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Geotechnical investigation and testing — Laboratory testing of soil —

Part 3:
Determination of particle density

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

Partie 3: Détermination de la masse volumique des grains

ICS: 13.080.20;93.020

ISO/CEN PARALLEL PROCESSING

This draft has been developed within the European Committee for Standardization (CEN), and processed under the **CEN lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five month enquiry.

Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month approval vote in ISO and formal vote in CEN.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

Reference number
ISO/DIS 17892-3:2014(E)

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Foreword

This document (EN ISO 17892-3:2013) has been prepared by Technical Committee CEN/TC 341 “Geotechnical investigation and testing”, the secretariat of which is held by BSI, in collaboration with Technical Committee ISO/TC 182 “Geotechnics”.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to announce this Technical Specification: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

CEN 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 tests*

— *Part 8: Unconsolidated undrained triaxial tests*

— *Part 9: Consolidated triaxial compression tests*

— *Part 10: Direct shear tests*

— *Part 11: Permeability tests*

— *Part 12: Determination of liquid and plastic 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 [1]).

1 Scope

This International Standard specifies methods for the determination of the particle density in soils.

This International Standard is applicable to the laboratory determination of the particle density of soil within the scope of geotechnical investigations, and describes two methods, a pycnometer method by fluid displacement and a pycnometer method by gas displacement.

The fluid pycnometer method is based on the determination of the difference in the volume of liquid required to fill the pycnometer with and without the sample being present. The density of solid particles is calculated from the dry mass of the soil particles and the volume difference. The described fluid pycnometer method applies to soil types with particle sizes under about 4 mm, or soils crushed to meet this requirement. Larger pycnometers are used for coarser materials.

The gas pycnometer method is based on the determination of the difference in the change in gas pressure, within the apparatus, between tests with the sample present and a reference test without a sample. The pressure difference is converted to a volume difference using Boyle's Law. The density of the particles is calculated from the dry mass of the sample and the volume difference. Particle size is limited by the dimensions of the specimen container of the particular gas pycnometer being used.

NOTE This document fulfils the requirements of the determination of particle 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.

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

EN ISO 14688-1: Geotechnical investigation and testing - identification and classification of soil. Part 1: identification and description.

ISO 386: Liquid in glass thermometers – principles of design, construction and use.

3 Terms and definitions

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

density of solid particles

ρ_s

mass of the particles divided by their volume.

4 Equipment

See Annex A for calibration requirements of the following equipment.

4.1 General

4.1.1 Balance

The balance shall have an accuracy of 0,01 g or 0,1% of the weighed soil mass, whichever is the greater.

4.1.2 Dessicator

The desiccator, if used, shall be of suitable size and contain dry, self indicating desiccant such as silica gel. It is not required if test specimen containers with close-fitting lids are used.

NOTE The purpose of the desiccator is to prevent absorption of moisture from air

4.1.3 Riffle box

A riffle box should be used to obtain a representative part of the specimen. Distribution by hand (quartering) is also acceptable, if this results in a representative part of the specimen.

4.1.4 Drying oven

The drying oven should be of the forced-draft type and shall be capable of maintaining a uniform temperature throughout the drying chamber. Any air circulation shall not be so strong that any transport of particles can take place.

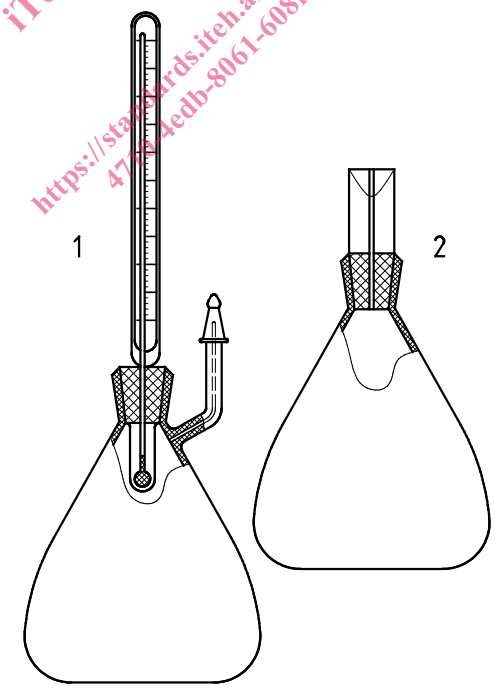
4.1.5 Sample crushing equipment

A mortar and soft-ended pestle (eg a pestle with a rubber or wooden tip) shall be used to break up dried soil specimens. More substantial sample crushing equipment may be required to crush gravel sized rock particles.

