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Testing methods for pervious concrete —

Part 2: Density and void content

Méthodes d'essai pour ciments perméables —

Partie 2: Titre manque

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Foreword

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

A list of all parts in the ISO 17785 series can be found on the ISO website.

Testing methods for pervious concrete —

Part 2:
Density and void content

1 Scope

This document specifies a procedure for testing the density and void content of freshly mixed and hardened pervious concrete specimens for pavement in the laboratory or cored from field placements.

This document also specifies formulae for calculating the density and void content of pervious concrete.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
density
ratio of the mass of a given quantity of concrete to its volume, (kg/m^3)

3.2
void content
percentage (%) of voids

3.3
pervious concrete
concrete which has interconnected voids that allow for water flow through them.

Note 1 to entry: Pervious concrete for pavement is usually made with little or no fine aggregate and contains narrowly graded coarse aggregate typically with the maximum size of 10 mm. The nominal maximum size is 25 mm.

4 Principle

4.1 Freshly mixed pervious concrete

For fresh pervious concrete, a sample is placed and consolidated in a standard measure. The density and void content of the pervious concrete are calculated based on the measured mass of the consolidated concrete specimen, the volume of the measure, and the total mass of materials batched.

The measured fresh density may be used as verification of mixture proportion.

4.2 Hardened pervious concrete

This test method for hardened pervious concrete applies to either core specimens or moulded cylinders.

For hardened pervious concrete, the dimensions of a specimen are measured to determine its volume. The specimen is dried to reach a constant mass and subsequently immersed in water to determine the volume of solids in the specimen. Void content is calculated using the difference between the total volume and the displaced volume when submerged.

Density and void content determined by other test methods for hardened pervious concrete can produce different numerical results, which can be incomparable.

5 Apparatus

5.1 General

The apparatus shall consist of:

a) making the specimen in the laboratory as instructed in this document, or receipt of a core specimen from the field;

b) equipment for preparing and measuring the test specimens.

5.2 Apparatus for making the specimens

5.2.1 Scoop of a size large enough so each amount of pervious concrete obtained from the sampling receptacle is representative.

5.2.2 Measure, a cylindrical container shall be made of steel or other suitable material 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 dimensions of the internal diameter and height of the container shall be not less than 150 mm.

5.2.3 Strike-off plate, a flat rectangular metal plate at least 6 mm thick or a glass or acryl plate at least 12 mm thick with length and width that are at least 50 mm greater than the diameter of the measure with which it is to be used. The edges of the plate shall be straight within a tolerance of 2 mm.

5.2.4 Coring machine to obtain cylindrical cores with a minimum diameter of 100 mm and a minimum height of 100 mm.

5.2.5 Mould, cylindrical container made of steel or other suitable material. The mould shall be made of non-absorbent material which does not react with cement paste. In addition, the mould shall not leak water during the preparing process and the specimens shall be easily demoulded.

5.3 Apparatus for measuring the specimens

5.3.1 Balance or scale accurate to 0,5 g or to within 0,3 % of the test load, whichever is greater, at any point within the range of use. The balance for hardened concrete shall be equipped with suitable apparatus for determining the submerged mass of the test specimen.

5.3.2 Jaw caliper with minimum depth of jaw 65 mm, and measuring range 0 mm to 300 mm with an accuracy to 0,25 mm.

5.3.3 Oven of sufficient size capable of maintaining a uniform temperature of 50 °C ± 5 °C.

5.3.4 Water bath with dimensions large enough to allow a specimen to soak and subsequently be placed into the suspended container below the balance. The water bath shall be constructed to maintain a constant water depth.

5.3.5 Thermometer (temperature measuring device) accurate to 0,5 °C.

5.3.6 Mallet with a rubber weighing approximately 0,6 kg ± 0,2 kg.

6 Sampling

The test shall be performed with a minimum of three similar specimens. The specimens shall be made based on the specifications applicable to the project and area of construction.

7 Procedure

7.1 Freshly mixed pervious concrete

7.1.1 Filling

Place the measure on a flat, level surface free from vibration. Moisten the inside of the measure before placing pervious concrete. Wipe any excessive water from the surfaces, using an absorbent cloth. Place the pervious concrete in the measure in two layers of approximately equal depth using the scoop. For consolidation, drop the hammer 20 times per layer at the full 300 mm drop height. For each layer, distribute the position of the tamper so that the entire surface area of the pervious concrete in the measure is consolidated equally. Before consolidating the final layer, fill the measure to overflowing. If, after 10 hammer drops to the final layer, it appears that there is insufficient concrete, add a small quantity of concrete with a trowel or scoop to correct the deficiency. Complete the consolidation of the final layer.

