INTERNATIONAL STANDARD

ISO 1920-2

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Testing of concrete —

Part 2:
Properties of fresh concrete

Essais du béton —

Partie 2: Caractéristiques du béton frais

Reference number
ISO 1920-2:2005(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 1920-2 was prepared by Technical Committee ISO/TC 71, *Concrete, reinforced concrete and pre-stressed concrete*, Subcommittee SC 1, *Test methods for concrete*.

This first edition of ISO 1920-2 cancels and replaces the first edition of ISO 4109:1980, ISO 4110:1979, ISO 4111:1979, ISO 4848:1980 and ISO 6276:1982, which have been technically revised.

ISO 1920 consists of the following parts, under the general title *Testing of concrete*:

— *Part 1: Sampling of fresh concrete*

— *Part 2: Properties of fresh concrete*

— *Part 3: Making and curing of test specimens*

— *Part 4: Strength of hardened concrete*

— *Part 5: Properties of hardened concrete other than strength*

— *Part 6: Sampling, preparing and testing of concrete cores*

— *Part 7: Non-destructive tests on hardened concrete*

Introduction

International Standards are widely adopted at the regional or national level and applied by manufacturers, trade organizations, purchasers, consumers, testing laboratories, authorities and other interested parties. Since these standards generally reflect the best experience of industry, researchers, consumers and regulators worldwide and cover common needs in a variety of countries, they constitute one of the important bases for the removal of technical barriers to trade. However, full adoption may not be practicable in all cases for reasons such as regional or national security, protection of human health or safety, or protection of the environment, or because of fundamental climatic, geographical or technological problems. As a consequence, the corresponding technical deviations to ISO standards are permitted where required by national or regional legislation or industry convention when adopting an International Standard.

Where such national deviations are required, it is important that they are clearly identified and the reasons for the deviations stated. Depending of on the method of adoption of the International Standard, the deviations will be noted in the national introduction, in the preface or foreword (for small numbers) or as a national annex (for large numbers). See ISO/IEC Guide 21-1 for more information.

ISO/TC 71 has identified those items in this part of ISO 1920-2 that may be the subject of national or regional deviations. The items are indicated in the text by the phrase "…except where the national annex to this part of ISO 1920 requires…".

Testing of concrete —

Part 2: **Properties of fresh concrete**

Caution — When cement is mixed with water, alkali is released. When sampling, prevent skin contact with wet cement or concrete by wearing suitable protective clothing (gloves, footwear, safety glasses). If wet 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.

Caution — The use of vibrating equipment, such as vibration tables, can cause damage to joints and loss of sensation due to nerve damage. Moulds, density containers, etc. should be clamped to the table and not held in position using one's hands while they are being vibrated.

1 Scope

This part of ISO 1920 specifies procedures for testing fresh concrete. It specifies the following test methods: determination of consistence (slump test, Vebe test, degree of compactability, flow-table test and for high-fluidity concrete, the slump-flow test), determination of fresh density and determination of air content by the pressure-gauge method and by the water-column method.

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.

ISO 1101:1983, *Technical drawing — Geometric tolerances — Tolerancing of form, orientation, location and run-out — Generalities, definitions, symbols, indications on drawings*

ISO 1920-1, *Testing of concrete — Part 1: Sampling of fresh concrete*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
fresh density
mass of a quantity of fully compacted fresh concrete divided by its volume

NOTE The fresh density is expressed in kilograms per cubic metre.

4 Determination of consistence

4.1 General

The consistence of the concrete is determined by one of the methods described below:

— slump test (see 4.3);

— Vebe test (see 4.4);

— degree of compactability (see 4.5);

— flow-table test. (see 4.6);

— slump-flow test for high-fluidity concrete (see 4.7).

These methods are not applicable to foamed concrete, no-fines concrete or where the maximum aggregate size exceeds 40 mm.

4.2 Sampling

Samples for the tests shall be obtained in accordance with ISO 1920-1. Each sample shall be remixed before carrying out the tests.

4.3 Slump test

4.3.1 Principle

The fresh concrete is compacted into a mould in the shape of a frustum of a cone. When the cone is withdrawn upwards, the distance the concrete has slumped provides a measure of the consistence of the concrete.

The slump test is applicable to a range of consistence of concrete that corresponds to slumps of between 10 mm and 210 mm. Outside this range, the measurement of slump may be unsuitable and other methods of determining the consistence should be considered.

If the slump continues to change over a period of 1 min after demoulding, this test is not suitable.

NOTE For high-fluidity concrete, the slump-flow test described in 4.7 is a more appropriate test.

4.3.2 Apparatus

Note the calibration requirements associated with each apparatus.

4.3.2.1 Mould, suitable of forming the test specimen, made of a metal not readily attacked by cement paste and not thinner than 1,5 mm.

The mould may be made either with or without a seam. The interior of the mould shall be smooth and free from projections such as protruding rivets and shall be free from dents. The mould shall be in the form of hollow frustum of a cone and shall have the following internal dimensions:

— diameter of base: 200 mm ± 2 mm;

— diameter of top: 100 mm ± 2 mm;

— height: 300 mm ± 2 mm.

The base and the top shall be open and parallel to each other and at right angles to the axis of the cone. The mould shall be provided, on the upper portion, with two handles at two-thirds of the height, and at the bottom with fixing clamps or foot pieces to hold it steady. A mould that can be clamped to the base is acceptable, provided the clamping arrangement can be fully released without movement of the mould or interference with the slumping concrete.

The mould shall be visually checked prior to each use to assure that it is clean and is not damaged or dented. The cone shall be checked annually to ensure that its dimensions and conditions remain within tolerances.

4.3.2.2 Tamping rod, straight, made of steel, having a circular cross-section with a diameter of 16 mm ± 1 mm, 600 mm ± 5 mm in length, and with rounded ends. The rod may be extended with a handle of plastic conduit, provided that the overall length does not exceed 1 000 mm.

The tamping rod shall be checked annually to ensure that its dimensions and conditions remain within tolerances.

4.3.2.3 Funnel (optional), made of a non-absorbent material not readily attacked by cement paste.

The funnel shall consist of two co-axial conical frustums having a common diameter of 100 mm, the ends being of greater diameter, one frustum to act as a filling funnel and the other as a collar to enable the funnel to be located on the outer surface of the mould.

The funnel shall be checked annually to ensure that its dimensions and conditions remain within tolerances.

4.3.2.4 Rule, graduated from 0 mm to 300 mm, at intervals not exceeding 5 mm, with the zero point being at the extreme end of the rule.

4.3.2.5 Base plate/surface, rigid, flat, non-absorbent and smooth plate or other surface on which to place the mould.

4.3.2.6 Shovel, with a square blade.

4.3.2.7 Re-mixing 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 remixed, using the square-bladed shovel.

4.3.2.8 Scoop, with a width of approximately 100 mm.

4.3.2.9 Timer or other similar **timing device**, to allow time measurement to 1 s.

The watch shall be properly calibrated at the time of test.

4.3.2.10 Moist cloth.

4.3.3 Procedure

Dampen the mould and the base plate. Wipe any excessive water from the surfaces, using an absorbent cloth. Place the mould on the horizontal base plate/surface. During filling, clamp or hold the mould firmly in place by standing on the two foot pieces.

Immediately after obtaining the sample in accordance with 4.2, fill the mould in three layers, each approximately one-third of the height of the mould when compacted. When adding the concrete, ensure that it is distributed symmetrically around the mould. Tamp each layer with 25 strokes of the tamping rod. Uniformly distribute the strokes over the cross-section of each layer. For the bottom layer, this will necessitate inclining the rod slightly and positioning approximately half the strokes spirally toward the centre. Tamp the second layer and the top layer each throughout its depth, so that the strokes just penetrate into the underlying layer. In filling and tamping the top layer, heap the concrete above the mould before tamping is started.

If the tamping operation of the top layer results in subsidence of the concrete below the top edge of the mould, add more concrete to keep an excess above the top of the mould at all times. Also ensure that the addition of concrete to the top layer does not provide extra compaction of the concrete. After the top layer has been tamped, scrape off the surface of the concrete level with the top of the mould by means of a sawing and rolling motion of the tamping rod.

Remove spilled concrete from the base plate/surface. Remove the mould in 5 ± 2 s by a steady upward lift with no lateral or torsional motion being imparted to the concrete. The lifting time may be shortened when required by the national annex.

The entire operation from the start of the filling to the removal of the mould shall be carried out without interruption and shall be completed within 180 s.

Immediately after removal of the mould, determine the slump, h, by measuring the difference between the height of the mould and that of the highest point of the slumped test sample (see Figure 1), except where the national annex to this part of ISO 1920 requires the measurement of the difference between the height of the mould and the centre point or the average height of the slumped concrete. Measure to the nearest 10 mm, except where the national annex to this part of ISO 1920 requires the measurement to the nearest 5 mm.

4.3.4 Test result

The test is valid only if it yields a true slump, this being a slump in which the concrete remains substantially intact and symmetrical as shown in Figure 2 a). If a specimen shears, as shown in Figure 2 b), take another sample and repeat the procedure.

Record the true slump, h, as shown in Figure 1 to the nearest 10 mm, or 5 mm when required by the national annex.

If two consecutive tests show a portion of the concrete shearing off from the mass of the test specimen, report the test as being invalid as the concrete lacks the necessary plasticity and cohesiveness for the slump test to be suitable.

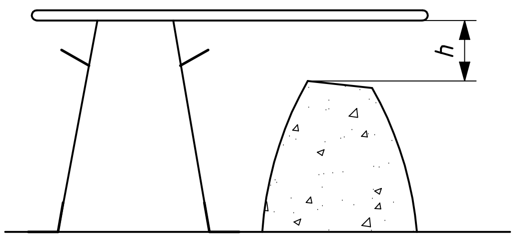
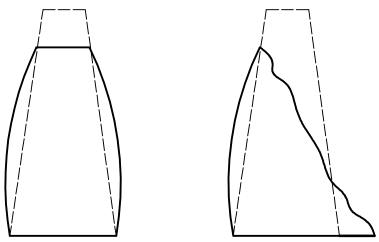


Figure 1 — Slump measurement



a) True slump b) Shear

Figure 2 — Forms of slump

4.3.5 Test report

In addition to the information required in Clause 7, the test report shall include the following:

a) the slump, if there is a true slump, measured to nearest 10 mm (or 5 mm when required by the national annex), or;

b) a notation that the test gave a sheared slump.

4.4 Vebe test

4.4.1 Principle

The fresh concrete is compacted into a slump mould. The mould is lifted clear of the concrete and a transparent disc is swung over the top of the concrete and carefully lowered until it comes in contact with the concrete. The slump of the concrete is recorded. The vibrating table is started and the time taken for the lower surface of the transparent disc to be fully in contact with concrete is measured.

If the Vebe time is less than 5 s or more than 30 s, the use of this test method to determine consistence may be unsuitable and other methods should be considered for this purpose.

4.4.2 Apparatus

Note the calibration requirements associated with each apparatus.

4.4.2.1 Consistometer (**Vebe meter**), consisting of the following items and as shown in Figure 3:

a) **container** (Figure 3, item 1), cylindrical in shape, having an internal diameter of 240 mm ± 5 mm and a height of 200 mm ± 2 mm, and made of a metal not readily attacked by cement paste. The thickness of the wall shall be 3 mm and that of the base, 7,5 mm.

   The container shall be watertight and of sufficient rigidity to retain its shape under rough usage. It shall be fitted with handles and protected from corrosion. The container shall be provided with suitable foot pieces to enable it to be securely clamped to the top of the vibrating table (Figure 3, item 7) by means of wing nuts (Figure 3, item 8).

b) **mould** (Figure 3, item 2), as described in 4.3.2.1, except that the fixing clamps or foot pieces are not required.

