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Soil quality — Determination of dry bulk density

Qualité du sol — Détermination de la masse volumique apparente sèche

Reference numbe
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Contents

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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.

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.

International Standard ISO 11272 was prepared by Technical Committee ISO/TC 190, *Soil quality*, Subcommittee SC 5, *Physical methods.*

Annexes A and B of this International Standard are for information only.

Introduction

The dry bulk density is used together with the particle density (see ISO 11508) for the calculation of the solids content and porosity of soil for the evaluation of soil structure, and conversion of concentrations of substances in soil from mass/volume to mass/mass and vice versa.

Soil quality — Determination of dry bulk density

1 Scope

This International Standard describes three methods for the determination of dry bulk density of soils calculated from the mass and the volume of a soil sample. The methods involve drying and weighing a soil sample, the volume of which is either known (core method, see 4.1) or has to be determined (excavation method, see 4.2, and clod method, see 4.3).

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 10381-1: –[1]), *Soil quality — Sampling — Part 1: Guidance on the design of sampling programmes.*

3 Definition

For the purposes of this International Standard, the following definition applies.

3.1 dry bulk density
Ratio of the oven-dry mass of the solids to the volume of the soil.

NOTE 1 The bulk volume includes the volume of the solids and of the pore space.

NOTE 2 The preferred SI unit of measurement is kilograms per cubic metre ($kg \cdot m^{-3}$) but grams per cubic centimetre ($g \cdot cm^{-3}$) is also very common. Note that x $g \cdot cm^{-3} = 1000$ x $kg \cdot m^{-3}$.

4 Test procedure

4.1 Core method

4.1.1 Principle

This method is applicable to stoneless and slightly stony soils. Core samples of known volume are taken with a metal sampling tool. The sample is dried in an oven, weighed and the dry bulk density is calculated.

[1]) To be published.

4.1.2 Apparatus

4.1.2.1 Core sample holders, thin-walled metal cylinders with a volume of 100 cm^3 to 400 cm^3, a steel cap for driving into the soil, and a driver.

4.1.2.2 Oven, heated and ventilated, capable of maintaining a temperature of (105 ± 2) °C.

4.1.2.3 Desiccator: sealed chamber in which the air is kept dry with the aid of silica gel or other desiccant.

4.1.2.4 Laboratory balance, capable of weighing to an accuracy of 1/1000 of the measured value.

4.1.3 Sampling and drying

Press or drive a core sample holder (4.1.2.1) of known volume without deflection and compaction into either a vertical or horizontal soil surface far enough to fill the sampler. Carefully remove the sample holder and its contents to preserve the natural structure, and trim the soil extending beyond each end of the sample holder with a straight-edged knife or sharp spatula. The soil sample volume is thus equal to the volume of the sample holder. Take at least six core samples from each soil layer. Place the holders containing the samples in an oven (4.1.2.2) at 105 °C until constant mass is reached (minimum 48 h). Remove the samples from the oven and allow them to cool in the desiccator (4.1.2.3). Weigh the samples on the balance (4.1.2.4) immediately after removal from the desiccator (m_t). Control mass is reached when the differences in successive weighings of the cooled sample, at intervals of 4 h, do not exceed 0,01% of the original mass of the sample.

NOTE 1 Swell/shrink soils (especially clays, muds and peats) change their bulk density with changing water content. Such soils should be sampled first in a moist state (i.e. field capacity); in addition they should be sampled in a wet state (water saturation) and in a dry state (i.e. wilting point). If the dry soil is too hard to be sampled, the bulk density of the peds can be determined according to 4.3, and the total soil volume according to 4.2.3.

NOTE 2 If bulk density (and water content) are the only parameters of interest, it is not necessary to keep the samples in their holders when taking them back to the laboratory: after the sample has been obtained and trimmed, the soil may be extracted from the holder, without loss, in order to be stored for transportation either in a metal box or in a heat-resistant plastic bag.

NOTE 3 It is normally worthwhile to combine a measurement of the water content with a measurement of the bulk density; in that case it is necessary to transport the samples without allowing loss of water by evaporation, and to begin the laboratory operations by weighing the fresh sample.

4.1.4 Calculation

The dry bulk density is calculated using equation (1):

$$^{b}\rho_s = \frac{m_d}{V} \qquad \ldots (1)$$

$$m_d = m_t - m_s$$

where

$^{b}\rho_s$ is the bulk density, dry, in grams per cubic centimetre;

m_d is the mass, in grams, of the core sample dried at 105 °C minus the mass of the core sample holder;

V is the volume, in cubic centimetres, of the sample holder;

m_s is the mass, in grams, of the empty sample holder;

m_t is the mass, in grams, of the sample holder together with the soil sample dried at 105 °C.

4.2 Excavation method

4.2.1 Principle

Bulk density is determined by excavating a quantity of soil, drying and weighing it, and determining the volume of the excavation by filling it with sand. This procedure is applicable to soils containing gravel and/or stones.

4.2.2 Apparatus

4.2.2.1 Earth-digging equipment, such as a spade, with a long sharp-edged straight blade.

4.2.2.2 Sampling equipment: flat-bladed spade, knife (for hard or stony soil), pick, spade chisel, hammer.

4.2.2.3 Equipment for collecting and cleaning, such as plastic sheet, brush, heat-resistant plastic bags or canisters.

4.2.2.4 Plastic film, thin, flexible, but stable.

4.2.2.5 Equipment for spreading sand, including funnel with a gauging rod (the falling height beneath the funnel mouth should be 5 cm), graduated cylinder of 1 dm^3 capacity.

