BRITISH STANDARD

BS EN
12350-6:2009

Testing fresh concrete

Part 6: Density

ICS 91.100.30

BSI
British Standards

National foreword

This British Standard is the UK implementation of EN 12350-6:2009. It supersedes BS EN 12350-6:2000 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/517/1, Concrete production and testing.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Testing fresh concrete - Part 6: Density

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Contents

Page

Foreword

This document (EN 12350-6:2009) has been prepared by Technical Committee CEN/TC 104 “Concrete and related products”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2009, and conflicting national standards shall be withdrawn at the latest by October 2009.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 12350-6:1999.

The results of a recent laboratory inter-comparison, part-funded by the EC under the Measurement and Testing programme, contract MAT1-CT94-0043mtp, have been taken into account. The compaction of specimens using hand tamping, vibrating table, or internal (poker) vibrator are accepted as equivalent. However, the use of an internal vibrator to compact specimens containing entrained air should be carried out with caution.

A procedure for calibrating the container has been included as a normative Annex A.

This series EN 12350 includes the following parts.

EN 12350 Testing fresh concrete

Part 1: Sampling;

Part 2: Slump-test;

Part 3: Vebe test;

Part 4: Degree of compactability;

Part 5: Flow table test;

Part 6: Density;

Part 7: Air content — Pressure methods;

Part 8: Self-compacting concrete - Slump-flow test (in preparation);

Part 9: Self-compacting concrete - V-funnel test (in preparation);

Part 10: Self-compacting concrete - L-box test (in preparation);

Part 11: Self-compacting concrete - Sieve segregation test (in preparation);

Part 12: Self-compacting concrete - J-ring test (in preparation).

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.

The following amendments have been made to the 1999-10 edition of this standard:

— editorial revision

— detailing of compaction process

— accuracy of balance, scales and other testing equipment.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European standard specifies a method for determining the density of compacted fresh concrete both in the laboratory and in the field.

NOTE It may not be applicable to very stiff concrete which cannot be compacted by normal vibration.

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.

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

3 Principle

Fresh concrete is compacted into a rigid and watertight container of known volume and mass and is then weighed.

4 Apparatus

4.1 Container, watertight, of sufficient rigidity to retain its shape, made of metal not readily attacked by cement paste, having a smooth internal face, with the rim machined to a plane surface. The rim and base shall be parallel. The smallest dimension of the container shall be at least four times the maximum nominal size of the coarse aggregate in the concrete, but shall be not less than 150 mm. The volume of the container shall be not less than 5 l.

4.2 Filling frame, filling may be simplified by using a filling frame fitted tightly to the container

4.3 Means of compacting the concrete, which may be one of the following:

a) internal (poker) vibrator with a minimum frequency of approximately 120 Hz (7 200 cycles per minute), the diameter of the internal vibrator not exceeding approximately one-quarter of the smallest dimension of the container;

b) vibrating table with a minimum frequency of approximately 40 Hz (2 400 cycles per minute);

c) compacting rod of circular cross-section, straight, made of steel, having a diameter of approximately 16 mm, length of approximately 600 mm and with rounded ends;

d) compacting bar, straight, made of steel having a square cross-section of approximately 25 mm $\times$ 25 mm and length of approximately 380 mm.

4.4 Balance or scales, capable of determining the mass of the compacted concrete to an accuracy of 0,01 kg

4.5 Straight-edged scraper, made of steel, not less than 100 mm greater in length than the maximum internal dimension of the top of the container

4.6 Scoop, of approximately 100 mm width

4.7 Steel trowel or float

4.8 Remixing container, flat tray of rigid construction and made from a non- absorbent material not readily attacked by cement paste. It shall be of appropriate dimensions such that the concrete can be thoroughly re-mixed, using the square-mouthed shovel.

4.9 Shovel, with square mouth

NOTE The square mouth is required to ensure proper mixing of material on the remixing container.

4.10 Mallet, soft faced

5 Sampling

The sample shall be obtained in accordance with EN 12350-1.

The sample shall be re-mixed using the remixing container and the square mouthed shovel or equivalent remixing procedure specified in the national annex NA before carrying out the test**.**

6 Procedure

6.1 Calibration

Calibrate the container in accordance with Annex A, to obtain the volume of the container (V).

6.2 Mass of container

Weigh the container to determine its mass (m_1) and record the value indicated.

6.3 Filling the container

Depending on the consistence of the concrete and the method of compaction, the container shall be filled in two or more layers to achieve full compaction, except in the case of self-compacting concrete for which the container shall be filled in one operation.

If a filling frame is used, the amount of concrete used to fill the mould shall be such that a layer of concrete remains in the filling frame after compaction. The thickness of this layer shall be 10 % to 20 % of the height of the container.

6.4 Compacting the concrete

6.4.1 General

The concrete shall be compacted immediately after placing in the moulds in such a way as to produce full compaction of the concrete with neither excessive segregation nor laitance. Each layer shall be compacted by using one of the methods described in 6.4.2 or 6.4.3.

In the case of self-compacting concrete, no mechanical or hand compaction shall be applied during filling or after the container is filled.

