

BS 1881-129:2011



BSI Standards Publication

## Testing concrete

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

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### Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 8, an inside back cover and a back cover.

## Foreword

### Publishing information

This part of BS 1881 has been published by BSI and came into effect on 31 August 2011. It was prepared by subcommittee B/517/1 *Concrete production and testing* and Technical Committee B/517, *Concrete and related products*. A list of organizations represented on these committees can be obtained on request to their secretary.

### Supersession

This part of BS 1881 supersedes BS1881-129:1992 which is withdrawn.

### Relationship with other publications

BS 1881 contains test methods for concrete currently used in the United Kingdom which are not covered by BS EN 12350, BS EN 12390 or BS EN 12504. Reference is made to the relevant part of BS EN 12350, BS EN 12390 and BS EN 12504 where appropriate. These test methods may be used in conjunction with BS EN 206-1.

BS 1881 is published in the following parts:

- Part 113, Method for making and curing no-fines cubes;
- Part 119, Method for determination of compressive strength using portions of beams broken in flexure (equivalent cube method);
- Part 122, Method for determination of water absorption;
- Part 124, Methods for analysis of hardened concrete;
- Part 125, Method for mixing and sampling fresh concrete in the laboratory;
- Part 128, Method for analysis of fresh concrete;
- Part 129, Method for the determination of density of partially compacted semi-dry fresh concrete;
- Part 204, Recommendations on the use of electromagnetic covermeters;
- Part 206, Recommendations for determination of strain in concrete;
- Part 207, Recommendations for the assessment of concrete strength by near-to-surface tests;
- Part 208, Recommendations for the initial surface absorption of concrete;
- Part 209, Recommendations for the measurement of dynamic modulus of elasticity of concrete;
- DD 216, Method for the determination of chloride content of fresh concrete.

### Information about this document

This part of BS 1881 has been revised to reflect the change from British to European standard test methods. It describes a method of test for determining the density of partially compacted semi-dry fresh concrete. The density of compacted fresh concrete can be measured by the method described in BS EN 12350-6 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 10 mm when measured in accordance with BS EN 12350-2.

The method developed for this type of concrete relies on compacting it by tamping, as used in the method for making no-fines concrete test cubes described in BS 1881-113.

The type of concrete tested by this method would typically be used in applications such as kerb backing, pipe haunching and blinding.

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 Highways Agency Specification for Highway Works [1] in respect of hydraulically bound material for roadbase and sub-base.

### **Hazard warnings**

**CAUTION** — When cement is mixed with water, alkali is released. Take precautions to avoid dry cement entering the eyes, mouth and nose whilst 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.

### **Use of this document**

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

### **Presentational conventions**

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principle auxiliary verb is "shall".

*Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.*

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## 1 Scope

This part of this British Standard contains the method by which the density of semi-dry, partially compacted concrete can be obtained for the purpose of determining the quantity of materials necessary to generate a volume of 1 cubic metre, also known as the "yield". The method applies to plain concrete made with aggregate having a nominal maximum aggregate size,  $D_{\max}$  of 40 mm or less but not to concrete with a slump of more than 10 mm when tested in accordance with BS EN 12350-2.

*NOTE 1 The method for the determination of density of concrete with a slump of more than 10 mm is described in BS EN 12350-6.*

*NOTE 2 This method is not applicable to concrete designed to conform to the requirements of the Specification for Highway Works [1] which describes a specific method for to be applied to hydraulically bound materials intended for use in highway pavements.*

## 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 1881-125, *Testing concrete – Part 125: Methods for mixing and sampling fresh concrete in the laboratory*

BS 8500-1, *Concrete – Complementary British Standard to BS EN 206-1 – Part 1: Method of specifying and guidance for the specifier*

BS EN 933-2, *Tests for geometrical properties of aggregates – Part 2: Determination of particle size distribution – Test sieves, nominal size of apertures*

BS EN 12350-1, *Testing fresh concrete – Part 1: Sampling*

BS EN 12350-2, *Testing fresh concrete – Part 2: Slump-test*

BS EN 12350-6, *Testing fresh concrete – Part 6: Density*

## 3 Terms and definitions

For the purposes of this part of BS 1881 the definitions given in BS 8500-1 and BS EN 12350-6 and the following apply.