   The mould shall be visually checked prior to each use to assure that it is clean and is not damaged or dented.

c) **disc** (Figure 3, item 3), transparent, horizontal, attached to a rod (Figure 3, item 9) that slides vertically through a guide sleeve (Figure 3, item 5) mounted on a swivel arm (Figure 3, item 13) and which can be fixed in position by a screw (Figure 3, item 15).

   The swivel arm also supports a funnel (Figure 3, item 4), the bottom of which coincides with the top of the conical mould when the latter is positioned concentrically in the container. The swivel arm is located by a holder (Figure 3, item 12) and can be fixed in position by a set-screw (Figure 3, item 6). When in the appropriate position, the axes of the rod and of the funnel shall be coincident with the axis of the container.

   The transparent disc shall be 230 mm ± 2 mm in diameter and 10 mm ± 2 mm in thickness. A weight (Figure 3, item 14) placed directly above the disc shall be provided such that the moving assembly consisting of the rod, the disc and the weight has a mass of 2 750g ± 50 g. The rod shall be provided with a scale graduated to at least 5 mm intervals to record the slump of the concrete.

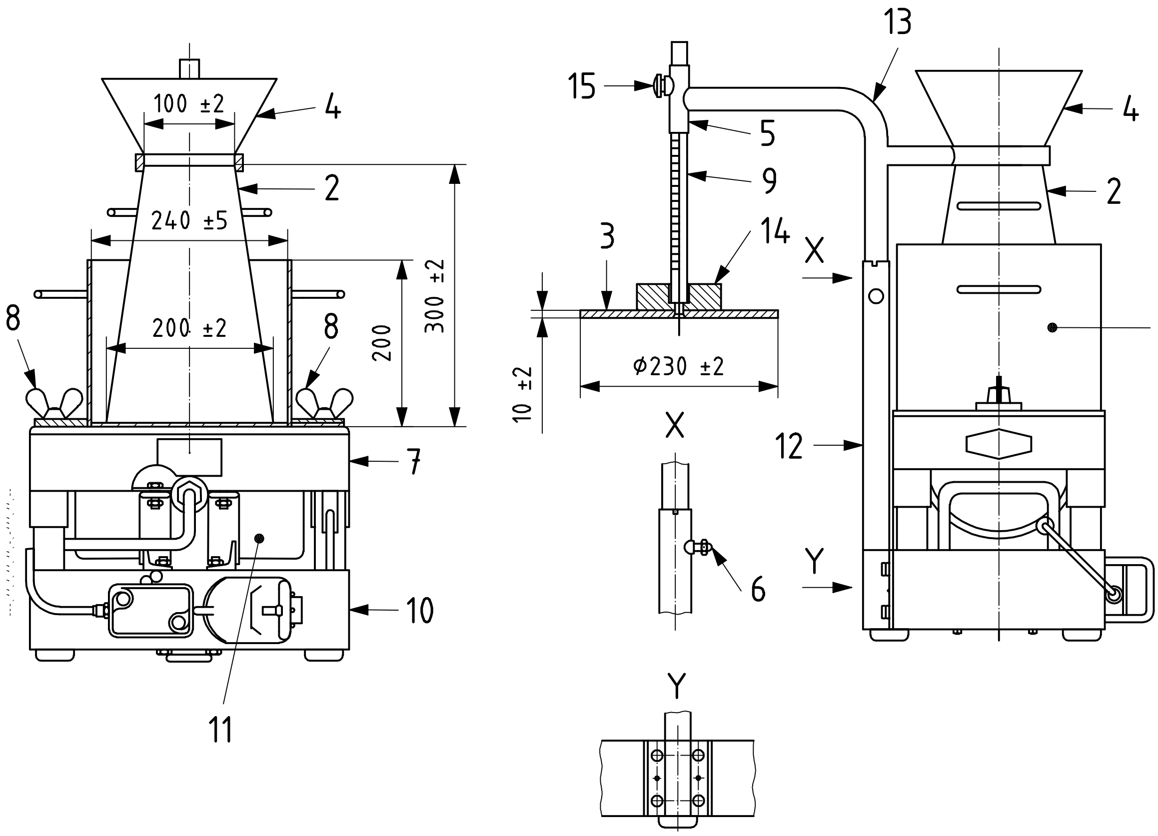
d) **vibrating table** (Figure 3, item 7), 380 mm ± 3 mm in length and 260 mm ± 3 mm in width, supported on four rubber shock absorbers.

A vibrator unit (Figure 3, item 11), carried on a base (Figure 3, item 10) resting on three rubber feet, shall be securely fixed beneath it. The vibrator shall operate at a frequency of 55 Hz ± 5,5 Hz and the vertical amplitude of the vibration of the table with the empty container on top of it shall be approximately 0,5 ± 0,02 mm.

The vibrating table shall be checked annually to ensure that the frequency and vertical amplitude remain within tolerances.

All the elements of the vibration table shall be checked annually to ensure that their dimensions remain within tolerances.

Dimensions in millimetres



Key

1	container	6	set-screw	11	vibrator unit
2	mould	7	vibrating table	12	holder
3	transparent disc	8	wing nuts	13	swivel arm
4	funnel	9	rod	14	weight
5	guide sleeve	10	base for vibrator	15	screw

Figure 3 — Consistometer (Vebe meter)

4.4.2.2 Tamping rod, straight, made of steel or other suitable metal, of circular cross-section, having a diameter of 16 mm ± 1 mm, 600 mm ± 5 mm in length, and with rounded ends.

4.4.2.3 **Stopwatch** or **clock**, capable of recording time to an accuracy of 0,5 s.

4.4.2.4 **Remixing container**, of rigid construction, made from a non-absorbent material not readily attacked by cement paste.

4.4.2.5 **Scoop**, with a width of approximately 100 mm.

4.4.2.6 **Moist cloth**.

4.4.3 Procedure

Place the Vebe meter (consistometer) on a rigid horizontal base free from extraneous vibration and shock. Make sure that the container (Figure 3, item 1) is firmly fixed to the vibrating table (Figure 3, item 7) by means of the wing nuts (Figure 3, item 8). Dampen the mould (Figure 3, item 2) and place it in the container. Swing the funnel (Figure 3, item 4) into position over the mould and lower the funnel on the mould. Tighten the screw (Figure 3, item 6) so that the mould cannot rise from the bottom of the container.

During the subsequent operations, ensure that the mould (Figure 3, item 2) does not rise or move until it is raised and do not allow any concrete to fall into the container (Figure 3, item 1).

From the sample of concrete obtained in accordance with 4.2, immediately fill the mould in three layers, each approximately one-third of the height of the mould when compacted. Tamp each layer with 25 strokes of the tamping rod. Uniformly distribute the strokes over the cross-section of each layer. For the bottom layer, this will necessitate inclining the rod slightly and positioning approximately half the strokes spirally toward the centre. Tamp the second layer and the top layer each throughout its depth, so that the strokes just penetrate into the underlying layer. In filling and tamping the top layer, heap the concrete above the mould before tamping is started.

If necessary, add further concrete to maintain an excess above the top of the mould throughout the tamping operation. After the top layer has been tamped, loosen the screw (Figure 3, item 6), raise and swing the funnel (Figure 3, item 4) through 90° and tighten the screw (Figure 3, item 6).

Scrape off the concrete level with the top of the mould with a sawing and rolling motion of the tamping rod. Remove the mould (Figure 3, item 2) from the concrete by raising it carefully in a vertical direction, using the handles. The operation of raising the mould shall be performed in 5 s to 10 s by a steady upward lift with no lateral or torsional motion being imparted to the concrete.

If the concrete shears [as shown in Figure 4 (b)], collapses [as shown in Figure 4 (c)], or slumps to the extent that it touches the wall of the container (Figure 3, item 1), this information shall be recorded.

If the concrete has not slumped into contact with the wall of the container (Figure 3, item 1) and a true slump, as shown in Figure 4 (a) has been obtained, the fact shall be recorded.

Swing the transparent disc (Figure 3, item 3) over the top of the concrete, tighten the screw (Figure 3, item 6), loosen the screw (Figure 3, item 15) and very carefully lower the disc until it just comes in contact with the concrete.

When the disc (Figure 3, item 3) just touches the highest point of the concrete without disturbing it, tighten the screw (Figure 3, item 15). When there is a true slump, the value of the slump shall be read from the scale (Figure 3, item 9) and the value recorded.

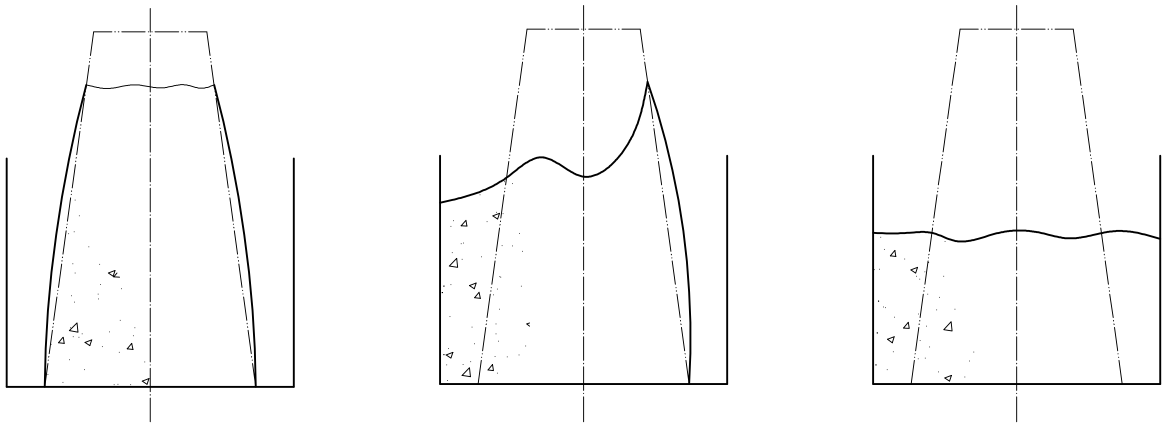
The screw (Figure 3, item 15) shall be loosened to allow the disc (Figure 3, item 3) to follow the concrete as it settles under the subsequent vibration. Simultaneously, start the vibration of the table and the timer. Observe through the transparent disc (Figure 3, item 3) how the concrete is being remoulded. As soon as the lower surface of the disc is fully in contact with cement grout, stop the timer and switch off the vibrating table. Record the time taken to the nearest second.

Complete the procedure within a period of 5 min from the start of filling.

The consistence of a concrete mix changes with time due to hydration of the cement and, possibly, loss of moisture. Tests on different samples should, therefore, be carried out at a constant time interval after mixing if strictly comparable results are to be obtained.

4.4.4 Test result

Record the time read from the stopwatch to the nearest second. This is the Vebe time expressing the consistence of the concrete under test.



a) True slump **b) Shear** **c) Collapse**

Figure 4 — Forms of slump

4.4.5 Test report

In addition to the information required in Clause 7, the test report shall include the following:

a) type of slump: true slump/collapse/shear;

b) when there is a true slump, the measured slump, to nearest 10 mm;

c) time from completion of mixing of the concrete until the time of removal of the mould;

d) Vebe time, in seconds.

4.5 Degree of compactability test

4.5.1 Principle

The fresh concrete is carefully placed with a trowel in a container avoiding any compaction while filling. When the container is full, the top surface is scraped off level with the top of the container. The concrete is compacted and the distance from the surface of the compacted concrete to the upper edge of the container is used to determine the degree of compactability.

If the degree of compactability is less than 1,04 or more than 1,46, the concrete has a consistence for which the degree of compactability test is not suitable.

4.5.2 Apparatus

4.5.2.1 Container, with parallel sides and a general shape as shown in Figure 6, made of metal not readily attacked by cement paste and having the following internal dimensions:

— base: 200 mm ± 2 mm × 200 mm ± 2 mm;

— height: 400 mm ± 2 mm;

— The thickness of the base and walls shall be at least 1,5 mm.

The bottom of the container may be perforated to facilitate emptying. A suitable plastic plate to cover the bottom has then to be placed inside the container.

The dimensions and condition of the container shall be checked at the time of test to ensure that they are within the tolerances.

