured in accordance with BS 1881 : Part 102. The method developed for this typo of concrete relies on compacting it by tamping, as used in the method for making no-fines concrete test cubes described in BS 1881 : Part 113.

Tests in accordance with this Part of BS 1881 are not applicable to lean concrete for road bases and other fully compacted very low workability concretes which have their own methods of density measurement included in their specifications, e.g. the Department of Transport *Specification for Highway Works* in respect of cement bound material for roadbase and sub-base.

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

Method

1 Scope

This Part of BSI 1881 describes a method for determining the density of partially compacted semi-dry fresh concrete. The method applies to plain and air-entrained concrete, made with aggregates having a nominal maximum size of 40 mm or less, but not to concrete with a slump of more than 5 mm when tested in accordance with BS 1881 : Part 102.

NOTE 1. The method for the determination of density of concrete with a slump of more than 5 mm is described in BS 1881 : Part 107.

NOTE 2. 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 1881 the definitions given in BS 6328 : Part 1 and BS 1881 Part 101 apply, together with the following.

2.1 density

Mass of a quantity of partially compacted semi-dry fresh concrete divided by its volume, expressed in kg/m^3.

2.2 semi-dry concrete

Very low workability concrete with a low water content and of a consistence producing a slump of less than 5 mm, which is too low to be measured with precision by the test described in BS 1881 : Part 102.

3 Apparatus

3.1 *Scales or balance*, capable of weighing the container (3.2) to an accuracy of 10 g or better at calibration and to an accuracy of 25 g or better during the measurement of density. Suitable capacities are likely to be 20 kg for the calibration and 60 kg for the measurement of density.

The balance shall be calibrated on initial commissioning and at least annually thereafter using weights of which the accuracy can be traced to the national standard of mass. The balance shall be recalibrated after relocation or disturbance. A certificate stating the accuracy shall be obtained from the organization carrying out these calibrations.

3.2 *Container*, watertight rigid cylinder of the dimensions specified in table 1, made of metal not readily attacked by cement paste, having a smooth internal face, the rim machined to a plane surface, the rim and base at right angles to the axis, and provided with handles.

Table 1. Dimensions of container

Nominal capacity	Inside diameter	Inside height	Minimum thickness of metal	Nominal internal radius between wall and base
m^3	mm	mm	mm	mm
0.01	200.0 ± 1.5	320.0 ± 1.5	4.0	20.0

3.3 *Scoop*, as described in 3.1 of BS 1881 : Part 101 : 1983.

3.4 *Tamper*, made of metal and of robust construction comprising a rammer and a guide tube, secured to the base of which is a flat, metal bearing plate. (See figure 1 for typical construction.) The rammer shall have a mass of 2500 ± 25 g and the complete tamper of 7700 ± 100 g. The rammer shall be able to fall 300 ± 3 mm. The bearing plate shall be circular of diameter 197.0 ± 1.5 mm and thickness not less than 12 mm.

NOTE. A suitable apparatus is the 2.5 kg rammer for the standard compaction test specified in BS 1377 : Part 4, made of mild steel and having a circular mild steel bearing plate welded centrally to the bottom of the guide tube. A similar, but not identical, apparatus that can also be used is described in BS 1881: Part 113.

3.5 *Straightedge*, made of steel, not less than 300 mm in length and not less than 4 mm in thickness.

3.6 *Glass pipette*, (if required), of known volume.

3.7 *Sampling tray*, minimum dimensions 900 mm x 900 mm x 50 mm deep of rigid construction and made from a non-absorbent material not readily attacked by cement paste.

3.8 *Square mouthed shovel*, size 2 in accordance with BS 3388.

3.9 *Thermometer*, 100 mm immersion, accurate to at least 0.6 °C and complying with BS 593 or BS 1704.