4.2 Fluid displacement equipment

4.2.1 Fluid pycnometer

A fluid pycnometer shall have a volume of at least 50 ml, a glass stopper which has been ground to fit precisely, and a capillary rising tube (see Figure 1).



Key

1 Pycnometer with capillary and thermometer

2 Pycnometer with capillary

Figure 1 — Examples of fluid pycnometers

4.2.2 Water bath or temperature controlled enclosure or cabinet

A thermostatically controlled water bath, or a temperature controlled room or cabinet, with temperature variation not exceeding ±0,5°C during the test shall be used.

4.2.3 Temperature measurement

A temperature measuring device accurate to 0,1°C shall be used. The temperature measuring device should preferably be included in the glass stopper of the pycnometer. Alternatively, a temperature measuring device may be placed in the water bath or in the temperature controlled enclosure/ room, as close to the pycnometer as possible.

4.2.4 Apparatus to remove entrapped air

A vacuum pump or water aspirator that is capable of producing a partial vacuum may be used to remove air from the sample during the test.

4.2.5 Control liquid

A control liquid of known or measured density is required to fill the pycnometer bottle. Distilled, demineralised or deionised water is often the most suitable liquid. Alternatively a suitable organic solvent such as hexane or kerosene may be used. Control liquids with a surface tension lower than that of water may be found to be preferable to rapidly saturate fine soils.

NOTE Use of liquids other than water may cause health or safety hazards, or contravene national laws.

4.3 Gas displacement equipment

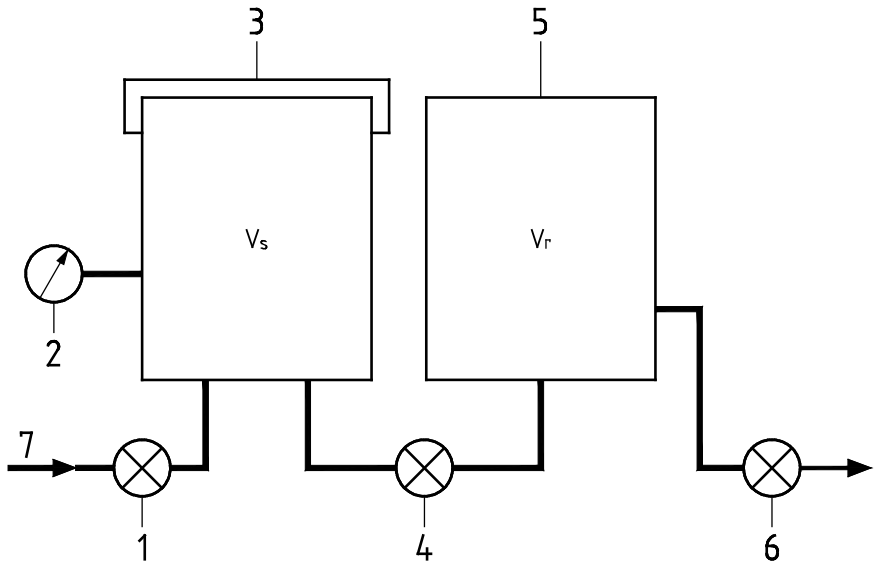
4.3.1 Gas pycnometer

A gas pycnometer system with sample and expansion chambers, isolation valves and a pressure gauge (see Figure 2). Other equipment arrangements are permitted, with pressure measurement being on either chamber. The pressure in the specimen chamber may be either increased or decreased on opening the isolation valve.

The chambers and valves shall be pressure-tight at the instrument's working pressures.

The system shall be fitted with a pressure gauge with an accuracy of 0,1 kPa or 0,1% of the working pressure of the gas pycnometer, whichever value is the greater.

For improved accuracy the sample chamber should have a volume not more than about two times that of the sample, and the volumes of the sample and expansion chambers should not differ by more than a factor of about three.



Key

1. Fill valve
2. Pressure indicator
3. Sample chamber
4. Isolation valve
5. Expansion chamber
6. Vent valve

Figure 2 — Schematic diagram of a typical gas pycnometer

4.3.2 Compressed gas

Helium is preferred as the measurement gas. Other gasses that give good diffusion into soil pores may be used, but this should be stated in the report. Unless otherwise specified as being acceptable by the gas pycnometer equipment manufacturer, research grade (>99,5% purity) helium should be used in conjunction with the instrument.