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Geotechnical investigation and testing — Laboratory testing of soil —

Part 4: Determination of particle size distribution

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

Partie 4: Détermination de la granulométrie

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.

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ISO/DIS 17892-4:2014(E)

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Foreword

This document (prCEN ISO 17892-4:2013) 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/TS 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.*

— *Part 8: Unconsolidated undrained triaxial test.*

— *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. 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 a method of determining the particle size distribution of soils.

This International Standard is applicable to the laboratory determination of the particle size distribution of a soil test specimen by sieving, or sedimentation, or a combination of both within the scope of geotechnical investigations. The particle size distribution is one of the most important physical characteristics of soil. Classification of soils is mainly based on the particle size distribution. Many geotechnical and geohydrological properties of soil are related to the particle size distribution.

The particle size distribution provides a description of soil, based on a subdivision in discrete classes of particle sizes. The size of each class can be determined by sieving and/or sedimentation. Coarse soils are usually tested just by sieving, but fine and mixed soils should be tested by a combination of sieving and sedimentation, depending on the composition of the soil.

Sieving is the process whereby the soil is separated in particle size classes by the use of test sieves. Sedimentation is the process of the settling of soil particles in a liquid, where differences in settling rates enable the particle size classes to be separated. Two sedimentation methods are described; the hydrometer method and the pipette method.

The methods described are applicable to all non-cemented soils with particle sizes less than 125 mm.

Depending on the purpose for the determination of the particle size distribution, pre-treatment or correction for calcium carbonate, dissolved salts and/or organic matter can be required.

Other methods that incorporate detection systems using x-rays, lasers, density measurements and particle counters are not covered by this document.

NOTE This document fulfils the requirements of the particle size analysis 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 14688-1, *Geotechnical investigation and testing - identification and classification of soil. Part 1: identification and description.*

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

EN ISO 17892-3, *Geotechnical investigation and testing — Laboratory testing of soil — Part 3: Determination of particle density.*

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

ISO 565, *Test sieves - Metal wire cloth, perforated metal plate and electroformed sheet - Nominal sizes of openings.*

ISO 3310-1, *Test sieves - Technical requirements and testing - Part 1: Test sieves of metal wire cloth.*

ISO 3310-2, *Test sieves - Technical requirements and testing - Part 2: Test sieves of perforated metal plate.*

3 Terms and definitions

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

3.1
particle size distribution
proportions by mass of the various particle size classes present in a soil

3.2
equivalent particle diameter
particle diameter calculated from sedimentation data using Stoke's law, assuming spherical particles

4 Equipment

4.1 General

See Annex A for calibration, maintenance and checks on the following equipment

4.1.1 Balances

The balance for sieve analysis and hydrometer test shall have an accuracy of 0,01 g or 0,1% of the weighed mass whichever value is the greater. The balance for pipette test shall have an accuracy of 0,001 g or 0,1% of the weighed mass whichever is the greater.

4.1.2 Drying ovens

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.

4.1.3 Timing devices

The watch or clock shall be accurate and readable to 1s.

4.1.4 Temperature measuring devices

Temperature measuring devices, such as thermometers and thermocouples, shall cover the temperature range of that part of the test and be accurate to 0,1°C.

4.1.5 Desiccator

A 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.

4.1.6 Test specimen containers

Test specimen containers shall be made of a material that does not change mass as a result of repeated drying cycles. Glass, porcelain and corrosion-resistant metals have been found to be suitable.

Containers shall have a capacity large enough to hold the mass of sample to be dried without spillage, but should not be so large that the mass of the empty container is significantly in excess of that of the specimen.

4.1.7 Sample separation following pre-treatment

If pre-treatment is required, a centrifuge or vacuum filter and ancillaries, or other apparatus used shall be suitable for separating out the soil particles from the reagent without altering the particle size distribution.

4.2 Sieving

4.2.1 Test sieves

Test sieves complying with ISO 3310-1 and ISO 3310-2, together with appropriate receivers, shall be used.

