INTERNATIONAL STANDARD

ISO 17892-1

First edition
2014-12-01

Geotechnical investigation and testing — Laboratory testing of soil —

Part 1: Determination of water content

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

Partie 1: Détermination de la teneur en eau

Reference number
ISO 17892-1:2014(E)

COPYRIGHT PROTECTED DOCUMENT

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

Published in Switzerland

Contents

Page

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.

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received. www.iso.org/patents

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 17892-1 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 17892-1 cancels and replaces ISO/TS 17892-1:2004, which has been technically revised. It also incorporates the Technical Corrigendum ISO/TS 17892-1:2004/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 1: Determination of water content

1 Scope

This International Standard specifies a method of determining the water content of soils.

This International Standard is applicable to the laboratory determination of the water (also known as moisture) content of a soil test specimen by oven-drying within the scope of geotechnical investigations. The water content is required as a guide to the classification of natural soils and as a control criterion in re-compacted soils, and is measured on samples used for most field and laboratory tests. The oven-drying method is the definitive procedure used in usual laboratory practice.

The practical procedure for determining the water content of a soil is to determine the mass loss on drying the test specimen to a constant mass in a drying oven controlled at a given temperature. The mass loss is assumed to be due to free water and is referenced to the remaining dry mass of solid particles.

NOTE This document fulfils the requirements of the determination of water content 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 386, *Liquid-in-glass laboratory thermometers — Principles of design, construction and use*

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
water content
w
ratio of the mass of free water to the mass of dry soil

3.2
fluid content
w_{fl}
ratio of the mass of free water including dissolved solids to the mass of dry soil

4 Equipment

See Annex A for calibration requirements of the following equipment.

4.1 Drying oven, of the forced-draft type and 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.

4.2 Thermometer or **thermocouple device**, accurate to 1°C, to check the temperature within the oven.

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

4.4 Test specimen containers.

4.4.1 Test specimen containers shall be constructed 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. One container is needed for each water content determination.

4.4.2 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. For larger specimens the container shall also allow the large surface area required of 5.2.1 to be met.

For soils with a tendency to absorb significant amounts of water vapour from air, or if the air humidity is more than about 60 %, containers with close-fitting lids should be used for testing test specimens having a mass of less than about 200 g.

NOTE The purpose of close-fitting lids is to prevent loss of moisture from test specimens before initial weighing and to prevent absorption of moisture from the atmosphere before final weighing.

4.5 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.

5 Test procedure

5.1 Test specimen preparation

5.1.1 If samples are stored prior to testing, they shall be kept in non-corrodible airtight containers at a temperature between approximately 3°C and 30°C, in an area protected against direct sunlight, local sources of heat and drafts.

5.1.2 The water content determination should be performed as soon as practicable.

5.1.3 The manner in which the test specimen is selected and its required mass is dependent on the purpose (application) of the test, the type of soil being tested and the type of sample (e.g. test specimen from another test, bag, tube, split barrel etc). Either a representative sample of the soil as a whole, after thorough mixing, shall be taken or separate portions from each type of soil shall be selected. A description of the test specimen shall be recorded. Details of any test specimen selection shall be reported with the test results.

5.1.4 For bulk samples, the test specimen shall be selected from the soil after it has been thoroughly mixed. The recommended minimum masses of moist soil for the determination of water content are listed in Table 1. If samples of lower mass are tested this should be stated in the test report.

Table 1 — Minimum test specimen mass

Grain size diameter D_{max}[a] mm	Recommended minimum mass of moist test specimen[b] g
0,063	30
2,0	100
10,0	500
31,5	3 000
63,0	21 000

a Maximum diameter of soil particles, excluding any discrete coarser particles present.

b Using a test specimen smaller than the minimum mass indicated requires discretion, though it may be adequate for the purpose of the test. A test specimen having a mass less than the indicated value shall be noted in the report of the results. In many cases, when working with a small sample containing a relatively large coarse particle, it is appropriate not to include this particle in the test specimen. If this occurs, it should be noted in the report of the results.

5.1.5 For small samples, a representative portion shall be selected in accordance with the following procedure:

5.1.5.1 For coarse soils, the soil shall be thoroughly mixed and then a test specimen of moist soil having a mass according to Table 1 shall be selected.

5.1.5.2 For fine soils, a representative sample shall be sliced in half (to check if the soil is layered) prior to selecting the test specimen. If the soil is layered see 5.1.3. The minimum mass of moist soil selected should not be less than 30 g, or should be in accordance with Table 1 if coarse particles are noted.