4.5.2.2 Trowel, with a flat blade (see Figure 5), or equivalent, e.g. square-bladed shovel.

Dimensions in millimetres

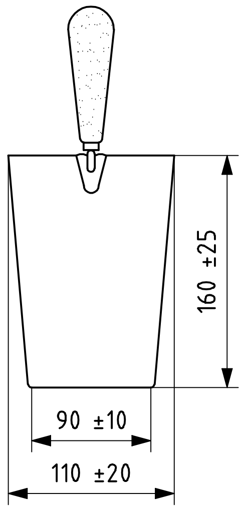


Figure 5 — Trowel

4.5.2.3 Means of compacting the concrete, consisting of one of the following:

a) **internal vibrator**, with a minimum frequency of 120 Hz (7 200 cycles per minute). The diameter of the vibrating head shall not exceed one-quarter of the smallest dimension of the container.

b) **vibrating table**, with a minimum frequency of 40 Hz (2 400 cycles per minute).

4.5.2.4 Remixing tray, of rigid construction, made from a non-absorbent material not readily attacked by cement paste.

4.5.2.5 Straight edged scraper, having a length of greater than 200 mm.

4.5.2.6 Rule, having a length of greater than 400 mm, having 1-mm subdivisions along its entire length with the zero point being at the extreme end of the rule.

4.5.2.7 Moist cloth.

4.5.3 Procedure

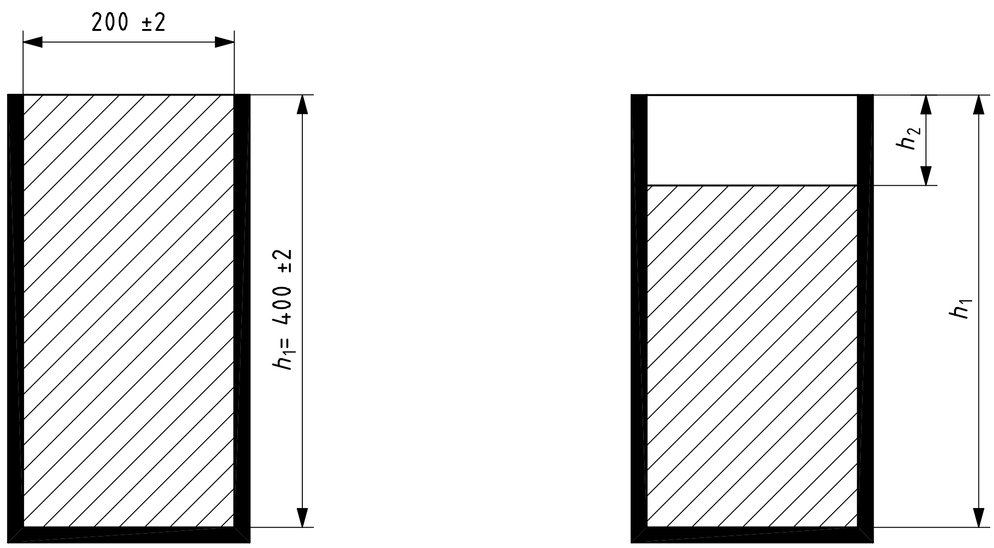
Clean the container and moisten the inner surfaces using a damp cloth.

Fill the container without tamping it, by tilting the trowel sideways from all four upper edges of the container in turn. When the container is full, remove all concrete above the upper edges, using the straight-edged scrapper with a sawing action, in such a way as to avoid any compaction.

Compact the concrete by means of a vibrating table (reference method) or by the use of an internal vibrator, until no further reduction in volume is determinable. During compaction, avoid loss of concrete through splashing or leakage.

After compaction, measure to the nearest millimetre, the distance between the surface of the compacted concrete and the upper edge of the container at the middle of each side of the container. Determine the mean value of the four measurements (see Figure 6).

Dimensions in millimetres



a) Before compaction

b) After compaction

Figure 6 — Concrete in container, before a) and after b) compaction

4.5.4 Test results

The degree of compactability is given by Equation (1)

$$c = \frac{h_1}{h_1 - h_2} \quad (1)$$

where

c is the degree of compactability;

h_1 is the internal height of the container;

h_2 is the mean value, to the nearest millimetre, of the distance from the surface of the compacted concrete to the upper edge of the container.

4.5.5 Test report

In addition to the information required in Clause 7, the test report shall include the following:

a) internal height of the container;

b) measurements of the distance from the top of the container to the top of the compacted concrete;

c) degree of compactability, expressed to nearest two decimal places.

4.6 Flow-table test

4.6.1 Principle

This test determines the consistence of fresh concrete by measuring the spread of concrete on a flat plate subjected to jolting.

The flow test is applicable to a range of consistence of concrete that corresponds to flow values between 340 mm and 620 mm. Outside this range, the measurement of flow may be unsuitable and other methods of determining the consistence should be considered.

If the concrete segregates during the test, this test is not suitable (see 4.6.3).

4.6.2 Apparatus

4.6.2.1 Flow-table, consisting of a flat plate with a plan area of 700 mm ± 2 mm × 700 mm ± 2 mm on which concrete can be placed, hinged to a rigid base onto which it can fall from a fixed height (see Figure 7).

The flow-table top shall have a metal surface with a minimum thickness of 2 mm and a flatness of within 1,5 mm as defined by ISO 1101:1983; (see also ISO 1920-3:2004, Annex B). The metal surface shall not be readily attacked by cement paste or be liable to rusting. This moving part shall have a mass of 16 kg ± 0,5 kg and may be attached using a pin-hinge to allow the weight to be checked. The construction of the plate shall be such as to prevent distortion of the upper surface. The tabletop shall be hinged to the base in such a way that no aggregate can become trapped easily between the hinged surfaces.

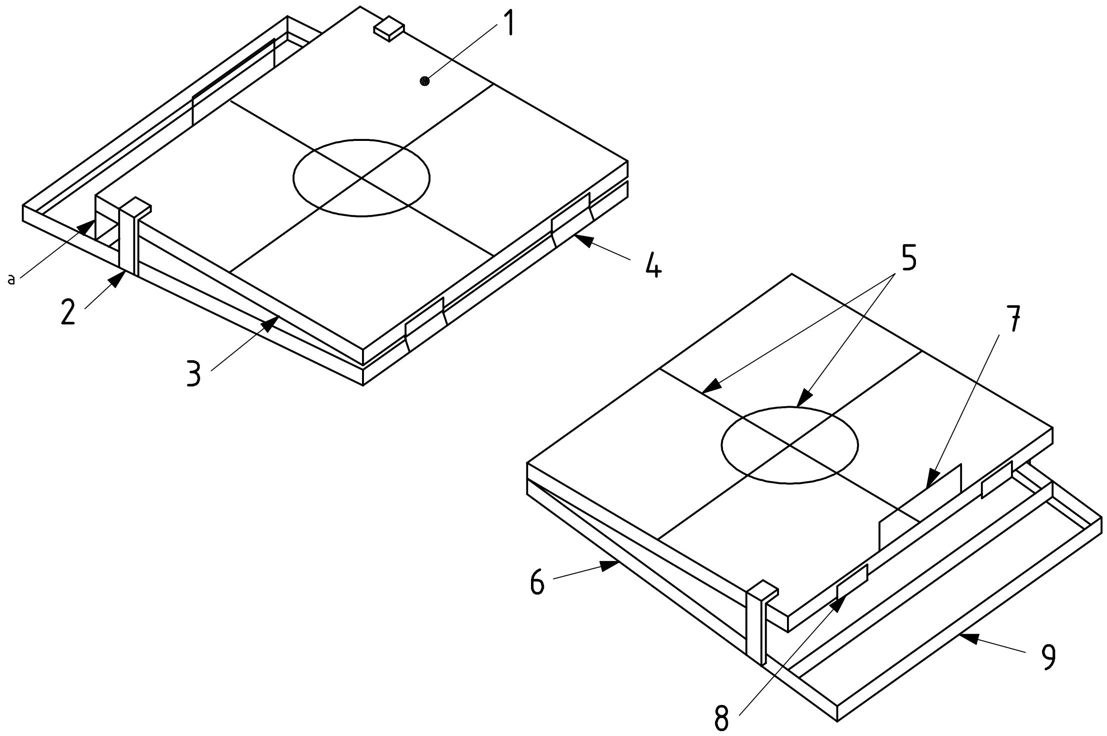
The centre of the table shall be scribed with a cross, the lines of which run parallel to the edges of the plate and with a central circle with a diameter of 210 mm ± 1 mm.

At the front corners of the plate, two hard, rigid blocks shall be firmly attached to the underside. They should be non-absorbent and should not deform when wet. These stops shall transfer the load of the tabletop to the base without distorting the table. The base frame shall be so constructed that this load is then transferred directly to the surface on which the apparatus is placed, so that there is minimal tendency for the tabletop to bounce when allowed to fall freely.

Footrests shall be provided to assist in stabilizing the table when in use.

The fall height of the tabletop, measured at the centre line of the front edge of the top place, shall be limited to 40 mm ± 1 mm by means of one or more stops.

A handle or lifting mechanism shall be provided for lifting the tabletop to ensure that the top is lifted without jerking and allowed to fall freely over the entire lifting height.



Key

1 metal plate
2 upper stop
3 tabletop
4 external hinges
5 markings
6 base frame
7 lifting handle
8 lower stop
9 toe-board

[a] Travel limited to 40 mm ± 1 mm.

Figure 7 — Typical flow table

4.6.2.2 Mould, made of metal not readily attacked by cement paste or liable to rust and with a minimum thickness of 1,5 mm.

The interior of the mould shall be smooth and free from projections, such as protruding rivets, and shall be free from dents. The mould shall be in the form of a hollow frustum of a cone having the following internal dimensions:

— diameter of base: 200 mm ± 2 mm;

— diameter of top: 130 mm ± 2 mm;

— height: 200 mm ± 2 mm.

The base and the top shall be open and parallel to each other and at right angles to the axis of the cone. The mould shall be provided with two metal foot pieces at the bottom and two handles above them (see Figure 8). The mould may be clamped to the table provided it is releasable without movement of the mould.

Dimensions in millimetres

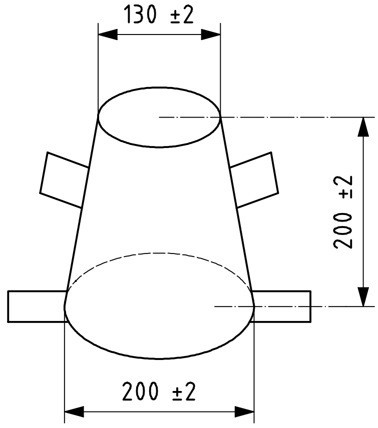


Figure 8 — Mould

4.6.2.3 Tamping bar, made of a non-absorbing hard material, having a square section of 40 mm ± 1 mm and a length of at least 200 mm. A further 120 mm to 150 mm shall be turned to a circular section to form a handle to the bar (see Figure 9).

Dimensions in millimetres

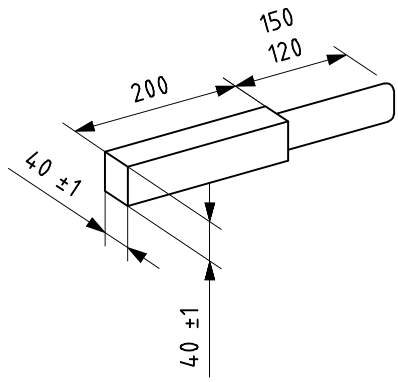


Figure 9 — Tamping bar

4.6.2.4 Scoop, with a width of approximately 100 mm.

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

4.6.2.6 Shovel, with a square blade.

4.6.2.7 Rule, with a minimum length 700 mm, having at least 5-mm subdivisions along its entire length.

4.6.2.8 Timer, with an accuracy of ± 1 s.

4.6.3 Procedure

Place the flow table on a flat, horizontal surface free from external vibration or shock. Ensure that the hinged top of the table can be lifted to the correct limit of its travel and is then free to fall to the lower stop. Check that the table is supported such that, when the top of the table falls to the lower stop, there is minimal tendency for the top to bounce.