4.2.2.6 Dry, graded sand of known volume, with a particle diameter of between 500 µm and 700 µm.

4.2.2.7 Balance, capable of weighing to an accuracy of 0,1 g.

4.2.2.8 Oven, heated and ventilated, capable of maintaining a temperature of (105 ± 2) °C.

4.2.2.9 Vacuum desiccator with self-indicating desiccant.

4.2.2.10 Sieve, with 2 mm apertures.

4.2.3 Field procedure

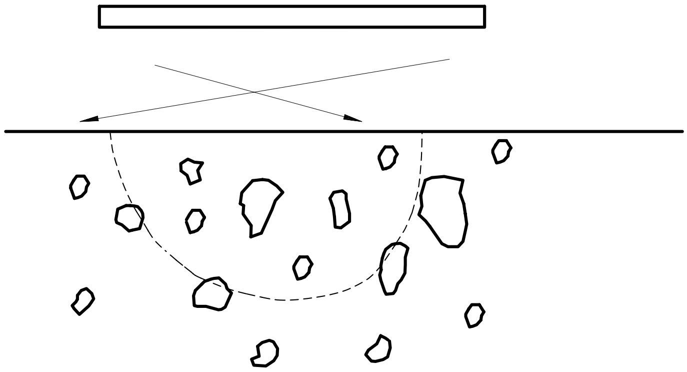
Level off the soil surface with the straight metal blade [figure 1 a)]. Dig a hole in the levelled soil having a representative content of larger gravel and stones (e.g. a hole of volume 20 dm^3 containing 30 % stones), avoiding compaction of the sides [figure 1 b)]. Put the excavated soil in bags for laboratory analysis (large nonporous stones such as granite pieces can be separated in the field, cleaned with a stiff brush and weighed on a field balance).

Line the hole with the plastic film (4.2.2.4). Using the funnel (4.2.2.5), fill the hole to excess with a known volume of sand (4.2.2.6) from a height of 5 cm [figure 1 c)]; then level the surface with the blade without packing down. Replace the excess sand into the graduated measuring cylinder (4.2.2.5), and read the volume [figure 1 d)]; the difference from the initial volume of sand is the volume V of the hole.

4.2.4 Laboratory procedure

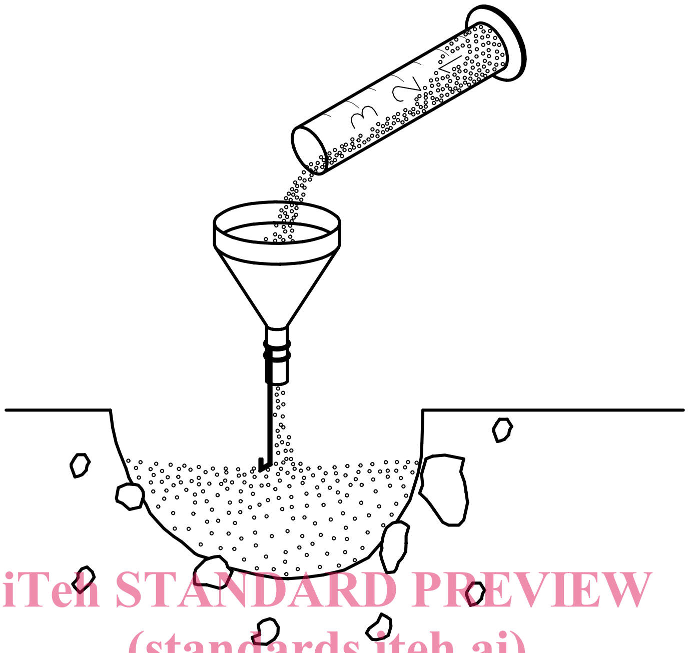
Determine the mass, in grams, of the moist excavated soil with a balance (4.2.2.7) (m_{pw}). Separate the stones and gravel from the fine soil with the sieve (4.2.2.10) (clean any dirty pieces with a cloth or a stiff brush), and weigh them on the laboratory balance (m_{xw}). Dry the stones and gravel in the oven (4.2.2.8) at (105 ± 2) °C and after cooling weigh them, in grams, on the laboratory balance (m_x).

Determine the water content of the fine soil (< 2,0 mm diameter) by drying a representative sample (5 g to 10 g) of known mass in the oven at (105 ± 2) °C until constant mass is reached. Remove the sample from the oven and allow to cool in the desiccator. Weigh the sample on the laboratory balance. Calculate the water content (w) as a mass ratio of the moist sample.

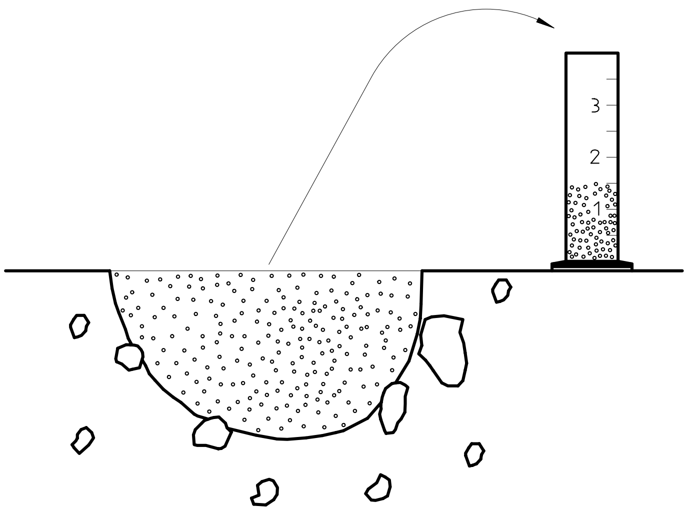


a) Level off soil surface

b) Dig a hole



c) Fill with sand



d) Remove the excess sand and measure its volume

Figure 1 — Excavation method — Field procedure