### 3.1 density

mass of a quantity of partially compacted semi-dry fresh concrete divided by its volume, expressed in  $\text{kg/m}^3$

### 3.2 semi-dry concrete

very low workability concrete with a low water content and of a consistency which, when measured by the slump test, produces a slump value of less than 10 mm which is too low to be measured with precision by the test described in BS EN 12350-2

## 4 Apparatus

**4.1 Balance(s)** with an accuracy of 0.01 kg, calibrated on first use and at least annually thereafter, and recalibrated after relocation or disturbance using weights of which the accuracy is traceable to the national standard of mass. A certificate stating the accuracy shall be obtained from the organization carrying out these calibrations.

**4.2 Sampling container(s)**, made from non-absorbent material not readily attacked by cement paste, for receiving increments of the concrete.

**4.3 Container**, watertight rigid cylinder of the dimensions specified in Table 1, made of metal or from a material on which in-use performance test data are available that demonstrates long-term equivalency to 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 m <sup>3</sup>	Inside diameter mm	Inside height mm	Minimum thickness of metal mm	Nominal internal radius between wall and base mm
0.01	200.0±1.5	320.0±1.5	4.0	20.0

**4.4 Scoop**, as described in BS EN 12350-1

**4.5 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 g ±25 g and the complete tamper of 7700 g ±100 g. The rammer shall be able to fall 300 mm ±3 mm. The bearing plate shall be circular, of diameter 197.0 mm ±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, 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 1881-113

