INTERNATIONAL STANDARD

ISO 17892-2

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Geotechnical investigation and testing — Laboratory testing of soil —

Part 2: Determination of bulk density

Reconnaissance et essais géotechniques — Essais de laboratoire sur les sols —

Partie 2: Détermination de la masse volumique

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword - Supplementary information

ISO 17892-2 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 341, *Geotechnical investigation and testing*, in collaboration with Technical Committee ISO/TC 182, *Geotechnics*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition of ISO 17892-2 cancels and replaces ISO/TS 17892-2:2004, which has been technically revised. It also incorporates the Technical Corrigendum ISO/TS 17892-2:2004/Cor 1:2006.

ISO 17892 consists of the following parts, under the general title "*Geotechnical investigation and testing — Laboratory testing of soil*":

— *Part 1: Determination of water content*

— *Part 2: Determination of bulk density*

— *Part 3: Determination of particle density*

— *Part 4: Determination of particle size distribution*

— *Part 5: Incremental loading oedometer test*

— *Part 6: Fall cone test*

— *Part 7: Unconfined compression test on fine-grained soils*

— *Part 8: Unconsolidated undrained triaxial test*

— *Part 9: Consolidated triaxial compression tests on water-saturated soils*

— *Part 10: Direct shear tests*

— *Part 11: Determination of permeability by constant and falling head*

— *Part 12: Determination of Atterberg limits*

Introduction

This document covers areas in the international field of geotechnical engineering never previously standardised internationally. It is intended that this document presents broad good practice throughout the world and significant differences with national documents is not anticipated. It is based on international practice (see Reference [1]).

Geotechnical investigation and testing — Laboratory testing of soil —

Part 2: Determination of bulk density

1 Scope

This International Standard specifies three methods for the determination of the bulk density of soils, comprising:

a) linear measurement method;

b) immersion in fluid method;

c) fluid displacement method.

This International Standard is applicable to the laboratory determination of the bulk density of soil within the scope of geotechnical investigations.

The linear measurement method is suitable for the determination of the bulk density of a specimen of soil of regular shape, including specimens prepared for other tests. The specimens used are either rectangular prisms or cylinders with circular cross sections.

The immersion in fluid method covers the determination of the bulk density of a specimen of natural or compacted soil by measuring its mass in air and its apparent mass when suspended in fluid. The method may be used when lumps of material of suitable size can be obtained.

The fluid displacement method covers the determination of the bulk density of a specimen of soil by measuring its mass in air and the mass of fluid displaced by immersion. The method may be used when lumps of material of suitable size can be obtained.

If the immersion in fluid method or fluid displacement method is used, and if the fluid is likely to penetrate into the specimen (eg water) the specimen should be coated before testing to prevent fluid penetration.

The bulk density of a soil is useful in the determination of the *in situ* overburden stress as a function of depth.

If required, the dry density of a specimen may be calculated from the bulk density and the water content, if known.

NOTE This International Standard fulfils the requirements of the determination of the bulk density of soils for geotechnical investigation and testing in accordance with EN 1997–1 and EN 1997–2.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 17892-1, *Geotechnical investigation and testing — Laboratory testing of soil — Part 1: Determination of water content*

ISO 14688-1, *Geotechnical investigation and testing — Identification and classification of soil — Part 1: Identification and description*

3 Terms and definitions

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

3.1
bulk density
ρ
mass of soil per unit volume of the material, including any water or gas it contains

3.2
dry density
ρ_d
mass of oven-dried soil per unit volume of the material

4 Equipment

4.1 Linear measurement method

The following items are necessary for the linear measurement method:

4.1.1 Cutting and trimming tools (e.g. a sharp knife, wire saw, spatula, cutting ring, soil lathe).

4.1.2 Steel straight edge, with a maximum deviation from straight of 0,1 % of its length.

4.1.3 Try-square or a jig (e.g. a mitre box) or **split mould**, to ensure that flatness shall be accurate to within 0,5 % of each dimension and that right-angles are within 0,5° of true.

4.1.4 Callipers, either analogue or digital, readable to 0,1 mm or 0,1 % of the measured length, whichever value is the greater.