The number of sieves used and their aperture sizes shall be sufficient to ensure that any discontinuities in the grading curve are detected.

The inclusion of sieves 63 mm, 20 mm, 6.3 mm, 2.0 mm, 0.63 mm, 0.20 mm and 0.063 mm, is recommended as these represent the boundary sizes for coarse materials as defined in EN ISO 14688-1. These facilitate sample description and classification.

4.2.2 Mechanical sieve shaker (optional)

A mechanical sieve shaker, if used, shall hold a nest of sieves with their lid and receiver securely. The design of the shaker shall ensure that the test material on any given sieve progresses over the surface of the sieve when it is agitated.

4.2.3 Ancillary apparatus

The ancillary apparatus shall consist of

- corrosion resistant trays;
- large corrosion resistant or plastic tray or bucket;
- scoop;
- sieve brushes;
- rubber tubing;
- laboratory glassware (eg beakers and flasks)
- riffle box (optional).

4.3 Hydrometer method

4.3.1 Hydrometer

The hydrometer shall be torpedo-shaped, made of glass, as free as possible from visible defects and preferably manufactured to a national standard. The hydrometer stem and bulb shall be circular in cross section and symmetrical around the main axis, without abrupt change in cross section.

The scale and inscription shall be marked clearly and permanently, showing no apparent irregularities in spacing. The range of the hydrometer shall be at least between 0,9950 g/ml and 1,0300 g/ml with graduation lines at intervals of 0,0005 g/ml or less. The markings may be directly in g/ml or may be the difference from 1,0000 g/ml, expressed in mg/ml. The hydrometer shall be indelibly marked with a unique identification number.

4.3.2 Sedimentation cylinders

Sedimentation cylinders marked at 1000 ml shall have constant cross sectional area throughout their length and be transparent to facilitate reading. The diameter shall be at least twice that of the hydrometer bulb and the length must be sufficient to ensure that the hydrometer can float freely in 1000 ml of pure water. Larger

cylinders of the same specification may be used provided the quantities of the contents are scaled up equally to ensure that the concentration of the suspension is maintained.

4.3.3 Water bath (optional)

The temperature in the cylinders shall not vary by more than 3°C during the test. Unless this is achieved within a temperature controlled room, a water bath fitted with a temperature controller shall be used. If using a water bath, the water level in the bath shall be maintained at least as high as the suspension in the sedimentation cylinder, throughout the test.

Note: temperature control is required to minimise the formation of convection currents within the suspension which may affect the results.

4.3.4 Mechanical shaker or mixer

The mechanical shaker or mixer shall be capable of keeping the appropriate quantities of soil and water in continuous suspension.

4.4 Pipette method

4.4.1 Pipette

The pipette shall have a nominal volume of 2% of the volume of the soil suspension. It shall be calibrated to an accuracy of 0,01% of its volume and be mounted in a pipette configuration (Figure 1).

4.4.2 Sedimentation cylinders

Sedimentation cylinders (marked at specified volume) shall be of constant cross sectional area throughout their length and transparent to facilitate reading. Cylinders should have a minimum volume of 500 ml.

4.4.3 Pipette specimen containers

Containers, for example glass bottles with ground-glass stoppers or evaporating dishes, suitable for the drying of aliquots removed from the sedimentation suspension by the pipette. Glass bottles about 25 mm diameter and about 50 mm tall have been found to be suitable for a 10 ml sampling pipette.

4.4.4 Water bath (optional)

The temperature in the cylinders shall not vary by more than 3°C during the test. Unless this is achieved within a temperature controlled room, a water bath fitted with a temperature controller shall be used. If using a water bath, the water level in the bath shall be maintained at least as high as the suspension in the sedimentation cylinder, throughout the test.

Note: temperature control is required to minimise the formation of convection currents within the suspension which may affect the results.