Clean the table and the mould and dampen immediately prior to testing, but keep free from superfluous moisture.

Ensure that the contact blocks are clean. Place the mould centrally on the tabletop and hold it in position by standing on the two foot pieces, or by the use of magnets.

Fill the mould with concrete in two equal layers using the scoop, levelling each layer by tamping lightly 10 times with the tamping bar. If necessary, add more concrete to the second layer to maintain an excess above the top of the mould. With the tamping bar, scrape off the concrete level with the upper edge of the mould and clean any excess concrete off the free area of the tabletop.

Wait 30 s after scraping off the concrete, then slowly raise the mould vertically by the handles over a period of 3 s to 6 s. While the operator stabilizes the flow-table by standing on the toe-board at the front of the table, slowly raise the tabletop until it reaches the upper stop in such a manner that the tabletop does not impact hard against the upper stop. Then allow the tabletop to fall freely to the lower stop. Repeat this cycle to give a total of 15 drops, each cycle taking not less than 2 s nor more than 5 s. Measure with the rule the maximum dimension of the concrete spread in the two directions, d_1 and d_2, parallel to the table edges and record each measurement to the nearest 10 mm (see Figure 10).

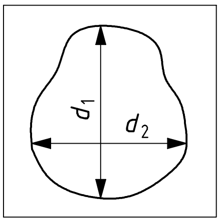


Figure 10 — Measurement of spread

Check the concrete spread for segregation. The cement paste can segregate from the coarse aggregate to give a ring of paste extending several millimetres beyond the coarse aggregate. Report that segregation has occurred and that the concrete was therefore unsatisfactory.

4.6.4 Test results

Determine the flow value $(d_1 + d_2)/2$ and record to the nearest 10 mm.

4.6.5 Test report

In addition to the information required in Clause 7, the test report shall include the following:

a) jolting rate, expressed in seconds per 15 jolts;

b) dimension d_1, expressed in millimetres;

c) dimension d_2, expressed in millimetres;

d) test result $(d_1 + d_2)/2$, expressed in millimetres;

e) statement on any segregation identified.

4.7 Slump-flow test

4.7.1 General

This test method is used to determine the slump-flow of high-fluidity concrete (including self-compacting concrete), anti-washout underwater concrete and the like. This test method is applicable to concrete having a slump greater than 210 mm.

4.7.2 Principle

The fresh concrete is placed into a mould in the shape of a cone. When the cone is withdrawn upwards, three measurements give indications of the consistence of the concrete:

— the measured slump-flow;

— time to flow to a diameter of 500 mm;

— time to end-of-flow.

4.7.3 Apparatus

4.7.3.1 Mould (**slump cone**), as described in 4.3.2.1.

The mould shall be checked annually to ensure that its dimensions and conditions remain within tolerances. Prior to each use, a visual check shall be made on the mould to verify that it is is clean and not damaged or dented.

4.7.3.2 Tamping rod, as described in 4.3.2.2.

The tamping rod shall be checked annually to ensure that its dimensions and conditions remain within tolerances.

4.7.3.3 Base plate, as described in 4.3.2.5.

In addition, the base plate shall have minimum dimensions of 800 mm × 800 mm, and two circles having the same centre point shall be marked on its surface:

— a circle having a diameter of 200 mm to aid the correct location of the mould;

— a circle having a diameter of 500 mm for measuring the time to 500 mm flow of the concrete (see 4.7.4.4).

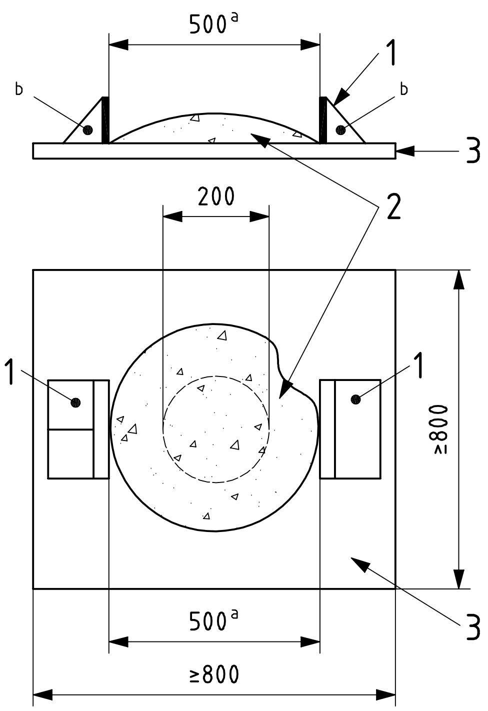
4.7.3.4 Callipers and **measuring scale**, with 1 mm increments.

4.7.3.5 Measuring jigs (optional), as shown in Figure 11.

NOTE Cut angle steel, for instance, is acceptable for these jigs.

Measuring jigs may be omitted if the flow can be measured accurately with a measuring scale.

Dimensions in millimetres



Key

1 measuring jig

2 concrete

3 plate

a Measurement with a measuring scale.

b 90°.

Figure 11 — Typical jig setting

4.7.3.6 Container, such as a bucket, with a capacity of approximately 12 l.

4.7.3.7 Stopwatches, two, capable of recording time to an accuracy of ± 0,1 s.

The watch shall be in calibration at the time of test.

4.7.3.8 Level.

4.7.3.9 Moist cloth.

4.7.4 Procedure

4.7.4.1 Placement of mould (slump-cone) and plate

Clean and dampen the inner surface of the mould and the top surface of the plate. Wipe any excessive water from the surfaces, using an absorbent cloth. Place the plate on a firm base away from any source of vibration and level the plate using a level. Place the mould in the centre of the plate as marked.

4.7.4.2 Filling the mould

Immediately after obtaining the sample, fill the mould from the container by pouring the concrete into the cone. During filling, clamp or hold the mould firmly in place by standing on the two foot pieces. The filling shall be done carefully to avoid segregation and overfilling of the mould and carried out within a 2-min period.

High-fluidity concrete should be added to the mould uniformly in one layer without tamping.

Anti-washout underwater concrete should be added to the mould in three layers. Rod each layer 25 times with a tamping rod as described in 4.3.3.

The method of filling shall be recorded.

4.7.4.3 Slump-flow measurements and calculation

Scrape off the top surface of the concrete to the level of the top edge of the slump cone. Remove the cone immediately from the concrete by raising the cone vertically in a steady lift. After the motion of the concrete has stopped, measure the diameter in the direction where it appears to be longest and in the direction at right angles to the first measurement, both measurements being recorded to the nearest 5 mm. If the spread of the concrete significantly deviates from the circular shape and the discrepancy between the two diameters is 50 mm or more, another test shall be conducted on a new sample taken from the same batch.

The time for raising the slump cone shall be 2 s to 3 s for 300 mm. In the case where the sample is likely to adhere to the cone and then drop, the cone shall be raised slowly over 10 s. If a large amount of the sample remains adhering to the inside of the cone, report the test as void and describe the reason. Another test shall be conducted on a new sample taken from the same batch.

The slump-flow, which is the average of the two measurements, shall be calculated and rounded to the nearest 10 mm, or 5 mm when required by the national annex.

4.7.4.4 Measurement of time to 500 mm flow

Measure the time from the beginning of the raising of the mould to the time when the flow first reaches the 500-mm diameter circle marked on the plate. Measure to an accuracy of 0,1 s, using a stopwatch.

4.7.4.5 Measurement of time to end-of-flow

Measure the time from the beginning of the raising of the mould to the time when no further flow is observed. Measure to an accuracy of 0,1 s, using a stopwatch.

4.7.5 Test report

In addition to the information required in Clause 7, the test report shall include the following:

a) slump-flow;

b) time to 500 mm flow;

c) time to end-of-flow;

d) segregation recognized by visual examination;

e) method of filling and compaction of concrete.

5 Determination of fresh density

5.1 Principle

The fresh concrete is compacted into a calibrated rigid and watertight container and is then weighed.

This test method may not be applicable to aerated concrete or very stiff concrete that cannot be compacted by normal vibration and care is needed in its use with these concretes.

5.2 Apparatus

5.2.1 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 internal diameter and height of the container shall be at least four times the maximum aggregate size in the concrete, but shall be not less than 150 mm. The volume of the container shall be not less than 5 l. The ratio of the diameter to the height of the container shall be $1,25 \geqslant d_c/h_c \geqslant 0,5$.

The container shall be calibrated in accordance with Annex B to obtain the volume (V) of the container. The container shall be in calibration at time of use. The frequency of the calibration shall be not less than once a year.

5.2.2 Filling frame (optional), made of metal not readily attacked by cement paste, fitted tightly to the container.

NOTE Filling can be simplified by using a filling frame.

5.2.3 Means of compacting the concrete in the container, which shall be one of the following:

a) **internal vibrator**, with a minimum frequency of 120 Hz (7 200 cycles per minute). The diameter of the vibrating head shall not exceed one-quarter of the smallest dimension of the mould;

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

c) **compacting rod**, of circular cross-section, straight, made of steel, having a diameter of 16 mm ± 1 mm, a length of 600 mm ± 5 mm and with rounded, roughly hemispherical, ends;

d) **compacting bar**, of square or round cross-section with mass greater than 1,8 kg for hand compacting.

5.2.4 Balance or **scales**, capable of determining the mass of the compacted concrete to an accuracy of 0,1 % of the mass of the concrete.

5.2.5 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.

5.2.6 Shovel, with a square mouth.

5.2.7 Remixing tray, of rigid construction and made from a non-absorbent material not readily attacked by cement paste.

The tray shall be of appropriate dimensions such that the concrete can be thoroughly remixed using the square-mouthed shovel.

5.2.8 Scoop, approximately 100 mm wide.

5.2.9 Steel float.

5.2.10 Moist cloth.

5.2.11 Mallet.

5.3 Sampling

The samples for the tests shall be obtained in accordance with ISO 1920-1. The samples shall be remixed before carrying out the tests.

5.4 Procedure

5.4.1 Mass of the container

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

5.4.2 Filling the container

If a filling frame is used, ensure that the amount of concrete used to fill the container is such that a layer of concrete remains in the filling frame after compaction, with a thickness of 10 % to 20 % of the height of the container.

Fill the concrete in a minimum of two layers.

5.4.3 Compacting the concrete

5.4.3.1 General

Compact the concrete immediately after placing it in the container in such a way as to produce full compaction of the concrete, with neither excessive segregation nor laitance. Compact each layer by using one of the methods described in 5.4.3.2 or 5.4.3.3.

NOTE 1 Using mechanical vibration, full compaction is achieved 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 To produce full compaction by hand, the number of strokes per layer required will depend upon the consistence of the concrete.

5.4.3.2 Mechanical vibration

5.4.3.2.1 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.

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

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

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

5.4.3.2.2 Compacting with vibrating table

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

5.4.3.3 Hand compaction with compacting rod or bar

Distribute the strokes of the compacting rod or bar in a uniform manner over the cross-section of the mould. 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 at least 25 strokes per layer. In order to remove pockets of entrapped air but not the entrained air, after the 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.

5.4.4 Surface levelling

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

5.4.5 Determining the mass and volume of the container

Weigh the container with its contents to determine its mass (m_2) and record the value indicated. The volume, V, of the container shall be determined in accordance with Annex B.

5.5 Test result

The density is calculated from Equation (2):

$$\rho_{\mathrm{fr}} = \frac{m_2 - m_1}{V} \tag{2}$$

where

ρ_{fr} is the density, expressed in kilograms per cubic metre, of the fresh concrete;

m_1 is the mass, in kilograms, of the container;

m_2 is the mass, in kilograms, of the container plus the mass of the concrete in the container;

V is the volume, expressed in cubic metres, of the container.

