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British Standard

Testing concrete

Part 107. Method for determination of density of compacted fresh concrete

Essais du béton

Partie 107. Méthode de determination de la masse volumique du béton frais compacte'

Prüfverfahren für Beton

Teil 107. Verfahren zur Bestimmung der Dichte von verdichtetem Frischbeton

Foreword

This Part of this British Standard, prepared under the direction of the Cement, Gypsum, Aggregates and Quarry Products Standards Committee, is a revision of clause 5 of BS 1881 : Part 2 : 1970. Testing in accordance with this Part of this standard will comply with ISO 6276. Together with Parts 102,103,104 and 106, this Part of BS 1881 supersedes BS 1881 : Part 2 : 1970, which is withdrawn. If other methods of determining density are used, it needs to be demonstrated that the results obtained are comparable with those obtained in the method described in this Part.

No estimate of repeatability or reproducibility is given in this Part of this British Standard. Reference should be made to BS 5497 : Part 1 for further information on the determination of repeatability and reproducibility.

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

1. Scope

This Part of this British Standard describes a method for determining the density of compacted fresh concrete. The method applies to plain and air-entrained concrete, made with lightweight, normal weight or heavy aggregates having a nominal maximum size of 40 mm or less, but not to aerated concrete or very stiff concrete which cannot be compacted by vibration alone. Formulae are given for calculating the volume of concrete per batch and the cement content per cubic metre.

NOTE. The titles of publications referred to in this standard are listed on page 3.

2. Definitions

For the purposes of this Part of this British Standard the definitions given in BS 5328 and BS 1881 : Part 101 apply together with the following.

density. The mass of a quantity of compacted fresh concrete divided by its volume, expressed in kilograms per cubic metre.

3. Apparatus

3.1 *Scales or balance.* Scales or balance capable of weighing up to 50 kg to an accuracy of 25 g or better.

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 checked after relocation or disturbance. A certificate stating the accuracy shall be obtained from the Organization carrying out the check.

3.2 Container. A watertight container, of sufficient rigidity to retain its shape, conforming to 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 cylindrical container

Nominal capacity	Inside diameter	inside height	Minimum thickness of metal	Radius between wall and base
m3	mm	mm	mm	mm
0.01	200 ± 1.5	320 ± 1.5	4	20

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

3.4 Compacting bar or vibrator. Compacting bar made from iron or steel weighing 1.8 ± 0.1 kg, at least 380 mm long and having a ramming face 25.0 ± 0.5 mm square, or a vibrating hammer or table suitable for compacting the concrete in accordance with 7.2 or 7.3.

3.5 Plasterer's steel float.

3.6 Straightedge, made of steel, not less than 300 mm in length.

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

3.8 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.

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

4. Calibration of the container

Weigh the empty container, place it on a horizontal surface and fill 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, 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 removed water to the mass of the water remaining in the container. Calculate the capacity of the container by dividing the mass of water, to the nearest 0.01 kg, required to fill the container, by 1000 kg/m3. Express the capacity to nearest 0.00001 m3.

Calibrate the container before initial use and at least annually thereafter .

5. Sampling

Obtain the sample of fresh concrete by the procedure given in BS 1881 : Part 101 or Part 125. Commence the determination of the density as soon as possible after sampling.

6. Preparing the sample for test

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

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 the third cone by repeated vertical insertion of the shovel across the apex of the cone, lifting the shovel clear of the concrete after each insertion.

NOTE. The following modifications to the mixing procedures may be necessary when preparing samples of very high workability concrete (e.g. superplasticized concrete) for test.

(a) *Sampling* tray. The vertical lips on the edges of the tray may have to be larger to contain the sample without spillage during mixing.

(b) *Mixing the sample.* The coning procedure is not suitable for very high workability concrete and the following alternative method of mixing is recommended. Having poured the concrete onto the sampling tray, use the shovel to turn the concrete from the outside toward the centre, working progressively once round all sides of the sampling tray.

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.

7. Procedure

7.1 General. Fill the container with concrete in such a way as to remove as much entrapped air as possible (without significantly reducing the amount of entrained air, if present) and to produce full compaction of the concrete with neither excessive segregation nor laitance. For this purpose, by means of the scoop, place the concrete in the container in six layers approximately equal in depth and compact each layer by using either the compacting bar or the vibrator in the manner described in 7.2 or 7.3. After the top layer has been compacted, smooth it level with the top of the container, using the plasterer's float, skim the surface with the straightedge and wipe clean the outside of the container. Weigh the container and its contents to the nearest 10 g, and by subtracting the mass of the empty container calculate and record the mass of the fullycompacted concrete to the nearest 10 g.