5.2 Test execution

5.2.1 Place the moist test specimen in a clean, dry container of known mass (m_c, including the mass of the lid, if one is to be used) and determine its total mass. This value shall be recorded (m_1). If containers without lids are used weighing shall be done immediately after placing the test specimen into the container. To assist in the oven-drying of large test specimens, they should be placed in containers having a large surface area (such as pans) and the soil broken up into smaller aggregations.

5.2.2 The lid (if used) shall be removed, the container with the moist test specimen shall be placed in a drying oven maintained at 105°C to 110°C and shall be dried either to a constant mass or for the minimum times specified in 5.2.3. Constant mass is regarded as the point at which there is less than 0.1 % further change in mass of the dry soil when dried for a further period of at least 1 h.

For soils containing gypsum or other minerals having a significant amount of chemically-bonded water, or for soil containing a significant amount of organic material, the mass change on drying may not be due just to loss of free water. In these circumstances, drying at a lower temperature, for example 50 °C, should be performed providing that the dry mass is determined using this constant weight method.

5.2.3 The time required to obtain constant mass will vary depending on the type of soil, size of test specimen, oven type and capacity, and other factors. The influence of these factors generally can be established by good judgement and with experience of the soils being tested and the apparatus being used.

In most cases, drying a fine soil at 105°C to 110°C for 16 h is sufficient. Coarse soils may often be dried to constant mass in a period of about 4 h at this temperature, when a forced-draft oven is used.

However if there is any doubt as to whether a soil is dry at this point, the specimen should be dried to constant mass in accordance with 5.2.2.

5.2.4 Since some dry soils may absorb moisture from moist test specimens, dried test specimens should be removed before placing further moist test specimens in the oven. However, this requirement is not applicable if the previously dried test specimens will remain in the drying oven for at least the minimum times specified in 5.2.3.

5.2.5 After the test specimen has dried, the container shall be removed from the oven.

5.2.6 Place the test specimen and container in a dessicator to cool and to keep the specimen dry, for weighing at a later time, or if the container does not have a lid, allow the test specimen and container to cool to room temperature and weigh within 1 h of the sample being removed from the oven.

NOTE Balances are susceptible to small errors when weighing hot items due to convection currents being set up by localized heating of air around the balance.

5.2.7 The mass of the container, lid and dried test specimen shall be determined (m_2).

6 Test results

The water content of the soil shall be calculated according to Formula (1):

$$w = \frac{m_1 - m_2}{m_2 - m_c} \times 100 = \frac{m_w}{m_d} \times 100 \quad (1)$$

where

w is the water content (%);

m_1 is the mass of container (and lid if used) and moist test specimen (g);

m_2 is the mass of container (and lid if used) and dried test specimen (g);

m_c is the mass of container (and lid if used) (g);

m_w is the mass of water (g);

m_d is the mass of dried test specimen (g).

There may be a significant contribution to the dry weight of specimens arising from dissolved solids in the soil pore water, e.g. salt in marine soils. In these circumstances, it may be appropriate to also calculate the fluid content, w_{fl} (see Annex C).

7 Test report

The test report shall affirm that the test was carried out in accordance with this document and shall include the following information:

a) identification of the specimen tested, e.g. by borehole number, sample number and sample depth and any other relevant details required, e.g. depth of specimen within a sample, method of sample selection if relevant;

b) a visual description of the specimen tested including any observed features noted after testing, following the principles in ISO 14688-1;

c) water content of the test specimen, below 100 % to one decimal place and above 100 % to the nearest whole percent;

d) any deviation from this procedure, including the drying temperature if not 105°C to 110°C.

Annex A
(normative)

Calibration, maintenance and checks

A.1 General requirements

All measurement equipment used in this standard shall be calibrated periodically, its performance shall be checked where required at intervals, and it shall be operated in a controlled environment if so specified. This Annex defines these requirements for this method.

If calibration of measurement equipment is carried out by a third party it shall be carried out by an accredited calibration laboratory. The certification shall show traceability to recognised national or international standards of measurement.

Where calibration of test measuring equipment is carried out in-house the laboratory shall hold appropriate reference standards or instruments that are used solely for calibration purposes. These should be calibrated by an accredited calibration laboratory with certification requirements as above. When not in use reference measurement equipment should be retained securely in a suitable environment separate from working standards or instruments. Reference standards and instruments shall be at least as accurate as the working device so that the desired accuracy of test measurement is achieved.

In house calibration procedures shall be documented, shall only be performed by approved persons and records of such calibrations, and of performance checks, shall be retained on file.