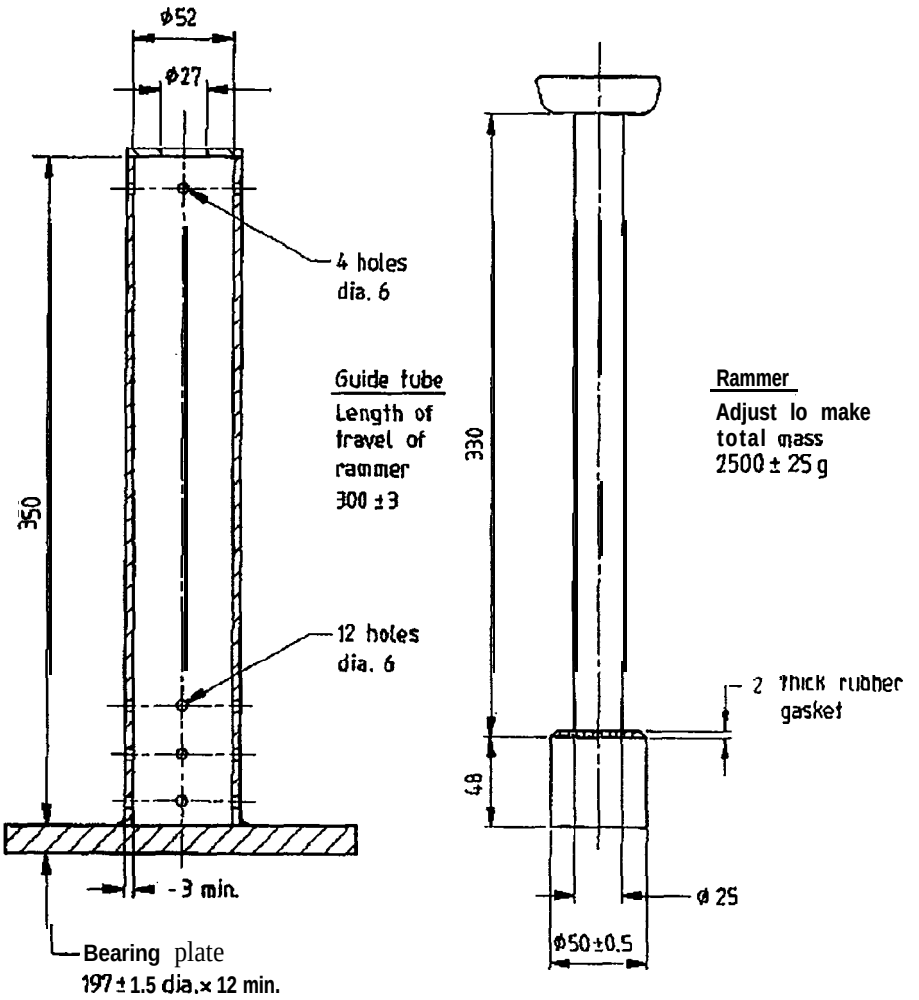
4 Calibration of the container

Weigh the empty container, place it on a horizontal surface and fill it with water at a temperature of *20 ± 5 °C so that no meniscus is above the rim.* If necessary, remove by means of a pipette a sufficient known volume of water to allow the container to be lifted and placed on the balance platform without loss of water. Weigh the container *and water.* Add the mass of any remnvcd water to the mass of water remaining in the container.

Calculate the capacity of the container, V, by dividing by 1000 kg/m^3 the mass of water, to the nearest 10 g, required to fill the container. Express the capacity to the nearest 0.00001 m^3. Calibrate the container before initial use and at least annually thereafter.

5 Sampling

Obtain the sample of fresh concrete by the procedure described in BS 1881 : Part 101 or BS 1881 : Part 125. Keep the sample covered to minimize evaporation. Commence the determination of the density as soon as possible, and not more than 30 min, after sampling.



NOTE 1. All dimensions shown are in millimetres.

NOTE 2. This design has been found satisfactory, but alternative designs may be used provided that the essential requirements are fulfilled.

Figure 1. Typical tamper for partially compacted semi-dry fresh concrete density test.

6 Preparing the sample for test

CAUTION. When cement is mixed with water, alkali is released. Take precautions to avoid dry cement entering the eyes, mouth and nose when mixing concrete. Prevent skin contact with wet cement or concrete by wearing suitable protective clothing. If cement or concrete enters the eye, immediately wash it out thoroughly with clean water and seek medical treatment without delay. Wash wet concrete off the skin immediately.

6.1 Empty the sample from the sample container(s) onto the sampling tray. Ensure that no more than a light covering of slurry is left adhering to the sample container(s).

6.2 Thoroughly mix the sample by shovelling it to form a cone on the sampling tray and turning this over with the shovel to form a new cone, the operation being carried out three times. When forming the cones, deposit each shovelful of the material on the apex of the cone so that the portions which slide down the sides are distributed as evenly as possible and so that the centre of the cone is not displaced. Flatten khe third cone by repeated vertical insertion of the shovel across the apex of the cone, lifting the shovel clear ok' tbe concrete after each insertion. Ensure that the flattened heap is uniform in thickness and diameter.

6.3 Divide the sample into four portions by quartering the flattened heap along two diameters intersecting at right. angles. Replace one pair of diagonally opposite quarters into the sample container(~) and shovel the remainder into a heap and remix as before. This material will form the first test portion. Retain the second test portion in the sample container(s) until required for testing. Then empty it onto the sampling tray and remix it as described in 6.2.

7 Procedure

7.1 Use the scoop to place carefully a layer of concrete about 110 mm deep into the container from the first test portion. Level the surface of the concrete with gloved fingers, taking care not to compact it. Carefully place the circular bearing plate of the tamper on top of the concrete with the axis of the tamper vertical. Raise the rammer to the top of its travel so that it just touches the top of the sleeve without slack. Allow the rammer to drop freely. Complete 16 such blows on the bottom layer of concrete.

7.2 Repeat the procednre described in 7.1 for a second and third layer. Fbr the fourth layer, overfill the container and slightly heap the concrete towards the centre and apply only five blows of the rammer. Remove the tamper and add or remove sufficient concrete such that after a further 10 blows the surcharge of concrete is between 5 nun and 10 nun above the rim of the container. If the surcharge is not between 5 nun and 10 mm after completion of compaction then repeat the test.