4.1.5 Balance, accurate to 0,01 g or 0,1 % of the weighed mass, whichever value is the greater.

4.2 Immersion in fluid method

The following items are necessary for the immersion measurement method:

4.2.1 Container of a suitable size.

4.2.2 Balance, accurate to 0,01 g or 0,1 % of the weighed mass, whichever is the greater.

4.2.3 Thermometer or **temperature measuring device**, accurate to 1°C.

4.2.4 Cradle and supporting frame, similar in principle to that shown in Figure 1 which, with the frame attached to the scoop or platform of the balance, can support the cradle below the balance.

4.2.5 Materials: modelling clay or putty and a suitable coating, to prevent fluid penetration (if used, e.g. paraffin wax).

4.2.6 Equipment for melting wax (if used), preferably electrically heated and thermostatically controlled.

4.3 Fluid displacement method

The following items are necessary for the fluid displacement method:

4.3.1 Rigid container with a siphon tube. The container shall be large enough to accommodate the specimen.

4.3.2 Container, to collect the fluid siphoning over from the specimen container.

4.3.3 Balance, accurate to 0,01 g or 0,1 % of the weighed mass, whichever value is the greater.

4.3.4 Thermometer or **temperature measuring device**, accurate to 1°C.

4.3.5 Materials: modelling clay or putty and a suitable coating, to prevent fluid penetration (if used, e.g. paraffin wax).

4.3.6 Equipment for melting wax (if used), preferably electrically heated and thermostatically controlled.

Alternatively, the equipment described in 4.2 can be used. In such case, a correction for the uplift for the cradle shall be included in the calculations.

5 Test procedure

Test specimens should be at least 50 cm^3 in volume, and preferably significantly larger.

NOTE If smaller specimens are tested they may be less representative of the material as a whole and the result may not be as accurate as suggested by the reported value.

5.1 Linear measurement method

5.1.1 General

The principle of the method is to weigh a specimen of known volume. Three procedures are specified for preparing the specimen. Other methods are also accepted if they provide representative specimens of regular shape.

5.1.2 Specimen from block sample

5.1.2.1 At least 10 mm from the outside face of the block sample shall be cut away and an approximately rectangular prism of soil slightly larger than the final dimensions of the specimen shall be formed. If the specimen is to be used for some other test, its shape and dimensions shall also be appropriate for that test.

5.1.2.2 For a rectangular prism specimen the faces shall be made plane and parallel by careful trimming and checking with a straight edge and try-square or other jig. The other four faces of the prism shall be trimmed so that they are mutually perpendicular and at right angles to the end faces.

5.1.2.3 For a cylindrical specimen the specimen shall be placed in a soil lathe and the excess soil removed with vertical cuts in thin layers. The specimen shall be rotated between each cut until a cylindrical specimen is produced. The specimen shall not be trimmed while it is being rotated. After trimming, the specimen shall be removed from the lathe. It shall be cut to the required length and the ends shall be made plane and normal to the specimen axis.

5.1.3 Specimen from sample tube

5.1.3.1 If the specimen is likely to deform on removal from the tube, its volume should be determined by measurement according to 5.1.5.4.

5.1.3.2 For samples that are extruded from a sample tube, measurements can be made directly on the sample. Remove the caps, wax or other sealing material from each end of the sample tube. Extrude the sample and trim surplus soil from the ends of the specimen until flat and perpendicular to the specimen axis. The measurements should then be made as soon as possible on the extruded sample.

5.1.4 Cylindrical specimen of smaller diameter than the sample tube

Either the sample may be extruded from the sample tube through a cylindrical cutter or a cylindrical cutter may be pushed into the sample. The sample tube or specimen cutter shall be pushed steadily at constant speed into the soil. The specimen shall be trimmed further to make the ends flat and perpendicular to the specimen axis, as necessary.

5.1.5 Measurements

5.1.5.1 The trimmed specimen shall be weighed to the nearest 0,01 g or 0,1 % of the total mass, whichever is the greater (m).

5.1.5.2 For a rectangular prism specimen, the lengths of the specimen shall be measured in at least three positions in each dimension to the nearest 0,1 mm or 0,1 % of the dimension being measured, whichever is the greater.