7.2 Compacting with compacting bar. When compacting each layer with the compacting bar, distribute the strokes of the compacting bar in a uniform manner over the cross section of the container, and ensure that the compacting bar does not penetrate significantly any previous layer nor forcibly strike the bottom of the container when compacting the first layer. The number of strokes per layer required to produce full compaction will depend upon the workability of the concrete but in no case shall the concrete be subjected to fewer than 80 strokes per layer. Record the number of strokes.

7.3 Compacting with vibrator. When compacting each layer by means of the vibrating hammer or table use applied vibration of the minimum duration necessary to achieve full compaction of the concrete. Over-vibration may cause excessive segregation and laitance or loss of entrained air, if present. The required duration of vibration will depend. upon the workability of the concrete and the effectiveness of the vibrator and vibration shall cease as soon as the surface of the concrete becomes relatively smooth and has a glazed appearance. Record the duration of vibration.

8. Calculation and expression of results

8.1 Calculation of density. Calculate the density, *D,* (in kg/m3) from the formula:

$$D = \frac{m}{V}$$

where:

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

V is the capacity of the container (in m3 I.

Express the result to the nearest 10 kg/m3.

8.2 Precision. Precision data are given in table 2. These apply to density measurements made on concrete taken from the same sample and when each test result is obtained a single density determination.

Table 2. Precision data for density of fresh concrete measurements

Range	Repeatability conditions		Reproducibility conditions	
	s_r	r	s_R	R
kg/m³	kg/m³	kg/m³	kg/m³	kg/m³
2300 t o 2400	5.5	15	10.2	29

NOTE 1. The precision data were determined as part of an experiment carried out in 1987 in which precision data were obtained for several of the tests described in BS 1881. The experiment involved 16 operators. The concretes were made using en ordinary Portland cement, Thames Valley sand, and Thames Valley 10 mm and 20 mm coarse aggregates.

NOTE 2. The difference between two test results from the same sample by one operator using the same apparatus within the shortest feasible time interval will exceed the repeatability valuer on average not more than once in 20 cases in the normal and correct operation of the method.

NOTE 3. Test results on the same sample obtained within the shortest feasible time interval by two operators each using their own apparatus will differ by the reproducibility value R on average not more than once in 20 cases in the normal and correct operation of the method.

NOTE 4. For further information on precision, and for definitions of the statistical terms used in connection with precision, see BS 5497 : Part 1.

8.3 Calculation of volume of concrete per batch. If the volume of concrete produced per batch, V_b, is required, calculate it (in m3) from the formula:

$$V_b = \frac{m_c + m_s + m_a + m_w}{D}$$

where:

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

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

D is the density of fully-compacted fresh concrete (in kg/m3).

Express the result to an accuracy of 1 %.

8.4 Calculation of cement content. If the cement content, C, (in kg/m3) of the fresh concrete is required, calculate it from the formula (see 8.2 for definition of symbols):

$$C = \frac{m_c}{V_b} \text{ or } C = \frac{D\, m_c}{m_c + m_s + m_a + m_w}$$

Express the result to the nearest 5 kg/m³.

9. Report

9.1 General. The report shall affirm that the density was determined in accordance with this Part of this British Standard. The report shall also state whether or not a certificate of sampling is available. If available a copy of the certificate shall be provided.

9.2 Information to be included in the report

9.2.1 *Mandatory information.* The following information shall be included in the test report:

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

(b) time and place of test;

(c) capacity of container and date of latest calibration:

(d) method of compaction (hand or vibration) including type of equipment used, the number of strokes of the compacting bar or the duration of vibration;

(e) density of compacted sample;

(f) name of person carrying out test.

9.2.2 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. strength grade and nominal air content);

(e) workability of the concrete;

(f) volume of concrete per batch;

(g) cement content of the concrete.

Publications referred to

BS 1881 Testing concrete
Part 101 Sampling fresh concrete on site
*Part 102 Method for determination of slump
*Part 103 Method for determination of compacting factor
*Part 104 Method for determination of Vebe time
*Part 106 Methods for determination of air content of fresh concrete
Part 125 Methods for mixing and sampling fresh concrete in the laboratory
BS 3388 Forks, shovels and spades
BS 5328 Methods for specifying concrete, including ready-mixed concrete
BS 5497. Precision of test methods
Part 1 Guide for the determination of repeatability and reproducibility for a standard test method
IS0 6276, Concrete, compacted fresh – Determination of density

*Referred to in the foreword only.

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Committees responsible for this British Standard

This British Standard was published under the direction of the Cement, Gypsum, Aggregates end Quarry Products Standards Committee CAB/ — . Its preparation was entrusted to Technical Committee CAB/4 upon which the following bodies were represented:

British Aggregate Construction Materials Industries
British Precast Concrete Federation Ltd.
British Ready Mixed Concrete Association
Cement Admixtures Association
Cement and Concrete Association
Cement Makers' Federation
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Sand and Gravel Association Limited
Society of Chemical Industry

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