7.3 With the straightedge, remove the surplus concrete using a sawing action about 5 mm above the rim. Remove large aggregate particles protruding above the rim individually. Then strike the concrete off level with the rim and fill any holes with fines from the surplus concrete, to obtain a reasonably flat; and level surface. Care should be taken not to overcompact the concrete by applying undue pressure when finishing the surface.

Weigh the. filled container, subtract the mass of the empty container and record the mass of concrete in the container, m, to the nearest 25 g.

7.4 Empty and clean the container and then repeat the procedures described in 7.1 to 7.3 on the second test potion.

8 Calculation and expression of results

8.1 Calculation af density

Calculate the density, D, (in kg/m^3) for each test portion using the following equation:

$$D = \frac{m}{V} \qquad (1)$$

where

m is the mass of concrete sample in the container (in kg);

V is the capacity of the container (in m^3).

Express the result to the nearest 10 kg/m^3.

Calculate the average of the two determinations and the difference between them. If the difference is 40 kg/m^3 or more discard the results and repeat the test on a new sample of concrete.

If the difference is 30 kg/m^3 or less, report the average.

8.2 Calculation of the volume of concrete per batch

If the volume of concrete produced per batch, V_b, is required, calculate it (in m^3) using the following equation:

$$V_b = \frac{m_c + m_s + m_a + m_w}{D} \qquad (2)$$

where

m_a is the mass per batch of coarse aggregate, in the condition used (in kg);

m_c is the mass per batch of cement (in kg);

m_s is the mass per batch of fine aggregate, in the condition used (in kg);

m_w is the mass of mixing water added to the batch (ii kg);

D is the density of partially compacted semidry fresh concrete obtained in accordance with 8.1 (in kg/m^3).

Express the result of an accuracy of 1%.

9 Precision

Precision data are given in table 2.

Table 2. Precision data for density of partially compacted semi-dry fresh concrete

Average density	Repeatability, r	Reproducibility, R
kg/m^3	kg/m^3	kg/m^3
2035	30	30

NOTE 1. The precision data were obtained in an experiment carried out in 1988 involving 15 operators. The experiment was designed and the data analysed following the principles given in BS 5497 : Part 1. The material used was a 1.5 m^3 batch of semi-dry fresh concrete, mixed from 20 mm gravel coarse aggregate, grading M of BS 882 : 1983 fine aggregate and containing 175 kg/m^3 of ordinary Portland cement. Each operator took a sample of at least 50 L and obtained two test results on this sample, each test result being the average of two determinations. Sampling and sample reduction was in accordance with BS 1881 : Part 101.

NOTE 2. The difference between two test results obtained on the same sample of semi-dry fresh concrete, within a short time interval, by one operator using the same equipment will exceed the repeatability limit r (see table 2) on average in not more than 1 in 20 cases in the normal and correct operation of the method.

NOTE 3. The difference between two test results obtained on different samples of the same load of semi-dry fresh concrete, within a short time interval, by different operators each using their own equipment will exceed the reproducibility limit R (see table 2) on average in not more than 1 in 20 cases in the normal and correct operation of the method.

10 Test report

10.1 General

The test report shall affirm that the density was determined in accordance with this Part of BS 1881. The report shall also state whether or not a certificate of sampling is available. If available, a copy of the certificate shall be provided.

10.2 Information to be included in the report

10.2.1 *Obligatory information*

The following information shall be included in the test report:

(a) date, Lime and place of sampling and sample identity number;

(b) time and place of test;

(c) identification number; capacity and date of latest calibration of the container;

(d) density of partially compacted semi-dry fresh concrete sample;

(e) name of person carrying out the test.

10.2.2 *Optional information*

If requested, the following information shall be included in the test report:

(a) name of project and place where concrete was used;

(b) name of supplier and source of concrete;

(c) date and time of production of concrete or delivery to site;

(d) specification of concrete mix, e.g. GEN1, ST1.

Publication(s) referred to

BS 593	Specification for laboratory thermometers
x3882	Specification for aggregates from natural sources for concrete
BS 1377	Methods of test for soils for civil engineering pm-poses Part 4 Compaction-related tests
BS 1704	Specification for solid-stem general purpose thermometers
BS 1881	Testing concrete Part 101 Method of sampling fresh concrete on site Part 102 Method for determination of slump Part 107 Method for determination of density of compacted hesh concrete Part 113 Method for making and curing no-fines test cubes Part 126 Methods for mixing and sampling fresh concrete in the laboratory
BS 3388	Specification for forks, shovels and spades
Bs 6328	Concrete Part 1 Guide to specifying concrete
BS 6497	Precision of test methods Part 1 Guide far the determination of repeatability and reproducibility for a standard test method by inter-laboratory tests

[1]Department of Transport. '*Specification for Highway Works*'.

[1] Referred to la the foreword only and obtainable from HMSO.

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