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Fine and coarse aggregates for concrete — Determination of the particle mass-per-volume and water absorption — Pyknometer method

Granulats fins et gros pour béton — Détermination de la masse volumique réelle et de l'absorption d'eau — Méthode du pycnomètre

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 7033 was prepared by Technical Committee ISO/TC 71, *Concrete, reinforced concrete and pre-stressed concrete.*

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Fine and coarse aggregates for concrete — Determination of the particle mass-per-volume and water absorption — Pyknometer method

1 Scope and field of application

This International Standard specifies a method for the determination of the particle mass-per-volume and the water absorption of fine and coarse aggregates for concrete. The method is based on the use of a pyknometer for the determination of the volume of the aggregate particles.

For aggregates with a nominal particle size larger than 4 mm, the method indicated in this International Standard is an alternative to the hydrostatic balance method described in ISO 6783.

2 References

ISO 4847, *Concrete — Sampling of normal weight aggregates.*[1)]

ISO 6274, *Concrete — Sieve analysis of aggregates.*

ISO 6783, *Coarse aggregates for concrete — Determination of particle density and water absorption — Hydrostatic balance method.*

3 Definitions

3.1 particle mass-per-volume : Quotient of the mass of a sample of aggregate particles to the volume occupied by the particles, including adhering materials and both permeable and impermeable voids. Permeable (or open) voids are defined as voids which are water-filled when the particles are in a saturated and surface-dry condition.

The mass-per-volume is expressed as mass per unit volume of the aggregate, i.e. in kilograms per cubic metre.

3.2 water absorption : Increase in mass of a sample of dry aggregate particles due to the penetration of water into the permeable (open) voids of the aggregate particles.

It is expressed as a percentage of dry mass of the sample.

4 Apparatus and equipment

4.1 Scale or **balance,** of adequate capacity and accurate within ± 0,1 % of the mass of the sample to be weighed.

4.2 Vessel or **flask** of non-water-absorbing material, referred to henceforward as a pyknometer, into which the aggregate test sample can be readily inserted and in which the volume content can be reproduced within ± 0,1 %. The volume of the container filled to the mark shall be at least 50 %, but not more than 200 %, greater than the space required to accommodate the test sample.

4.3 Well-ventilated oven, thermostatically controlled to maintain a temperature of 105 ± 5 °C.

4.4 Metal container of sufficient size to contain the sample and of such shape and dimensions that it will fit in the oven.

4.5 Supply of water, free from any impurity (e.g. dissolved air) that would significantly affect its density.

For fine aggregate testing, the following apparatus is necessary.

4.6 Mould, of non-water-absorbing material in the form of a frustrum of a cone, with nominal dimensions 40 mm at the top, 90 mm at the bottom, and 75 mm high.

4.7 Metal tamper, having a mass of 340 ± 15 g and a flat circular tamping face 23 ± 3 mm in diameter.

4.8 Shallow tray, of non-water-absorbing material having a plane bottom of area not less than 0,1 m^2 and an edge of not less than 50 mm height.

4.9 Means of supplying a current of warm air, such as a hair-drier.

For coarse aggregate testing, the following apparatus is necessary.

1) At present at the stage of draft.

4.10 Container of a size sufficient to contain the sample covered with water.

4.11 Two dry soft absorbent cloths, each not less than 750 mm by 450 mm.

4.12 Test sieves corresponding to the nominal minimum and maximum particle sizes, respectively, that define the aggregate sample to be tested.

5 Sampling

The sampling of the aggregate shall be carried out as described in ISO 4847.

When sampling fine aggregate, i.e. samples of aggregates with a nominal maximum particle size of 4 to 5 mm[1], the mass of the sample shall not be less than 1 kg.

The mass of coarse aggregate samples shall not be less than 2 kg.[2]

6 Procedure

Place the prepared sample in the tray (4.8 for fine aggregates) or in the container (4.10 for coarse aggregates) as appropriate.

Add water (4.5) and ensure that the sample is completely immersed. Soon after immersion, remove bubbles of entrapped air by gentle stirring, for instance with a rod.

Keep the sample immersed in water for about 24 h, the water temperature being maintained at 20 ± 5 °C for at least 20 h of immersion. Then carefully drain the water from the sample by decantation, taking care that no material is lost.

Bring the sample to a saturated surface-dry condition. This is achieved as follows :

a) For fine aggregates : Spread the sample in a uniform layer over the bottom of the tray. Then expose the aggregate to a gentle current of warm air to evaporate surface moisture and stir it at frequent intervals to ensure uniform drying until no free moisture can be seen and the aggregate particles no longer adhere to one another.

