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Geotechnical investigation and testing — Laboratory testing of soil —

Part 12: Determination of Atterberg limits

Reconnaissance et essais géotechniques — Essais de sol au laboratoire —

Partie 12: Détermination des limites d'Atterberg

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Foreword

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ISO/TS 17892-12 was prepared by the European Committee for Standardization (CEN) in collaboration with Technical Committee ISO/TC 182, *Geotechnics*, Subcommittee SC 1, *Geotechnical investigation and testing*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this document, read "...this European pre-Standard..." to mean "...this Technical Specification...".

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 density of fine-grained soil*

— *Part 3: Determination of particle density — Pycnometer method*

— *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 soil*

— *Part 8: Unconsolidated undrained triaxial test*

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

— *Part 10: Direct shear tests*

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

— *Part 12: Determination of the Atterberg limits*

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Foreword

This document (CEN ISO/TS 17892-12:2004) has been prepared by Technical Committee CEN/TC 341 “Geotechnical investigation and testing”, the secretariat of which is held by DIN, 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.

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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 document specifies methods of test for the determination of the Atterberg limits of a soil. The Atterberg limits comprise the liquid limit, plastic limit and shrinkage limit. These limits are also called consistency limits. This document covers the determination of the liquid limit and the plastic limit only.

The liquid limit is the water content at which a soil changes from a liquid to a plastic state. This document describes the determination of the liquid limit of a specimen of natural soil, or of a specimen of soil from which material retained on a 0,4 mm or nearest sieve has been removed, using the fall-cone method. This standard has adopted both the 60 g/60° cone and the 80 g/30° cone as it has been shown that both cones give essentially the same value of the liquid limit. Other cone devices may be adopted provided they can be shown to give results equal to those obtained from the tests described herein.

NOTE The Casagrande method is an alternative method for the determination of the liquid limit. Experience has shown that the results are subject to the performance and judgement of the operator. Moreover, the Casagrande type apparatus and test method have undergone many small but significant variations since it was first proposed by Casagrande in 1932. These variations give rise to differences in the values of the liquid limit determined from the test. The fall-cone method is the preferred method of determining the liquid limit of a soil.

The plastic limit of a soil is the lowest water content at which the soil is plastic. The determination of the plastic limit is normally made in conjunction with the determination of the liquid limit. It is recognised that the results of the test are subject to the judgement of the operator, and that some variability in results will occur.

The Atterberg limits are influenced by oxidation or other changes in the specimen, resulting from storing it too long or otherwise by treating it in an unsuitable way. This applies especially to quick clays, sulphide clays and organic soils.

2 Normative references

The following referenced document is indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

CEN ISO/TS 17892-1, *Geotechnical investigation and testing — Laboratory testing of soil — Part 1: Determination of water content (ISO/TS 17892-1:2004)*.

3 Terms and definitions

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

3.1
liquid limit
w_L
empirically established water content at which a soil passes from a liquid state to a plastic state

3.2
plastic limit
w_P
empirically established water content at which a soil becomes too dry to be plastic

3.3
plasticity index
I_P
numerical difference between the liquid limit and the plastic limit of a soil

NOTE A soil which has a plasticity index of zero or one for which the plastic limit cannot be determined is called non-plastic. The term consistency in this context refers to the relative ease with which a soil can be deformed. A characteristic of a cohesive soil is that, with decreasing water content, its consistency changes from that of a liquid (ability to flow under its own mass) to a

plastic material that is mouldable and keeps its general form after deformation, to a solid (non-plastic with a brittle rupture occurring at small deformations). There is also an intermediate state between a solid and a plastic consistency where the soil behaves as a semi-solid. The Atterberg limits are empirically established water content limits which represent these changes in behaviour.

3.4
liquidity index
I_L
ratio of the difference between water content and the plastic limit of a soil, to the plasticity index

NOTE The liquidity index is a measure of the consistency of the soil in the remoulded state at the natural water content, and is also used as an indication of the sensitivity of a soil.

3.5
consistency index
I_C
ratio of the difference between the liquid limit and the water content, to the plasticity index

NOTE The consistency index is, like the liquidity index, a measure of the consistency of the soil in the remoulded state. The consistency index and the liquidity index are related by the following relationship:

$$I_C = 1 - I_L$$

3.6
activity index
I_a
ratio of the plasticity index to the clay size fraction of the soil

NOTE The activity index can be an indication of the colloidal properties of a clay, and is principally dependent on the amount and the type of clay minerals and organic colloids present as well as on the electrolyte content of the pore water.

3.7
clay size fraction
CF
dry mass of particles having an equivalent diameter of less than 0,002 mm divided by the total dry mass of the specimen (or of the dry mass after removal of the coarse fraction)

3.8
coarse fraction
particles that are retained on the 0,4 mm

4 Apparatus

4.1 General

The following items are necessary to determine Atterberg limits:

a) spatulas;

b) spray bottle (preferably of plastic) with distilled water;

The addition of distilled water dilutes the pore fluid, which may affect the measured liquid limit. Consideration should be given to using water taken in-situ should the effect on the liquid limit be significant.

c) evaporating dish;

d) a corrosion resistant airtight container;

e) balance (accuracy 0,03 g, readable to 0,01 g);

f) apparatus for determination of water content according to CEN ISO/TS 17892-1;

g) stopclock or stopwatch, readable to 1 s;

h) mortar with rubber-covered pestle (when required, for the preparation of mixed grained soil);

i) sieves; for preparation of mixed-grained soils, sieves with apertures of 2 mm and 0,4 mm or nearest shall be used;

j) a flat mixing plate (alternatively, a mixing tray may be used).

4.2 Liquid limit equipment

4.2.1 General

4.2.1.1 The cone apparatus shall permit the cone to be held firmly initially and to be released instantaneously to fall freely in a vertical direction into the soil (see Figure 1).