Key

1 Rubber suction bulb
2 Tap
3 Safety bulb suction inlet
4 Safety bulb
5 Three-way tap
6 Outlet tube
7 Sampling pipette
8 Sedimentation cylinder
9 Graduated scale
10 Sliding panel
11 Clamps

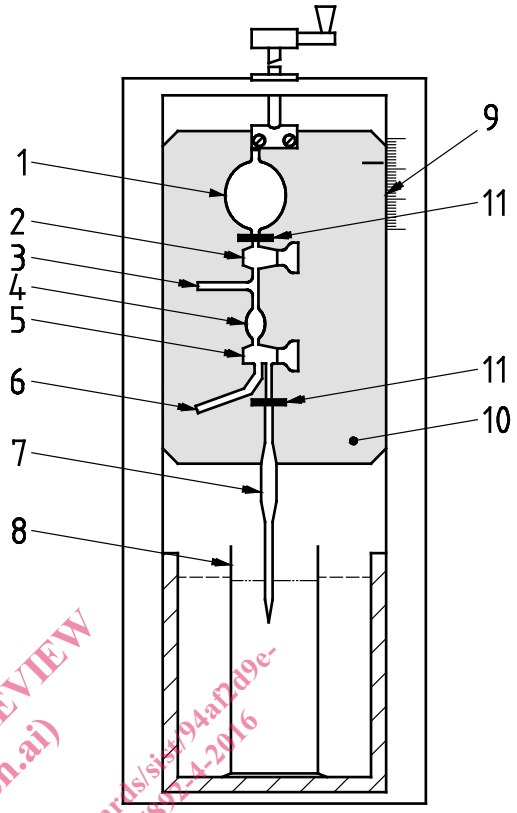

Figure 1 — Example of pipette configuration

4.4.5 Mechanical shaker or mixer

The mechanical shaker or mixer shall be capable of keeping the appropriate quantities of soil and water in continuous suspension.

4.4.6 Centrifuge (optional)

The centrifuge or vacuum filter and ancillaries, or any other apparatus shall be suitable for separating out the soil particles following pre-treatment for the removal of salts, organic and/or calcareous matter.

4.5 Reagents

4.5.1 General

Reagents shall be of analytical reagent quality.

4.5.2 Water

The water shall be distilled, de-ionised or demineralised. Where distilled is referred to in this standard, the terms are interchangeable.

4.5.3 Dispersing agent

Where a dispersing agent is required by the test procedure, options include but are not limited to:

— Sieving: sodium hexametaphosphate or sodium pyrophosphate, approximately 2 g/l dissolved in water;

— Sedimentation: sodium hexametaphosphate, approximately 40 g/l, or sodium pyrophosphate, approximately 20 g/l, dissolved in water.

Dispersing agent solutions shall not be used more than one month after their preparation.

4.5.4 Hydrogen peroxide (optional)

Hydrogen peroxide (20% V/V) may be used to remove organic material. See Annex B.

4.5.5 Hydrochloric acid (optional)

Hydrochloric acid (0,2 M ± 0.02 M) may be used to remove carbonate. See Annex B.

5 Test procedure

5.1 Selection of test method

The test method or combination of methods should be specified prior to testing, or be selected on the following basis:

If a sample has less than about 10% of particles smaller than 0.063 mm sedimentation analysis is not normally required. Similarly, if the sample has less than about 10% of particles larger than 0.063 mm sieve analysis is not normally required. For all other samples a combination of sieve analysis and sedimentation should be performed in order to determine the full particle size distribution.

If only a sieve or only a sedimentation test is performed, the mass of excluded sample must be determined and taken into account in the calculations.

5.2 Sieving

5.2.1 General

5.2.1.1 The general procedure for sieving is outlined schematically in Figure 2. The test may be performed either on a moist or dried specimen. If a moist sample is used, the dry mass is calculated from its wet mass after drying in accordance with EN ISO 17892-1.

5.2.1.2 If a dry specimen is required, it shall be oven-dried at 105°C to 110°C either to constant mass or for a minimum of 16 hours, unless the soil is susceptible to heating. Susceptible soils may be dried at a lower temperature, eg 50°C.

NOTE Soils susceptible to heating include organic soils, gypsum and certain tropical soils.