**4.6 Straight edge**, made of steel, not less than 300 mm in length and not less than 4 mm in thickness.

**4.7 Remixing container**, as described in BS EN 12350-2.

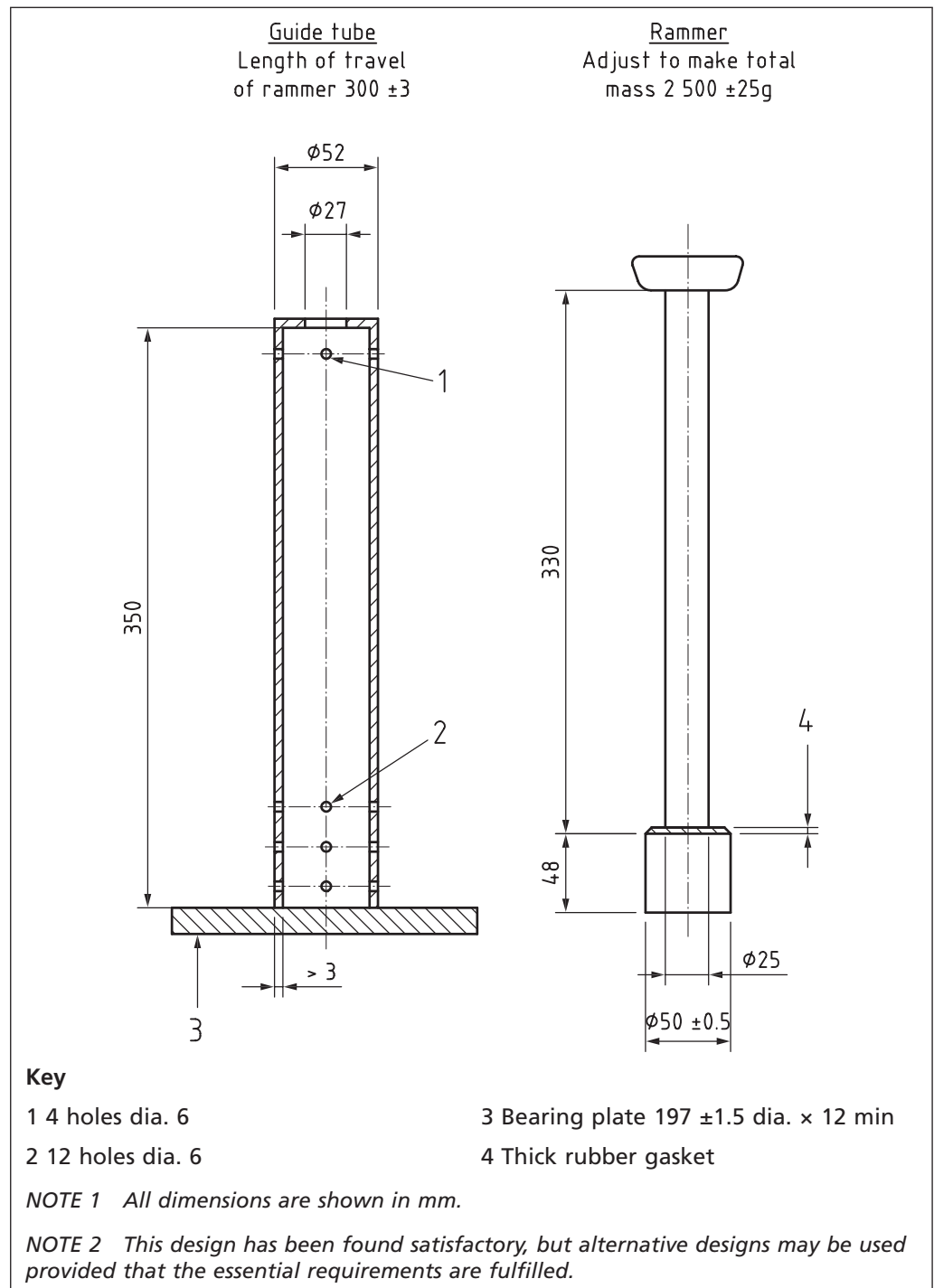
**4.8 Square mouthed shovel**, as described in BS 12350-2.

**4.9 Thermometer**, to measure the temperature of the fresh concrete to an accuracy of 1 °C.

**4.10 Glass plate**.



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



## 5 Calibration of the container

5.1 Weigh the empty container (4.3) and glass plate (4.10) to an accuracy of 0.01 kg and record the indicated mass.

5.2 Place the container (4.3) on a horizontal surface and fill with water at a temperature of  $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ .

5.3 Fill the container (4.3) to overflowing and slide the glass plate (4.10) over it to exclude any air bubbles.

5.4 Weigh the container (4.3), glass plate (4.10) and water to an accuracy of 0.01 kg and record the indicated mass.

5.5 Calculate the volume of the container by dividing the total mass of water (kg), required to fill the container, by  $998\text{ kg/m}^3$ .

5.6 Express the volume (V) of the container in cubic metres to an accuracy of  $0.01\text{ m}^3$ .

## 6 Sampling

6.1 Obtain the sample of fresh concrete by the procedure described in BS EN 12350-1 or BS 1881-125. Keep the sample covered to minimize evaporation.

6.2 Commence the determination of the density as soon as possible, while the concrete remains in a fresh and malleable state and not more than 90 min after sampling.

*NOTE A shorter period, 30 min might be necessary to ensure the determination of density is made with the concrete in a condition similar to that at the intended time of use.*

## 7 Preparing the sample for test

7.1 Empty the sample onto the remixing container (4.3). Ensure that no more than a light covering of paste is left adhering to the sample container(s).

7.2 Thoroughly mix the sample by shovelling it to form a cone on the sampling tray and turning this over with the shovel (4.8) to form a new cone. Repeat this operation three times.

7.3 Divide the sample into sub-samples as described in BS EN 933-2 using either the quartering technique or a riffle box of a size capable of providing the required size of sub-sample.