The density of the concrete shall be expressed to the nearest 10 kg/m^3.

Equations for calculating the volume of concrete per batch and the cement content per cubic metre are given in Annex C.

5.6 Test report

In addition to the information required in Clause 7, the test report shall include the following:

a) calculated fresh density of the compacted concrete;

b) consistence of the concrete (optional);

c) calculated volume of concrete per batch (when required);

d) calculated cement content of the concrete (when required).

6 Determination of air content

6.1 General

The methods described in this clause are applicable for concrete made with normal weight or relatively dense aggregates passing a 63-mm sieve.

Neither method is applicable to concretes made with lightweight aggregates or aggregate with high absorption.

Two test methods are described, both of which use apparatus that based on the principle of Boyle-Mariotte's law. For the purpose of reference, the two methods are designated as the pressure-gauge method and the water-column method, and the respective apparatus as a pressure-gauge meter and a water-column meter.

6.2 Sampling

Obtain the sample of fresh concrete in accordance with ISO 1920-1. If the concrete contains coarse aggregate particles that would be retained on 63-mm sieve, sieve a sufficient amount of the representative sample over a 63-mm sieve to yield somewhat more than enough material to fill the container selected for use. Carry out the sieving operation with the minimum loss of the mortar. Make no attempt to wipe adhering mortar from the coarse aggregate particles retained on the sieve. Remix the sample before carrying out the test.

6.3 Filling the container and compacting the concrete

6.3.1 Means of compaction

The means for compacting the concrete in the container shall be one of the following:

a) internal vibrator with a minimum frequency of 120 Hz (7 200 cycles per minute). The diameter of the vibrating head shall not exceed one-quarter of the smallest dimension of the mould;

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

c) compacting rod of circular cross-section, straight, made of steel, having a diameter of 16 mm ± 1 mm, a length of 600 mm ± 5 mm and with rounded, roughly hemispherical, ends;

d) compacting bar of square or round cross-section with mass greater than 1,8 kg for hand compacting.

6.3.2 Filling the container

Using the scoop, place the concrete in the container in such a way as to remove as much entrapped air as possible. Place the concrete in three layers, approximately equal in depth. Compact the concrete immediately after placing it in the container, in such a way as to produce full compaction of the concrete, with neither excessive segregation nor laitance. Compact each layer by using one of the methods described in 6.3.3.

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 The number of strokes per layer required to produce full compaction by hand, will depend upon the consistence of the concrete.

The quantity of material used in the final layer shall be sufficient to fill the container without having to remove excess material. A small quantity of additional concrete may be added if necessary and further compacted in order to fill the container.

6.3.3 Compacting the concrete

6.3.3.1 General

Compact the concrete by one of the methods described below.

6.3.3.2 Mechanical vibration

6.3.3.2.1 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.

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

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

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

6.3.3.2.2 Compacting with vibrating table

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

6.3.3.3 Hand compaction with compacting rod or bar

Distribute the strokes of the compacting rod or bar in a uniform manner over the cross-section of the mould. 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 at least 25 strokes per layer. 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.

6.4 Pressure-gauge method

6.4.1 Principle

A known volume of air at a known pressure is merged in a sealed air chamber with the unknown volume of air in the concrete sample. The dial on the pressure gauge is calibrated in terms of percentage of air for the resultant pressure.

6.4.2 Apparatus

The apparatus shall be in calibration, using the procedure given in Annex E, at the time of the test.

It is recommended that the apparatus be calibrated at a frequency dependent on use but at least once per year.

6.4.2.1 Pressure-gauge method apparatus, which shall consist of the following items (see Figure 12):

a) **container**, a flanged cylindrical vessel, of steel or other hard metal, not readily attacked by cement paste, having a nominal capacity of at least 5 l and a ratio of diameter to height of not less than 0,75 or more than 1,25.

   The outer rim and the interior surfaces of the vessel shall be machined to a smooth finish. The container shall be watertight and in addition it and the cover assembly shall be suitable for an operating pressure of approximately 0,2 MPa.

b) **cover assembly**, consisting of a flanged rigid cover, of steel or other hard metal not readily attacked by cement paste.

The outer rim and lower surface of the flange as well as the interior surfaces shall be machined to a smooth finish. The cover shall have provision for being clamped to the container to make a pressure seal without entrapping air at the joint between flanges of the cover and the container.

c) **pressure gauge**, fitted to cover the assembly, calibrated to indicate air content from 0 % to at least 8 % and preferably 10 %.

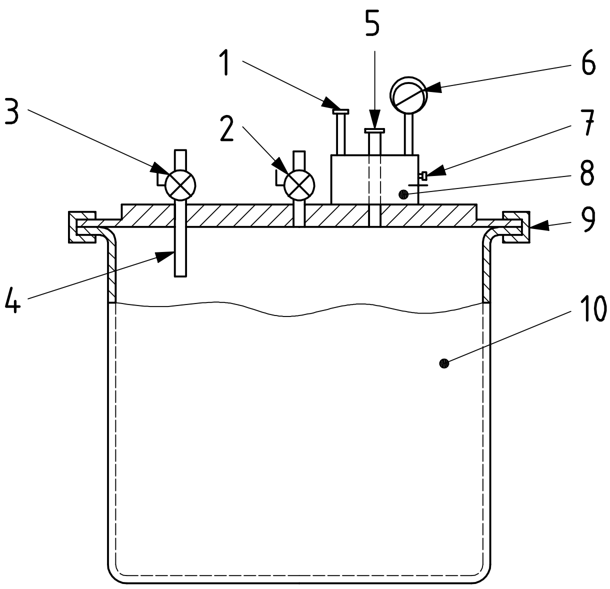
The scale of the gauge shall be graduated as follows:

— 0,1 % for the range (0 to 3) %;

— 0,2 % for the range (3 to 6) %;

— 0,5 % for the range (6 to 10) %.

d) **air pump**, a pressure pump which may be built into the cover.



Key

1	pump	6	pressure gauge
2	valve B	7	air-bleeder valve
3	valve A	8	air chamber
4	extension tubing for calibration checks	9	clamping device
5	main air valve	10	container

Figure 12 — Pressure-gauge method apparatus

6.4.2.2 **Scoop**, approximately 100 mm wide.

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

6.4.2.4 **Shovel**, with a square mouth.

6.4.2.5 **Syringe**, rubber, suitable for injecting water into the container either through valve A or valve B.

6.4.2.6 **Mallet**, soft-faced, with a mass of approximately 250 g.

6.4.3 Filling the container and compacting the concrete

Fill the container and compact the concrete in accordance with 6.3.

6.4.4 Procedure

Thoroughly clean the flanges of the container and cover assembly. Clamp the cover assembly in place, and ensure that there is a good seal between the cover and the container. Close the main air valve and open valve A and valve B. Using a rubber syringe, inject water through either valve A or valve B until water emerges from the other valve. Lightly tap the apparatus with the mallet until all entrapped air is expelled.

Ensure that the air-bleeder valve on the air chamber is closed and pump air into the air chamber until the hand on the pressure gauge is on the initial pressure line. After allowing a few seconds for the compressed air to cool to ambient temperature, stabilize the hand on the pressure gauge at the initial pressure line by further pumping in or bleeding off air as necessary. During this process lightly tap the gauge. Close both valve A and valve B and then open the main air valve. Tap the sides of the container sharply. Lightly tap the pressure gauge to stabilize it, then read and record the value indicated on the pressure gauge, which is the apparent percentage of air, C_1. Open valves A and B in order to release the pressure before the cover assembly is removed.

6.5 Water-column method

6.5.1 Principle

Water is introduced to a predetermined height above a sample of compacted concrete of known volume in a sealed container and a predetermined air pressure is applied over the water. The reduction in volume of the air in the concrete sample is measured by observing the amount by which the water level is lowered, the water column being calibrated in terms of percentage of air in the concrete sample.

6.5.2 Apparatus

6.5.2.1 General

The apparatus shall be in calibration at the time of the test, using the procedure in Annex F. If the apparatus has been moved to a location that differs in elevation by more than 200 m from the location at which it was last calibrated, it shall be recalibrated; see Annex F.

It is recommended that the apparatus be calibrated at a frequency dependent upon use, but at least once per year.

6.5.2.2 **Water-column method apparatus**, which shall consist of the following items (see Figure 13):

a) **container**, a flanged cylindrical vessel, of steel or other hard metal, not readily attacked by cement paste, having a nominal capacity of at least 5 l and a ratio of diameter to height of not less than 0,75 nor more than 1,25.

   The outer rim and upper surface of the flange and the interior surfaces of the vessel shall be machined to a smooth finish. The container shall be watertight and in addition it and the cover assembly shall be suitable for an operating pressure of approximately 0,1 MPa and be sufficiently rigid to limit the pressure expansion constant, e, (see F.8) to not more than 0,1 % air content.

b) **cover assembly**, a flanged rigid conical cover, fitted with a standpipe.

The cover shall be of steel or other hard metal not readily attacked by cement paste and shall have interior surfaces inclined at not less than 10° from the surface of the flange. The outer rim and lower surface of the flange and the sloping interior face shall be machined to a smooth finish. The cover shall have provision for being clamped to the container to make a pressure seal without entrapping air at the joint between the flanges of the cover and the container.

c) **standpipe**, consisting of a graduated glass tube of uniform bore or a metal tube of uniform bore with a glass gauge attached.

The graduated scale shall indicate air content of 0 % to at least 8 % and preferably 10 %. The scale shall be graduated with divisions every 0,1 % air content, the divisions being not less than 2 mm apart.

NOTE A scale in which 25 mm represents 1 % of air content is convenient.

d) **cover**, the cover shall be fitted with a suitable device for venting of the air chamber, a non-return air-inlet valve and a small valve for bleeding off water.

The applied pressure shall be indicated by a pressure gauge connected to the air chamber above the water column. The gauge shall be graduated with divisions every 0,005 MPa, the divisions being not less than 2 mm apart. The gauge shall have a full-scale reading of 0,2 MPa.

e) **deflecting plate** or **spray tube**, a thin non-corrodible disc of not less than 100 mm diameter to minimize disturbance of the concrete when water is added to the apparatus.

Alternatively, a brass spray tube of appropriate diameter that may be an integral part of the cover assembly or provided separately may be used. The spray tube shall be constructed so that when water is added to the container, it is sprayed onto the walls of the cover in such a manner as to flow down the sides causing minimum disturbance to the concrete.

f) **air** (**pressure**) **pump**, with a lead facilitating connection to the non-return air-inlet valve on the cover assembly.

6.5.2.3 Scoop, approximately 100 mm wide.

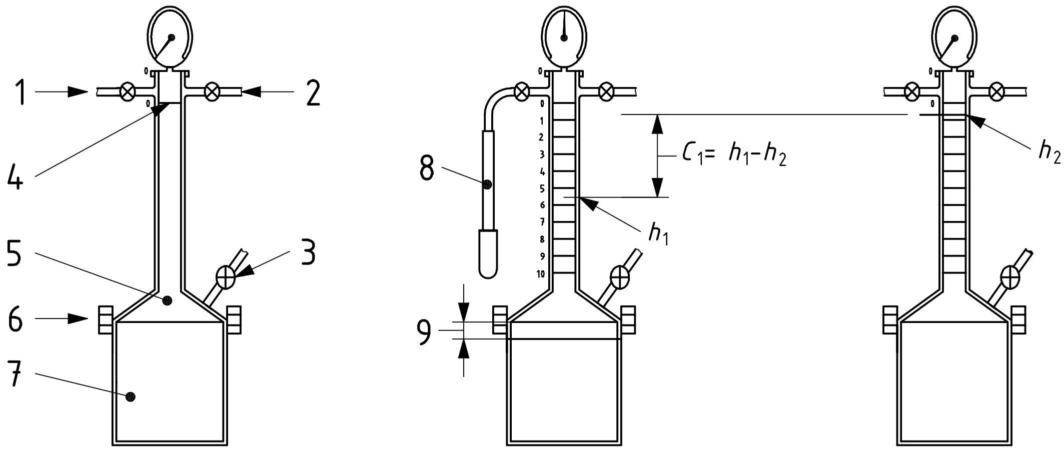
6.5.2.4 Remixing tray, of rigid construction, made from a non-absorbent material not readily attacked by cement paste.