5.1.5.3 For a cylindrical specimen, the diameter shall be measured in two perpendicular directions, at each end and near the middle, to the nearest 0,1 mm or 0,1 % of the dimension being measured, whichever is the greater. The length shall be measured along three lines spaced at about 120° around the circumference, to the nearest 0,1 mm or 0,1 % of the dimension being measured, whichever is the greater.

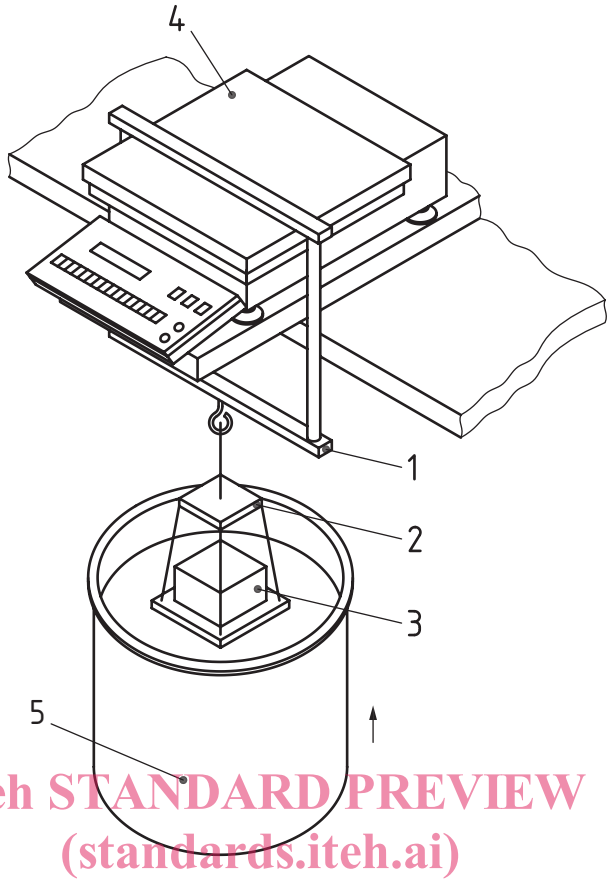
5.1.5.4 If the specimen is likely to deform on removal from the tube its volume should be determined by measuring the inside diameter and the length of the sample tube. If the tube is not full, allowance should be made for any missing sample. Each length shall be measured to the nearest 0,1 mm or 0,1 % of the dimension being measured, whichever is the greater. The mass of the specimen should then be determined by difference, by weighing the tube with the specimen and the clean tube after extrusion of the specimen.

5.1.5.5 If the dry density is required, the water content of a representative portion of the sample shall be determined in accordance with ISO 17892-1.

5.2 Immersion in fluid method

5.2.1 Equipment preparation

5.2.1.1 The balance shall be supported with the platform over the container and with sufficient clear space between the underside of the supports and the top of the container. A suitable arrangement is shown in Figure 1.



Key

1 supporting frame
2 cradle
3 specimen (with coating if used)
4 balance
5 fluid container

Figure 1 — Method of determining density by immersion in fluid

5.2.1.2 The cradle, supporting frame and fluid container shall be adjusted so that the cradle is suspended in the fluid without touching either the bottom or the sides of the container. The container shall be filled with fluid to a depth so that the specimen to be tested shall be completely submerged when on the cradle.

5.2.1.3 Set the balance reading to zero or otherwise record the indicated reading.

5.2.2 Specimen preparation and measurements

5.2.2.1 The soil specimen shall be trimmed if necessary.

5.2.2.2 The specimen shall be weighed to the nearest 0,01 g or 0,1 % of the mass whichever is the greater (m).

5.2.2.3 All the surface voids of the specimen shall be filled with a material which is insoluble in the fluid and the specimen shall be re-weighed to the nearest 0,01 g or 0,1 % of the mass, whichever is the greater (m_f). Care should be taken to fill only natural air voids present in the sample before sampling (generally with wax or putty) and not the cavities resulting from loss of coarse particles during collection