Allow the sample to cool to room temperature whilst stirring it. Fill the mould (4.6) loosely with part of the sample and lightly tamp 25 times with the tamper (4.7). Do not refill the space left after tamping. Gently lift the mould clear of the aggregate. If the aggregate cone does not collapse, then continue drying and repeat the cone test just until the collapse situation occurs at mould removal. Take a sample of not less than 0,5 kg of the now-saturated surface-dried aggregate and determine its mass (m_a) by weighing.

b) For coarse aggregates : Remove the aggregate sample from the container (4.10). Place it on a dry cloth (4.11) and gently surface-dry it with the cloth, transferring it to a second dry cloth when the first will remove no further moisture. Then spread it out not more than one stone deep on the second cloth and leave it exposed to the atmosphere away from direct sunlight or any other source of heat until all visible films of water are removed but the aggregate still has a damp appearance. Determine the mass (m_a) of the aggregate sample by weighing.

Place the aggregate sample in the pyknometer (4.2) and fill with water. Note the temperature of the water. Shake or roll the pyknometer gently until all entrapped air has escaped. Refill with water to the calibrated capacity of the pyknometer. Then dry the pyknometer on the outside and determine the total mass (m_b) of pyknometer, sample and water by weighing.

Empty the contents of the pyknometer into the metal container (4.4), taking care to ensure that all the aggregate is transferred. Refill the pyknometer with water to its calibrated capacity. Note the temperature. The difference in the temperature of the water in the pyknometer during the first and second weighing shall not exceed 1 °C. Then dry the pyknometer on the outside and determine the total mass (m_c) of pyknometer and water by weighing.

When it is desired to determine the particle mass-per-volume of the sample on an oven-dried basis, drain the water from the sample in the metal container by decantation and place metal container with sample in the oven at a temperature of 105 ± 5 °C for about 24 h or until constant mass is achieved. Determine the mass (m_d) of the oven-dried sample by weighing.

7 Calculations

7.1 Calculate the particle mass-per-volume, ϱ_{ps}, on a saturated surface-dried sample basis using the expression :

$$\varrho_{ps} = \frac{m_a}{m_a - (m_b - m_c)} \times \varrho_w$$

where

ϱ_w is the mass-per-volume (density), in kilograms per cubic metre, of the water at the test temperature[3];

m_a is the mass of the saturated surface-dried aggregate sample, in grams;

m_b is the total mass of the pyknometer, the sample and the water, in grams;

m_c is the total mass of the pyknometer and the water, in grams.

1) When comparison is to be made to the hydrostatic balance method (see ISO 6783), particles finer than 0,063, 0,075 or 0,080 mm respectively shall be removed by washing on the respective test sieves.

2) If convenient, the sample may be divided into sub-samples, testing being carried out on each sub-sample.

3) The density of pure water is 998,2 kg/m^3 at 20 °C and 997,5 kg/m^3 at 25 °C.

7.2 Calculate the particle mass-per-volume, ϱ_{po}, on an oven-dried sample basis using the expression :

$$\varrho_{po} = \frac{m_d}{m_a - (m_b - m_c)} \times \varrho_w$$

where

m_d is the mass of the oven-dried sample, in grams;

ϱ_w, m_a, m_b and m_c are as defined in 7.1.

7.3 Calculate the water absorption, a, as a percentage of dry mass using the expression :

$$a = \frac{100 \times (m_a - m_d)}{m_d}$$

where

m_a is as defined in 7.1;

m_d is as defined in 7.2.

7.4 If testing is carried out on sub-samples, calculate the average values of ϱ_{ps}, ϱ_{po}, and a.

7.5 Values of particle mass-per-volume shall be calculated to the nearest 10 kg/m^3, and values of absorption to the nearest 0,1 %.

8 Test report

The test report shall contain at least the following minimum information :

a) identification of the sample;

b) type and maximum particle size of aggregate;

c) moisture condition of the sample when received;

d) mass of the sample as tested;

e) size and shape of the pyknometer used in the test;

f) temperature of the water used in the test;

g) clear indication whether the particle mass-per-volume reported is on an oven-dried or on a saturated surface-dried basis;

h) test results.

9 Accuracy

The particle mass-per-volume of fine and coarse aggregates for concrete shall be determined with an accuracy of ± 10 kg/m^3.

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