It shall be of appropriate dimensions such that the concrete can be thoroughly remixed using a square-mouthed shovel.

6.5.2.5 Shovel, with a square blade.

6.5.2.6 Container, fitted with a spout, having a capacity of 2 l to 5 l, to fill the apparatus with water.

6.5.2.7 Mallet, soft-faced, with a mass of approximately 250 g.



a) Zero pressure

b) System operating at pressure P

c) Zero pressure after release of pressure P

Key

1 non-return valve
2 air vent or valve
3 bleed valve
4 mark
5 water
6 clamp
7 concrete
8 air pump
9 pressure-lowered level

h_1 reading at pressure P
h_2 reading at zero pressure after the pressure has been released

$h_1 - h_2 = C_1$ when the container holds concrete.

$h_1 - h_2 = G$ (aggregate correction factor) when the container holds only aggregate and water.

$C_1 - G = C_c$ (air content of concrete).

Figure 13 — Water-column method apparatus

6.5.3 Filling the container and compacting the concrete

Fill the container and compact the concrete as described in 6.3.

6.5.4 Procedure

Thoroughly clean the flanges of the container and cover assembly. In the absence of the spray tube, place the deflecting plate, centrally on the concrete and press it into contact. Clamp the cover assembly in place, and ensure that there is good pressure seal between the cover and the container. Fill the apparatus with water and tap lightly with the mallet to remove air adhering to the interior surfaces of the cover. Bring the level of water in the standpipe to zero by bleeding through the small valve with the air vent open. Close the air vent and apply the operating pressure, P, by means of the air pump. Record the reading on the gauge tube, h_1, and release the pressure. Read the gauge tube again and if the reading h_2 is 0,2 % air content or less, record the value $(h_1 - h_2)$ as the apparent air content, C_1, to the nearest 0,1 % air by volume. If h_2 is greater than 0,2 % air content, apply the operating pressure, P, again, giving a gauge tube reading h_3 and a final reading h_4 after release of the pressure. If $(h_4 - h_2)$ is 0,1 % air content or less, record the value $(h_3 - h_4)$ as the apparent air content. If $(h_4 - h_2)$ is greater than 0,1 % air content, it is possible that leakage is occurring and the test shall be disregarded.

6.6 Calculations and expression of results

6.6.1 Air content of the sample tested

Calculate the air content, C_c, of the concrete in the container from Equation (3):

$$C_c = C_1 - G \quad (3)$$

where

C_1 is the apparent air content, expressed to the nearest 0,1 %, of the sample tested;

G is the aggregate correction factor, expressed to the nearest 0,1 %.

The aggregate correction factors shall be determined as described in Annex G and Annex H.

Express the air content as a percentage to the nearest 0,1 %.

In some cases, when it is required by the national annex, the air content of concrete can be calculated as shown in Equation (4):

$$C_c = \frac{(\rho_{abs} - \rho_{fr})}{\rho_{abs}} \times 100 \quad (4)$$

where

ρ_{fr} is the density, expressed in kilograms per cubic metre, of fresh concrete calculated in 5.5;

ρ_{abs} is the absolute density of concrete which does not include air.

6.6.2 Air content of the mortar fraction

When required, calculate the air content of the mortar fraction of the concrete, C_m, from Equation (5):

$$C_m = \frac{100 C_c V_c}{100 V_m + C_c (V_c - V_m)} \quad (5)$$

where

V_m is the absolute volume, expressed in cubic metres, of the constituents of the mortar fraction (i.e. cement, water and fine aggregate) of the concrete, air-free, as determined from the original batch masses;

V_c is the absolute volume, expressed in cubic metres, of the constituents of the concrete, air-free, as determined from the original batch masses.

Express the air content as a percentage to the nearest scale division.

6.7 Test report

In addition to the information required in Clause 7, the test report shall include the following:

— aggregate correction (where appropriate);

— identification of test method and procedure used, i.e. pressure-gauge method or water-column method;

— information relevant to the specific test, e.g. altitude;

— measured apparent air content;

— calculated air content (C_c) of the concrete;

— when required, calculated air content of the mortar fraction (C_m).

7 Test report

In addition to the specifics required for each test method, the report shall include the following information:

a) identification of the test sample;

b) location of performance of test;

c) time of performance of test;

d) temperature of the remixed sample (optional);

e) observations on condition of test sample (optional);

f) method of compaction:

- for mechanical compaction, the duration,
- for hand compaction, the number of strokes;

g) identification of person carrying out the test or part of the test;

h) any deviation from standard test method;

i) declaration by the person carrying out the test that it was carried out in accordance with this part of ISO 1920-2, except as noted in 7 h).

Annex A
(informative)

Precision — Data for the density measurements

Precision data are given in Table A.1. These apply to fresh concrete density measurements made on concrete taken from the same sample and when each test result represents a single density determination.

Table A.1 — Precision data for density of fresh concrete measurements

Range kg/m3	Repeatability conditions [a]		Reproducibility conditions [b]	
	s_r kg/m3	r kg/m3	s_R kg/m3	R kg/m3
2 300 to 2 400	5,5	15	10,2	29

[a] The difference between two tests 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.

[b] Test results on the same sample obtained within the shortest feasible time interval by two operators, each using its 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 1 The containers used complied with the requirements:

- nominal capacity: 0,01 m3;
- 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 2 The precision data include the procedures of sampling, as well as the determination of the density of the fresh concrete.

NOTE 3 For further information on precision, and for definitions of the statistical terms used in connection with precision, see ISO 5725 (all parts).

Annex B
(normative)

Calibration of the container for the density test

B.1 Apparatus

The apparatus shall be as follows:

B.1.1 Scales or **balance**, capable of weighing the container either empty or full of water to an accuracy of 0,1 %.

B.1.2 Glass plate.

B.2 Procedure

Weight the empty container and glass plate to an accuracy of 0,1 % and record the indicated mass.

Place the container on a horizontal surface and fill with water at a temperature of 20 °C ± 5 °C. The container shall be filled to overflowing and the glass plate slid over it to exclude any air bubbles. Remove any excess water from the outside of the container plate.

Weigh the container, glass plate and water to an accuracy of 0,1 % and record the indicated mass.

Calculate the volume of the container by dividing the total mass, expressed in kilograms, of water required to fill the container by 998.

Express the volume, V, expressed in cubic metres, of the container to an accuracy of 0,1 %.

B.3 Calibration interval

The container shall be calibrated before initial use and at least annually thereafter.

It is recommended that the balance be calibrated at least annually.

Annex C
(informative)

Additional calculations for the density test

C.1 General

Once the density of the compacted fresh concrete has been determined, it is possible to use the result to calculate

a) volume of concrete per batch;

b) cement content.

C.2 Calculation of volume of concrete per batch

If the volume of concrete produced per batch is required, it shall be calculated from Equation (C.1):

$$V_{\mathrm{b}} = \frac{m_{\mathrm{T}}}{\rho_{\mathrm{fr,c}}} \quad \text{(C.1)}$$

where

V_{b} is the volume, expressed in cubic metres, of concrete produced per batch;

m_{T} is the sum of the masses, expressed in kilograms, of all the constituents of the concrete as batched;

$\rho_{\mathrm{fr,c}}$ is the density, expressed in kilograms per cubic metre, of the fully-compacted fresh concrete.

The result shall be expressed to an accuracy of 1 %.

C.3 Calculation of cement content

If the cement content of the fresh concrete is required, it shall be calculated from the formula:

$$C = \frac{m_{\mathrm{c}}}{V_{\mathrm{b}}} \text{ or } C = \frac{\rho_{\mathrm{fr,c}} \times m_{\mathrm{c}}}{m_{\mathrm{T}}} \quad \text{(C.2)}$$

where

C is the cement content, expressed in kilograms per cubic metre:

$\rho_{\mathrm{fr,c}}$ is the density, expressed in kilograms per cubic metre, of the fully-compacted fresh concrete;

V_{b} is the volume, expressed in cubic metres, of the concrete produced per batch;

m_{T} is the sum of the masses, expressed in kilograms, of all the constituents of the concrete as batched;

m_{c} is the mass, expressed in kilograms, of the cement as batched.

The result shall be expressed to the nearest 5 kg/m^3.

Annex D
(informative)

Precision — Water-column method

Precision data for the water-column method are given in Table D.1. These apply to air content measurements made by the water-column method on concrete taken from the same sample and compacted by hand when each test result is obtained for a single air content determination.

Table D.1 — Precision data for air content measurements

Level %	Repeatability conditions [a]		Reproducibility conditions [b]	
	s_r %	r %	s_R %	R %
5,6	0,16	0,4	0,45	1,3

[a] 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.

[b] Test results on the same sample obtained within the shortest feasible time interval by two operators, each using its 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 For further information on precision, and for definitions of the statistical terms used in connection with precision, see ISO 5725 (all parts).

Annex E
(normative)

Calibration of apparatus — Pressure-gauge method

E.1 General

The calibration test detailed shall be made as frequently as necessary to check the accuracy of the graduations indicating air content on the dial of the pressure gauge. Recalibration of the apparatus is not required with changes in elevation at which it is used or with changes in atmospheric pressure.

E.2 Apparatus

The apparatus shall be as follows:

E.2.1 Calibration cylinder, made of brass or other non-corrodible metal having a capacity of approximately 0,3 l, which may be integral with the cover assembly.

E.2.2 Transparent plate, rigid and transparent, suitable for use as a closure for the container.

E.2.3 Balances, capable of weighing up to 1 kg to an accuracy of ± 0,5 g over the range used in the test and a calibrated balance capable of weighing up to 20 kg to an accuracy of ± 5 g over the range used in the test.

E.3 Checking the capacity of the container

The capacity of the container is found by determining the mass of water, $m_{\mathrm{w,con}}$, required to fill it.

Smear a thin film of grease on the flange of the container to make a watertight joint between the transparent plate and the top of the container. Fill the container with water at ambient temperature and place the transparent plate over it to eliminate any convex meniscus.

Wipe away surplus water and determine the mass of the container filled with water by weighing on the balance.

E.4 Checking air content graduations on the pressure gauge

Screw the extension tubing (see Figure 12) into the threaded hole beneath valve A on the underside of the cover assembly and clamp the cover assembly into place, taking care to ensure that there is a good pressure seal between cover and container. Close main air valve and open valves A and B. Add water through valve A until all trapped air has been expelled through valve B. Pump air into the air chamber until the pressure reaches the indicated initial pressure line. After allowing a few seconds for the compressed air to cool to ambient temperature, stabilize the indicator on the pressure gauge at the initial pressure line by further pumping in or bleeding off air as necessary. During this process lightly tap the gauge and close valve B.

Remove the water from the apparatus to the calibration cylinder in just sufficient quantity to fill it completely or up to a predetermined line marked on it, then determine the mass, $m_{\mathrm{w,dis}}$, of water displaced by weighing on the balance.

Depending upon the particular apparatus design, control the flow of water either by opening valve A and using the main air valve to control the flow, or by opening the main air valve and using valve A to control the flow.

Then release the pressure in the container by opening valve B. (If the apparatus employs an auxiliary tube for filling the calibration cylinder, open valve A so that the tube is drained back into the container, or alternatively, if the calibration is an integral part of the cover assembly, close valve A immediately after filling the calibration vessel and leave it closed until the test has been completed.) The volume of air in the container is now equal to the volume of the displaced water; close all valves, pump air into the air chamber until the pressure reaches the initial pressure line, and then open the main air valve. The air content indicated by the pressure gauge corresponds to the percentage of air, C_1, determined to be in the container, where $C_1 = m_{w,dis}/m_{w,con} \times 100$ %. If two or more determinations show the same variation from the correct air content, reset the hand on the pressure gauge to the correct air content and repeat the test until the gauge reading corresponds to the calibrated air content within 0,1 % air content.