NOTE 1 Full compaction is achieved using mechanical vibration, when there is no further appearance of large air bubbles on the surface of the concrete and the surface becomes relatively smooth with a glazed appearance, without excessive segregation.

NOTE 2 Further guidance on methods of compaction for concretes having different consistencies or cast in different sizes of containers, may be given in national annex NA.

6.4.2 Mechanical compaction

6.4.2.1 Compacting with internal vibrator

Apply the vibration for the minimum duration necessary to achieve full compaction of the concrete. Avoid over-vibration, which may cause loss of entrained air.

NOTE Care should be taken not to damage the container. The use of a filling frame is recommended.

Ensure that the vibrator is kept vertical and not allowed to touch the bottom or sides of the container.

Laboratory tests have shown that great care is needed if loss of entrained air is to be avoided, when using an internal vibrator.

6.4.2.2 Compacting with vibrating table

Apply the vibration for the minimum duration necessary to achieve full compaction of the concrete. The container should preferably be attached to, or firmly held against the table. Avoid over-vibration, which may cause loss of entrained air.

6.4.3 Compacting by hand with compacting rod or bar

Distribute the strokes of the compacting rod, or bar, in a uniform manner over the cross-section of the container. Ensure that the compacting rod, or bar, does not forcibly strike the bottom of the container when compacting the first layer, nor penetrate significantly any previous layer. Subject the concrete to a sufficient number of strokes per layer, typically 25 for concretes having a consistence equivalent to slump classes S1 and S2, in order to remove pockets of entrapped air but not the entrained air. After compaction of each layer, tap the sides of the container smartly with the mallet until large bubbles of air cease to appear on the surface and depressions left by the compacting rod or bar, are removed.

6.5 Surface levelling

If a filling frame is used, remove it immediately after compaction.

After the top layer has been compacted, smooth it level with the top of the container, using the steel float or trowel. Skim the surface and rim with the straightedge and wipe the outside of the container clean.

6.6 Weighing

Weigh the container with its contents to determine its mass (m_2) and record the value indicated.

7 Calculation of density

The density is calculated from the formula:

$$D = \frac{m_2 - m_1}{V}$$

where

D is the density of the fresh concrete, in kg/m³;

m_1 is the mass of the empty container, in kg;

m_2 is the mass of the container completely filled with compacted concrete, in kg;

V is the volume of the container, in m³.

Express the density of the fresh concrete to the nearest 10 kg/m^3.

8 Test report

The report shall include:

a) identification of the test sample;

b) location of performance of test;

c) date of test;

d) method of compaction;

e) calculated density of the fresh concrete, in kg/m³;

f) any deviation from standard test method;

g) declaration by the person technically responsible for the test that it was carried out in accordance with this document, except as noted item f).

The report may include:

h) temperature of the concrete sample at time of test;

i) time of test;

j) consistence of the concrete.

9 Precision

Precision data are given in Table 1. These apply to density measurements made on concrete taken from the same sample and compacted by hand using a compacting bar when each test result represents a single density determination.

Table 1 — Precision data for density of fresh concrete measurements

Range	**Repeatability conditions**		**Reproducibility conditions**	
kg/m^3	S_r kg/m^3	r kg/m^3	S_R kg/m^3	R kg/m^3
2 300 to 2 400	5,5	15	10,2	29

NOTE 1 The precision data were determined as part of an experiment in the UK in 1987 in which precision data were obtained for several of the tests described in the then BS 1881. The experiment involved 16 operators. The concretes were made using an ordinary Portland cement, Thames Valley sand, and Thames Valley 10 mm and 20 mm coarse aggregates. (Hand compaction using a compacting bar was used.)

NOTE 2 The containers used complied with the requirements of BS 1881:Part 107:

nominal capacity:	0,01 m^3
inside diameter:	200 mm ± 1,5 mm
inside height:	320 mm ± 1,5 mm
minimum thickness of metal:	4 mm
radius between wall and base:	20 mm

NOTE 3 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 value *r* on average not more than once in 20 cases in the normal and correct operation of the method.

NOTE 4 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 5 The precision data includes the procedures of sampling, as well as the determination of density of fresh concrete.

NOTE 6 For further information on precision, and for definitions of the statistical terms used in connection with precision, see ISO 5725.

Annex A
(normative)

Calibration of container

A.1 Apparatus

A.1.1 Scales or balance, capable of weighing the container empty and also full of water, to an accuracy of 0,01 kg.

A.1.2 Glass plate

A.2 Procedure

Weigh the empty container and glass plate to an accuracy of 0,01 kg and record the indicated mass.

Place the container on a horizontal surface and fill with water at a temperature of (20 ± 5) °C. Fill the container to overflowing and slide the glass plate over it to exclude any air bubbles.

Weigh the container, glass plate and water to an accuracy of 0,01 kg and record the indicated mass.

Calculate the volume of the container by dividing the total mass of water (in kilograms), required to fill the container, by 998 kg/m3.

Express the volume (V) of the container in cubic metres to an accuracy of 0,01 dm³.

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