7.4 A minimum of two sub-samples are required for the operations described in Clause 8.

## 8 Procedure

**8.1** Use the scoop (4.4) to carefully place 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.

**8.2** Carefully place the circular bearing plate of the tamper (4.5) 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 15 such blows.

**8.3** Repeat 8.1 and 8.2 for a second and third layer of concrete.

**8.4** Create a fourth layer, by overfilling the container and slightly heaping the concrete towards the centre.

**8.5** Apply five blows of the rammer as described in 8.2.

**8.6** Remove the tamper (4.5) and add or remove sufficient concrete such that after a further 10 blows the surcharge of concrete is between 5 mm and 10 mm above the rim of the container.

**8.7** If the surcharge is not between 5 mm and 10 mm after completion of compaction then repeat 8.1 to 8.6 with a fresh specimen.

**8.8** With the straightedge (4.6), remove the surplus concrete using a sawing action about 5 mm above the rim. Remove large aggregate particles protruding above the rim individually.

**8.9** 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, taking care not to overcompact the concrete by applying undue pressure when finishing the surface.

**8.10** Weigh the filled container, subtract the mass of the empty container and record the mass of concrete in the container (4.3), to the nearest 0.01 kg.

**8.11** Empty and clean the container and then repeat 8.1 to 8.9 on the second test portion.

## 9 Calculation and expression of results

### 9.1 Calculation of density

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

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

where

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

$V$  is the capacity of the container (in  $\text{m}^3$ ).

Express the result to the nearest  $10 \text{ kg/m}^3$ .

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

If the difference is less than  $40 \text{ kg/m}^3$ , report the mean.

## 9.2 Calculation of the volume of concrete per batch

If the volume of concrete produced per batch,  $V_b$ , is required, calculate it (in m<sup>3</sup>) using the following equation:

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

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 (in kg);
- $D$  is the density of partially compacted semi-dry fresh concrete obtained in accordance with Clause 8 (in kg/m<sup>3</sup>).

Express the result to an accuracy of 1 %.

## 10 Test report

The test report shall include:

- a) identification of the sample;
- b) date, time and place of sampling;
- c) copy of certificate of sampling, if available;
- d) location where the test was performed;
- e) date and time of test;
- f) identification and capacity of the container;
- g) density of partially compacted semi-dry fresh concrete sample, to the nearest 10 kg/m<sup>3</sup>;
- h) the volume of the concrete per batch,  $V_b$  (if required) in m<sup>3</sup>;
- i) any deviations from the standard procedure; and
- j) a declaration from the person technically responsible for the test that it was carried out in accordance with this document, except as detailed in item i).

*NOTE* The report may also include:

- 1) name of project and place where concrete was used;
- 2) name of supplier and source of concrete;
- 3) date and time of production of concrete or delivery to site; and
- 4) specification of concrete mix, e.g. GEN1, ST1.

## 11 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 <sup>3</sup>	kg/m <sup>3</sup>	kg/m <sup>3</sup>
2 035	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 5497-1. The material used was a 1.5 m<sup>3</sup> 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<sup>3</sup> 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 1881-101.

*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.

## Bibliography

### Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 1377, *Methods of test for soils for civil engineering purposes*

BS 1881-101 *Testing concrete – Part 101: Method of sampling fresh concrete on site*<sup>1)</sup>

BS 1881-113, *Testing concrete – Part 113: Method for making and curing no-fines test cubes*

BS 5497-1, *Guide for the determination of repeatability and reproducibility for a standard test method by inter-laboratory tests*<sup>2)</sup>

### Non-standards publications

[1] Highways Agency. *Specification for Highway Works*<sup>3)</sup>.

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<sup>1)</sup> BS 1881-101 is now withdrawn

<sup>2)</sup> BS 5497-1 is now withdrawn

<sup>3)</sup> Referred to in the foreword only and obtainable from HMSO.



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