Annex F
(normative)

Calibration of apparatus — Water-column method

F.1 General

The calibration tests described in F.3, F.4, F.5 and F6 shall be made at the time of the initial calibration of the apparatus and at any time when it is necessary to check whether the capacity of the calibration cylinder or container may have changed. The calibration test described in F.7 and F.8 shall be made as frequently as necessary to check the pressure gauge in order to ensure that the proper gauge pressure, P, is being used. Recalibration of the apparatus shall also be required when the location at which it is to be used varies in elevation by more than 200 m from that at which it was last calibrated.

F.2 Apparatus

The apparatus shall be as follows:

F.2.1 Calibration cylinder, hollow, made of brass or other strong non-corroding metal, having a capacity of approximately 0,3 l.

The rim of the cylinder shall be machined to a smooth plane surface at right angles to the axis of the cylinder.

F.2.2 Support, for the calibration cylinder, made of non-corroding material and which allows free flow of water into and out of the cylinder in the inverted position.

F.2.3 Spring, non-corroding coil, spring or equivalent for retaining the calibration cylinder in place.

F.2.4 Transparent plates, two, rigid, one suitable for use as a closure for the calibration cylinder and one as a closure for the container.

F.2.5 Balances, one calibrated and capable of weighing up to 1 kg to an accuracy of ± 0,5 g over the range used in the test and one calibrated and capable of weighing up to 20 kg to an accuracy of ± 5 g over the range used in the test.

F.3 Capacity of the calibration cylinder

Using the 1-kg balance, determine the capacity of the calibration cylinder by measuring the mass of water required to fill it. For this purpose, fill the weighed cylinder with water at ambient temperature (15 °C to 25 °C) and carefully cover it with the previously weighed transparent plate, ensuring that no air bubbles are trapped under the plate and that surplus water is wiped away before weighing the assembly. By repeating this procedure, make a total of three weighings of the covered cylinder filled with water. Calculate the average mass, $m_{\mathrm{w,cyl}}$, of water contained in the full cylinder and record it to the nearest 0,5 g.

F.4 Capacity of the container

Using the 20-kg balance, determine the capacity of the container by measuring the mass of water required to fill it. For this purpose, smear a thin film of grease on the flange of the container, and, after weighing together with the transparent plate, fill with water at ambient temperature (15 °C to 25 °C) and make a watertight joint by sliding the transparent plate over the top of the container, ensuring that no air bubbles are trapped under the plate and that surplus water is wiped away before weighing the assembly. By repeating this procedure, make a total of three weighings of the covered container filled with water. Calculate the average mass, $m_{\text{w,con}}$, of water contained in the full container and record it to the nearest 5 g.

F.5 Pressure expansion constant

The pressure expansion constant, e, is determined by filling the apparatus with water, making sure that all entrapped air has been removed and that the water level is exactly on the zero mark, and applying an air pressure of 100 kPa. The reading of water column (in percent air content) will be the pressure expansion constant, e, for the apparatus.

Strictly speaking, the air pressure applied during this procedure should be the required operating pressure, P, determined as in F.8. However, as the value of e is needed to determine P by way of the calibration constant K, a logically closed cycle of operations exists. In practice, the change in e due to a change in P is small enough to be ignored. As P is commonly about 100 kPa, this value is prescribed to overcome the problem. Its use will lead to a value of e that is sufficiently accurate for the test.

F.6 Calibration constant

The calibration constant, K, is the reading needed on the air content scale during the routine calibration procedure to obtain the gauge pressure required to make the graduations on the air content scale correspond directly to the percentage of air introduced into the container by the calibration cylinder when the container is full of water.

The constant, K, is generally calculated in accordance with Equation (F.1); see note:

$$K = 0{,}98 \times R + e \qquad \text{(F.1)}$$

where

e is the pressure expansion constant (see F.5);

R is the capacity of the calibration cylinder expressed relative to the capacity of the container and is calculated as follows; see F.3 and F.4:

$$R = \frac{m_{\text{w,cyl}}}{m_{\text{w,con}}} \times 100 \qquad \text{(F.2)}$$

NOTE The factor 0,98 is used to correct for the reduction in the volume of air in the calibration vessel when it is compressed by a depth of water equal to the depth of the container. This factor is approximately 0,98 for a 200 mm deep container at sea level. Its value decreases to approximately 0,975 at 1 500 m above sea level and 0,970 at 4 000 m above sea level. The value of the constant will decrease by about 0,01 for each 100 mm increase in bowl depth. Hence the term $0{,}98 \times R$ represents the effective volume of the calibration vessel, expressed as a percentage of the container under normal operating conditions.

F.7 Required operating pressure

Place the calibration cylinder support centrally on the bottom of the clean container and place the cylinder on the support with its open end downward. Place the coil spring on the cylinder and clamp the cover assembly carefully in place.

Fill the apparatus with water at ambient temperature to a level above the zero mark on the air content scale. Close the air vent and pump air into the apparatus approximately to the operating pressure (about 100 kPa). Lightly tap the sides and cover with the mallet to remove as much entrapped air as possible adhering to the interior surfaces of the apparatus and gradually reduce the pressure by opening the vent. Bring the water level exactly to the zero mark by bleeding water through the small valve in the conical cover and close the air vent. Apply pressure by means of the pump until the reading of the water level equals the calibration constant, K (see F.6). Record the pressure, P, indicated on the pressure gauge. Gradually release the pressure by opening the vent until zero pressure is indicated. If the water level returns to a reading less than 0,05 % air content, take the pressure, P, as the operating pressure. If the water level fails to return to a reading below 0,05 % air content, check the apparatus for leakage and repeat the procedure.

F.8 Alternative operating pressure

The range of air contents that can be measured with a particular apparatus can be extended by determining an appropriate alternative operating pressure. For example, if the range is to be doubled, the alternative operating pressure, P_1, is that for which the apparatus indicates half of the calibration reading, K, (see F.6).

Exact calibration requires the determination of the pressure expansion constant, e (see F.5), for the reduced operating pressure but, since the change in the pressure expansion constant can normally be disregarded, the alternative operating pressure can be determined during the determination of the normal operating pressure (see F.7).

Annex G
(normative)

Aggregate corrector factor — Pressure-gauge method

G.1 General

The aggregate correction factor will vary with different aggregates and although ordinarily it will remain reasonably constant for a particular aggregate, an occasional check should be carried out. The aggregate correction factor can be determined only by a test, as it is not directly related to the water absorption of the particles.

G.2 Aggregate sample size

Determine the aggregate correction factor by applying the operating pressure on a combined sample of the coarse and fine aggregates in the approximate amounts, proportions and moisture conditions that exist in the concrete sample. Obtain the sample of aggregate either by washing the cement through a 150 µm sieve from the concrete sample tested or by using a combined sample of fine and coarse aggregate similar to that used in the concrete. In the latter case calculate the masses, m_f and m_c, of fine and coarse aggregate, respectively, to be used from Equations (G.1) and (G.2):

$$m_f = V_o \rho_{fr} f_f \quad \text{(G.1)}$$

$$m_c = V_o \rho_{fr} f_c \quad \text{(G.2)}$$

where

f_f and f_c are the proportions, expressed as fractions by mass of the total concrete mix (aggregates, cement and water), of the fine and the coarse aggregate, respectively;

V_o is the capacity, expressed in cubic metres, of the container determined as specified in E.3;

ρ_{fr} is the density, expressed in kilograms per cubic metre, of concrete to be tested, determined in accordance with Clause 5 or calculated from the known proportions and densities of the materials and the nominal air content.

G.3 Filling the container

Partially fill the container of the apparatus with water, then introduce the combined sample of aggregate in small scoopfuls. This shall be done in such a manner as to entrap as little air as possible.

If necessary, add additional water to inundate all of the aggregate. After the addition of each scoopful, remove any foam promptly, then stir the aggregate with the compacting bar and tap the container with the mallet to release any entrapped air.

G.4 Determination of aggregate correction factor

When all the aggregate has been placed in the container, wipe clean the flanges of the container and the cover assembly thoroughly and clamp the cover assembly into position, so that a pressure-tight seal is obtained. Close the main valve and open valves A and B. Using the rubber syringe, inject water through either valve A or valve B until water emerges from the other valve. Tap the apparatus lightly with the mallet until all entrapped air is expelled from this same valve. Remove a volume of water from the container approximately equivalent to the volume of air that would be contained in a typical concrete sample of a size equal to the volume of the container. Remove the water in the apparatus in the manner described in E.4 for the calibration test. Complete the test using the procedure described in 6.4.4.

The aggregate correction factor, G, expressed as a percentage of the capacity of the container, is equal to the reading on the air content scale minus the volume of water removed from the container.

Annex H
(normative)

Aggregate correction factor — Water-column method

H.1 General

The aggregate correction factor will vary with different aggregates and, although it will remain reasonably constant for a particular aggregate, an occasional check should be carried out. The aggregate correction factor can be determined only by a test, as it is not directly related to the water absorption of the particles.

H.2 Aggregate sample size

Determine the aggregate correction factor by applying the operating pressure on a combined sample of the coarse and fine aggregates in the approximate proportions and moisture conditions that exist in the concrete sample. Obtain the sample of aggregates either by washing the cement from the concrete sample tested for air content, through a 150 µm sieve, or by using a combined sample of fine and coarse aggregate similar to that used in the concrete. In the latter case calculate the masses, m_f and m_c, of the fine and the coarse aggregate, respectively, to be used from Equations (G.1) and (G.2):

$$m_\mathrm{f} = V_\mathrm{o} \rho_\mathrm{fr} f_\mathrm{f} \quad \text{(G.1)}$$

$$m_\mathrm{c} = V_\mathrm{o} \rho_\mathrm{fr} f_\mathrm{c} \quad \text{(G.2)}$$

where

f_f and f_c are the proportions, expressed as fractions by mass of the total concrete mix (aggregates, cement and water), respectively, of the fine and the coarse aggregate;

V_o is the capacity, expressed in cubic metres, of the container; see F.4;

ρ_fr is the density, expressed in kilograms per cubic metre, of concrete to be tested, determined in accordance with Clause 5 or calculated from the known proportions and densities of the materials and the nominal air content.

H.3 Filling the container

Partially fill the container of the apparatus with water, then introduce the combined sample of aggregate in small scoopfuls. This shall be done in such a manner as to entrap as little air as possible. If necessary, add additional water to inundate all of the aggregate. After the addition of each scoopful, remove any foam promptly, then stir the aggregate with the compacting bar and tap the container with the mallet to release any entrapped air.

H.4 Determination of aggregate correction factor

When all the aggregate has been placed in the container, wipe clean the flanges of the container and clamp the cover in position. Fill the apparatus with water and tap lightly with the mallet to remove air adhering to the interior surfaces of the apparatus. Bring the level of the water in the standpipe to zero by bleeding through the small valve with the air vent open. Close the air vent and apply the operating pressure, P, by means of the air pump.

Record the reading of the gauge tube as h_1, release the pressure and take a further reading, h_2. Repeat the entire procedure once, obtaining a second pair of readings, h_3 and h_4. Take the average value of $(h_1 - h_2)$ and $(h_3 - h_4)$ as the aggregate correction factor, G, unless the two values of $(h_1 - h_2)$ and $(h_3 - h_4)$ differ by more than 0,1 % air content, in which case carry out further determinations until consistent results are obtained.

Annex I
(informative)

Examples of test reports and worksheets

I.1 Example of a slump-test report

Client

Test organization

Accreditation certificate ref

Test Location

Test Item

Sample identification: Date and time received:

Concrete reference number (or mix details):

Condition of sample: at time of test:

abnormalities:

temperature: (if required)

Details of test preparation (including the method of compaction):

Test and Test results

Time of performance of test: Mould reference number:

Sampling procedure: Rod reference number:

Any deviation from standard test method: Rule reference number:

Environmental conditions:

Measured slump (h):

Test 1: mm   Test 2: mm

Test 1: mm   Test 2: mm

Type of slump: normal/shear

Except as detailed above, this test was carried out in accordance with ISO 1920-2.