Notwithstanding the required calibration or check intervals in this Annex, whenever any item of reference equipment or test measurement equipment has been mishandled, repaired, dismantled, adjusted or overhauled it shall be recalibrated before further use.

All calibrated equipment shall be used only within the range for which it has been calibrated.

A.2 Environmental conditions

There are no specific environmental conditions applicable to the execution of this test method.

A.3 Equipment

A.3.1 Ovens

The set temperature close to the centre of the usable oven space of an empty oven shall be checked by means of a calibrated temperature measuring device at least once a year.

The temperature distribution of an empty oven shall be checked before first use and after any major repair or replacement of heater elements and/or thermostat. If any of the individual temperature points is found to be outside the specified range of the set temperature, remedial action shall be taken.

A.3.2 Thermometers

Reference thermometers complying with ISO 386 shall be calibrated or replaced at intervals not exceeding five years. All other liquid-in-glass thermometers shall be calibrated before first use and shall be re-calibrated or replaced at intervals not exceeding five years.

An ice point or another appropriate single point check of working thermometers shall be carried out six months after first being brought into use, then annually in addition to the five year calibration interval requirement.

If thermocouples are used for verifying oven temperatures, they shall be calibrated against a reference thermocouple, reference platinum resistance thermometer or reference liquid-in-glass thermometer before first use and thereafter at least once a year.

A.3.3 Balances

Balances shall be calibrated over their working range, using certified reference weights, at least once a year in the location in which they are used. Reference weights shall be appropriate to the category of balance being calibrated, and shall have a tolerance (maximum permissible error) better than the resolution of the balance to be calibrated. Reference weights shall be calibrated when first brought into use and thereafter at least every two years.

Balances shall be checked on each day of use to confirm the zero point and to confirm the mass of a test item of known mass. The test item should not corrode or otherwise change mass with time and should have a mass within the range 50 % to 80 % of the working range of the balance. The results of these checks shall be recorded. If the balance can not be zeroed or the mass of the test weight is found to be outside the tolerance specified in 4.3, the balance shall be taken out of service until remedial action is complete.

Annex B
(informative)

Explanations

In some situations, for example in the field control of earthworks, a rapid method of measurement of water content may be required and a number of rapid methods are available, e.g. the sand bath method, the microwave oven-drying method and the gas pressure test method using calcium carbide. It should not be assumed that these methods are appropriate for all soil types and when they are used on a particular soil, some tests should also be carried out using the oven-drying method as a check. This especially applies for soils containing clay or organic material.

Annex C
(informative)

Fluid content

For soils with significant levels of dissolved salts in the pore water, e.g. marine soils, the "fluid content" may be a more appropriate measure, i.e. the mass of pore fluid (water plus salts) per unit dry mass of soil. This can be calculated from the measured water content, w (in %), by one of the following two ways:

a) If the proportion by mass of salt in the fluid is known (salinity ρ, in mg of salt per g of fluid), the fluid content, w_{fl} (in %), by mass is calculated from Formula C.1:

$$w_{fl} = \frac{1\,000w}{1\,000 - \rho\left(1 + w/100\right)} \tag{C.1}$$

b) If the salt content is known in terms of volume (salinity q, in g of salt per litre of fluid), the density of the fluid, ρ_{fl} (in Mg/m^3), also needs to be known. The fluid content (in %) by volume can then be calculated from Formula C.2:

$$w_{fl} = \frac{1\,000w}{1\,000 - (q/\rho_{fl})\cdot\left(1 + w/100\right)} \tag{C.2}$$

NOTE Open ocean seawater contains about 35 mg of salt per g of seawater and has a density of about 1,024 Mg/m^3. However soil pore water can vary considerably from this. The word "salt" is a generic term for all of the chemical species dissolved in the soil pore water which may or may not include sodium chloride.

If the fluid content is reported, it shall be reported in addition to the water content, and shall be reported below 100 % to one decimal place and above 100 % to the nearest whole percent. The salinity value used in the calculation shall also be reported, together with whether this value was measured or assumed.

Bibliography

[1] DIN. ISSMGE (Eds.) (1998), *Recommendations of the ISSMGE for geotechnical laboratory testing*; (in English, German and French); published by Beuth Verlag, Berlin

[2] EN 1997-1, *Eurocode 7 — Geotechnical design — Part 1: General rules*

[3] EN 1997-2, *Eurocode 7 — Geotechnical design — Part 2: Ground investigation and testing*

ICS 13.080.20; 93.020

Price based on 10 pages