NOTE 1 Hammer for tamping can be a device that conforms to standard test methods for laboratory compaction characteristics of soil. The mass of the hammer can be approximately 4,5 kg.

NOTE 2 Consolidation can be carried out with a method consistent with the actual construction method, as the density and void content are strongly affected by the consolidation method.

7.1.2 Strike off

After consolidation, strike off the top surface of the concrete and finish it flat with the strike-off plate so that the concrete surface is level with the top of the measure. Several sawing-motion strokes with the edge of the plate produce a flat finished surface.

7.1.3 Cleaning and weighing

After strike-off, clean excess concrete from the exterior of the measure and determine the mass of the concrete and measure to an accuracy consistent with the requirements of 5.3.1.

7.2 Hardened pervious concrete

7.2.1 Moulded cylinder preparation

A test specimen for hardened pervious concrete shall consist of a cylindrical specimen with a height twice as large as its diameter. The specimen shall be nominally 100 mm in diameter.

7.2.2 Core preparation

Core specimens shall be full depth, or trimmed. A minimum trimming shall be performed to produce a specimen with regular surface area and shape with ends generally perpendicular to the longitudinal axis. Sampling of cores or trimming shall be performed at the age of not less than 7 d or after the concrete is strong enough so the bond between mortar and the aggregate is not disturbed.

7.2.3 Measuring

Determine the dimensions of the test specimen. Record the average length and diameter to the nearest 0,25 mm.

7.2.4 Constant dry mass

Determine the constant dry mass of the specimen to the nearest 0,5 g. Dry the specimen in a ventilated oven at a temperature of 50 °C ± 5 °C in 24 h ± 1 h and determine the mass. Repeat this procedure in 24-h increments until the mass changes by less than 0,5 %.

7.2.5 Submerging

Submerge the specimen in water at 20 °C ± 2 °C and allow it to sit upright for 30 min ± 5 min. Keeping the specimen under water, tap the side of the specimen 10 times with the rubber mallet, fully submerging the mallet below the water. Rotate the specimen slightly after each tap so that taps are equally spaced around the circumference of the specimen. Still keeping the specimen submerged, invert it and determine the submerged mass, m_s, to the nearest 0,5 g.

NOTE Typical stirrup arrangement to submerge the specimen in water can be presented as in ISO 1920-5.

7.2.6 Measuring temperature

Measure the temperature of the water in the water bath used in the determination of the submerged mass of the specimen.

8 Calculation

8.1 Density

8.1.1 Freshly mixed pervious concrete

Calculate the net mass of the concrete by subtracting the mass of the measure, m_m, from the mass of the measure filled with concrete, m_c. Calculate the density by dividing the net mass of concrete by the volume of the measure, V_m, as per Formula (1).

$$D_f = \frac{m_c - m_m}{V_m} \quad (1)$$

where

D_f is density of fresh pervious concrete (kg/m^3);

m_c is mass of measure filled with concrete (kg);

m_m is mass of measure (kg);

V_m is volume of the measure (m^3).

8.1.2 Hardened pervious concrete

Calculate the density of the cylinder specimen as per Formula (2).

$$D_h = \frac{M_d}{V_d} \tag{2}$$

where

D_h is density of hardened pervious concrete (kg/m^3);

M_d is dry mass of the specimen (kg);

V_d is volume of the specimen (m^3).

8.2 Void content

8.2.1 Freshly mixed pervious concrete

Calculate the percentage of voids as per Formula (3).

$$A_f = \frac{D_t - D_f}{D_t} \times 100\,\% \tag{3}$$

where

A_f is void content of fresh pervious concrete, including entrained and entrapped air voids in the cement paste (%);

D_t is theoretical density of fresh concrete computed on an air free basis (kg/m^3);

D_f is density of fresh pervious concrete (kg/m^3).

The theoretical density is a laboratory determination, and is assumed to remain constant for all batches made using identical component ingredients and proportions. It is calculated using Formula (4).

$$D_t = \frac{m_t}{V_t} \tag{4}$$

where

D_t is theoretical density of fresh concrete computed on an air free basis (kg/m^3);

m_t is total mass of all materials batched (kg);

V_t is sum of the absolute volumes of the component ingredients in the batch (m^3).

8.2.2 Hardened pervious concrete

Calculate the percentage of voids of the cylinder specimen as per Formula (5).

$$A_h = \left\{1 - \frac{(m_d - m_s)/\rho_w}{V_d}\right\} \times 100\,\% \tag{5}$$

where