Technical Responsibility

Responsible person: Name: Position:

Signature:

Test Report identification

Test Report No: Date issued:

I.2 Example of a Vebe-test report

Client | **Test organization**

	Accreditation certificate ref

Test Location

Test Item

Sample identification: Date and time received:

Concrete reference number (or mix details):

Condition of sample: at time of test:

abnormalities:

temperature: (if required)

Details of test preparation (including the method of compaction):

Test and Test results

Time of performance of test: Consistometer reference number:

Sampling procedure:

Any deviation from standard test method:

Environmental conditions:

Type of slump: true / collapse / shear:

Measured slump: mm

Vebe time: sec

Except as detailed above, this test was carried out in accordance with ISO 1920-2.

Technical Responsibility

Responsible person: Name: Position:

Signature:

Test Report identification

Test Report No: Date issued:

I.3 Example of a degree-of-compactability test report

Client

Test organization

Accreditation certificate ref

Test Location

Test Item

Sample identification: Date and time received:

Type of sample: composite / spot

Concrete reference number (or mix details):

Condition of sample: at time of test:

abnormalities:

temperature: (if required)

Details of test preparation (including the method of compaction)

Test and Test results

Time of performance of test:

Sampling procedure:

Any deviation from standard test method:

Environmental conditions:

Measured:	distance(s)	mm	mm	mm	mm
	mean(s)	mm			

Calculation of Degree of Compactability: $c = \frac{h_1}{h_1 - s}$:

Except as detailed above, this test was carried out in accordance with ISO 1920-2.

Technical Responsibility

Responsible person: Name: Position:

Signature:

Test Report identification

Test Report No: Date issued:

I.4 Example of a flow-table test report

Client

Test organization

Accreditation certificate ref

Test Location

Test Item

Sample number:

Date and time received:

Concrete details:

Condition of sample:

at time of test:

- abnormalities:
- temperature: (if required)
- Details of test preparation:

Test and Test results

Time of performance of test:

Sampling procedure:

Jolting rate:

Table reference number:

Mould reference number:

Segregation, if any:

Rod reference number:

Rule reference number:

Timer reference number:

Measured flow:

Dimension (d_1:) ______ mm

Dimension (d_2): ______ mm

Flow Value: $F = \frac{d_1 + d_2}{2}$: ______ mm

Any deviations from the standard:

Technical Responsibility

Responsible person:

Name:

Position:

Signature:

Test Report identification

Test Report No:

Date issued:

I.5 Example of a slump-flow test report

Client

Test organization

Accreditation certificate ref

Test Location

Test Item

Sample identification: Date and time received:

Concrete reference number (or mix details):

Condition of sample: at time of test:

abnormalities:

temperature: (if required)

Details of test preparation (including the method of compaction):

Test and Test results

Time of performance of test: Mould reference number:

Sampling procedure: Rod reference number:

Method of filling and compacting of concrete:

Any deviation from standard test method: Scale reference number:

Environmental conditions:

Measured time to 500 mm flow: sec

Measured time to end of flow: sec

Measured slump-flow: mm

Except as detailed above, this test was carried out in accordance with ISO 1920-2.

Technical Responsibility

Responsible person: Name: Position:

Signature:

Test Report identification

Test Report No: Date issued:

I.6 Example of a compacted-fresh-concrete-density test report

Client reference (if appropriate)

Test organization

Accreditation certificate ref

Test Location

Test Item

Sample identification:

Concrete reference number (or mix details):

Condition of sample:

Date and time received:

at time of test:

abnormalities:

temperature: (if required)

Test and Test results

Time of performance of test:

Sampling procedure:

A. Method of compaction:

Vibrating Table	☐	reference:	Internal vibrator	☐	reference:	time:
Compacting rod	☐	reference:	Compacting bar	☐	reference:	tamps:

B.

Measured mass of empty container (m_1): kg

Measured mass of container and concrete (m_2): kg

Calibrated volume of container (V): m^3

Calculated density (ρ_{fr}) $= \frac{m_2 - m_1}{V}$: kg/m^3

Any deviations from the standard:

Except as detailed above, this test was carried out in accordance with ISO 1920-2.

Technical Responsibility

Responsible person: Name: Position:

Signature:

Test Report identification

Test Report Number: Date issued:

I.7 Example of a supplement to the compacted-fresh-concrete-density test report

I.7.1 Calculated volume of concrete per batch

I.7.1 **Volume of concrete per batch**

Mass of coarse aggregate* per batch	________	kg
Mass of fine aggregate (sand)* per batch	________	kg
Mass of cement per batch	________	kg
Mass of mixing water added	________	kg
Mass of any other constituents	________	kg
Total Mass (m_T)	________	kg
Calculated density (from certificate)	________	kg/m^3
Volume of concrete produced per batch (V_b)		m^3

* Note: saturated, surface dry.

I.7.2 Calculated cement content

Compacted fresh density certificate number.

I.7.2 **Cement content**

Mass of cement per batch (m_c):		kg
Volume of concrete produced per batch (V_b):		m^3
Cement content (C) $= \frac{m_c}{V_b}$:		kg/m^3

Technical Responsibility

Responsible person: Name: Position:

Signature:

Test Report identification

Test Report Number: Date issued:

I.8 Example of a test report for the determination of the air content using the pressure-gauge method

Client reference (if appropriate) **Test organization**

Client reference	Test organization
	Accreditation certificate ref

Test Location

Air meter reference: Apparatus in calibration: Yes/No

Undamaged and clean: Yes/No

Aggregate correction factor, G: Worksheet reference:

Sample identification:

Location test:

Method of compaction:				
	Vibrating Table	☐	reference:	time:
	Internal vibrator	☐	reference:	time:
	Tamping rod	☐	reference:	strokes:
	Compacting bar	☐	reference:	strokes:

Time at start of test:

Meter reading, C_1:

Air content of sample, $C_c = C_1 - G$ [%]

Any deviations from the standard:

Except as detailed above, the sample was tested in accordance with ISO 1920-2.

Technical Responsibility

Responsible person: Name: Position:

Signature:

Test Report identification

Test Report Number: Date issued:

I.9 Example of a test report for the determination of the air content using the water-column method

Client reference (if appropriate)

Test organization

Accreditation certificate ref

Test Location

Air meter reference: Apparatus in calibration: Yes/No

Undamaged and clean: Yes/No

Aggregate correction factor, G: Worksheet reference:

Sample identification:

Location test:

Method of compaction:	Internal vibrator	☐	reference:	time:
	Vibrating Table	☐	reference:	time:
	Compacting rod	☐	reference:	strokes:
	Compacting bar	☐	reference:	strokes:

Time at start of test:

Reading at working pressure, h_1: %

Reading after release, h_2: %

If $h_2 \leqslant 0,2$ % Apparent air content, $C_1 = h_1 - h_2$ %

If $h_2 > 0,2$ % repeat application of pressure.

Reading at working pressure, h_3: %

Reading after release, h_4: %

If $h_4 - h_2 \leqslant 0,1$ % Apparent air content, $C_1 = h_3 - h_4$: %

If $h_4 - h_2 > 0,1$ % Abandon test.

Air content of sample, $C_c = C_1 - G$: %

Any deviations from the standard:

Except as detailed above, the sample was tested in accordance with ISO 1920-2.

Technical Responsibility

Responsible person: Name: Position:

Signature:

Test Report identification

Test Report Number: Date issued:

I.10 Example of a test report for the determination of the aggregate correction value using the pressure-gauge method

Client reference (if appropriate) **Test organization**

	Accreditation certificate ref

Test Location

Air meter reference: Undamaged and clean: Yes/No

Location of test:

Aggregate sample used: washed concrete sample ref:

or: mass fines, $m_f = V_o \rho_{fr} f_f$: g

mass coarse, $m_c = V_o \rho_{fr} f_c$ g

Mass of water displaced, $m_{w,dis}$: g

Mass, $m_{w,con}$ of water in full container: g

Reading on meter, G_1: %

Aggregate correction factor, $G = G_1 - (m_{w,dis}/m_{w,con} \times 100)$: %

Any deviations from the standard:

Except as detailed above, the sample was tested in accordance with ISO 1920-2.

Technical Responsibility

Responsible person: Name: Position:

Signature:

Test Report identification

Test Report Number: Date issued:

I.11 Example of a test report for the determination of the aggregate correction value using the water-column method

Client reference (if appropriate) **Test organization**

Accreditation certificate ref

Test Location

Air meter reference: Apparatus in calibration: Yes/No

Undamaged and clean: Yes/No

Aggregate sample used: washed concrete sample ref:

or: mass fines, $m_f = V_o \rho_{fr} f_f$:

mass coarse, $m_c = V_o \rho_{fr} f_c$

Reading at working pressure, h_1: %

Reading after release, h_2: %

Apparent air content, $G_1 = h_1 - h_2$: %

Reading at working pressure, h_3: %

Reading after release, h_4: %

Apparent air content, $G_1 = h_3 - h_4$: %

If $|G_1 - G_2| > 0{,}1$ %, repeat until consistent results are obtained.

Any deviations from the standard:

Except as detailed above, the sample was tested in accordance with ISO 1920-2

Technical Responsibility

Responsible person: Name: Position:

Signature:

Test Report identification

Test Report Number: Date issued:

I.12 Example of a test report for the calibration of the pressure-gauge meter

Client reference (if appropriate) **Test organization**

Accreditation certificate ref

Test Location

Air meter reference: Undamaged and clean: Yes/No

Location test:

Balance 1 reference:

Balance 2 reference:

Mass of water in full container, $m_{w,con}$: g

Mass of water in displaced, $m_{w,dis}$: g

Air content, $C_1 = m_{w,dis}/m_{w,con} \times 100$: %

Air content, reading 1: %

Air content, reading 2: %

Air content, reading 3: %

Air content, reading 4: %

Any deviations from the standard:

Except as detailed above, the sample was tested in accordance with ISO 1920-2.

Technical Responsibility

Responsible person: Name: Position:

Signature:

Test Report identification

Test Report Number: Date issued:

I.13 Example of a test report for the calibration of the water-column meter

Client reference (if appropriate) **Test organization**

Accreditation certificate ref

Test Location

Air meter reference: Undamaged and clean: Yes/No

Balance 1 reference:

Balance 2 reference:

Mass of water in full container, $m_{w,cyl}$: g

Mass of water in meter cylinder, $m_{w,con}$: g

Pressure expansion constant, e: %

Location of test: Height above sea level (to nearest 100 m):

Calibration constant, $K = 0{,}98\ (m_{w,cyl}/m_{w,con} \times 100) + e$:

Working pressure, P:

Final water level:

If final water level $>$ 0,05 %, check for leaks and repeat procedure.

Any deviations from the standard:

Except as detailed above, the sample was tested in accordance with ISO 1920-2.

Certified that the apparatus listed was/was not in calibration.

Technical Responsibility

Responsible person: Name: Position:

Signature:

Test Report identification

Test Report Number: Date issued:

I.14 Example of an air content test report

Client reference (if appropriate) **Test organization**

	Accreditation certificate ref

Test Location

Test Item

Sample number: Date and time received:

Condition of sample: on receipt:
at time of test:
abnormalities:
temperature: (if required)

Details of test preparation:

Test and Test results

Air meter reference:

Aggregate correction factor worksheet reference:

Method of compaction:

Internal vibrator	☐	reference:	Vibrating Table	☐	reference:	time:
Compacting rod	☐	reference:	Compacting bar	☐	reference:	strokes:

Time at start of test:

Air content of sample: %

Any deviations from the standard:

Except as detailed above, this test was carried out in accordance with ISO 1920-2.

Technical Responsibility

Responsible person: Name: Position:

Signature:

Test Report identification

Test Report Number: Date issued:

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