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Geotechnical investigation and testing — Laboratory testing of soil —

Part 12: Determination of liquid and plastic limits

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

Partie 12: Détermination des limites de liquidité et de plasticité

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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 (see 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 (see www.iso.org/patents).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

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

This first edition of ISO 17892-12 cancels and replaces ISO/TS 17892-12:2004, which has been technically revised. It also incorporates ISO/TS 17892-12:2004/Cor.1:2006.

A list of all the parts in the ISO 17892 series can be found on the ISO website.

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 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 12: Determination of liquid and plastic limits

1 Scope

This document specifies methods for the determination of the liquid and plastic limits of a soil. These comprise two of the Atterberg limits for soils.

The liquid limit is the water content at which a soil changes from the liquid to the 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 larger than about 0,4 mm has been removed. This document describes two methods: the fall cone method and the Casagrande method.

NOTE The fall cone method in this document should not be confused with that of ISO 17892-6.

The plastic limit of a soil is the water content at which a soil ceases to be plastic when dried further.

The determination of the plastic limit is normally made in conjunction with the determination of the liquid limit. It is recognized that the results of the test are subject to the judgement of the operator, and that some variability in results will occur.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

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

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

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply. ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
liquid limit
w_L
water content at which a soil passes from the liquid to the plastic state, as determined by the liquid limit test

3.2
plastic limit
w_P
water content at which a specimen ceases to be plastic when dried further, as determined by the plastic limit test

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

3.4
non plastic soil
soil which has a plasticity index of zero or one for which the plastic limit cannot be determined

4 Apparatus

4.1 General

See also Annex A for more manufacturing tolerances (where appropriate), calibration, maintenance and checks on the equipment.

4.1.1 **Balance**.

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

4.1.2 **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. Containers used for plastic limit determinations shall have close fitting lids.

4.1.3 **Water**.

Water should be distilled, de-ionized or demineralized. Where distilled is referred to in this document, the terms are interchangeable.

4.1.4 **Ancillary apparatus.**

4.1.4.1 **Spatulas**.

4.1.4.2 **Spray bottle (preferably of plastic)**.

4.1.4.3 **Evaporating dishes**.

4.1.4.4 **Sieves complying with ISO 3310-1**.

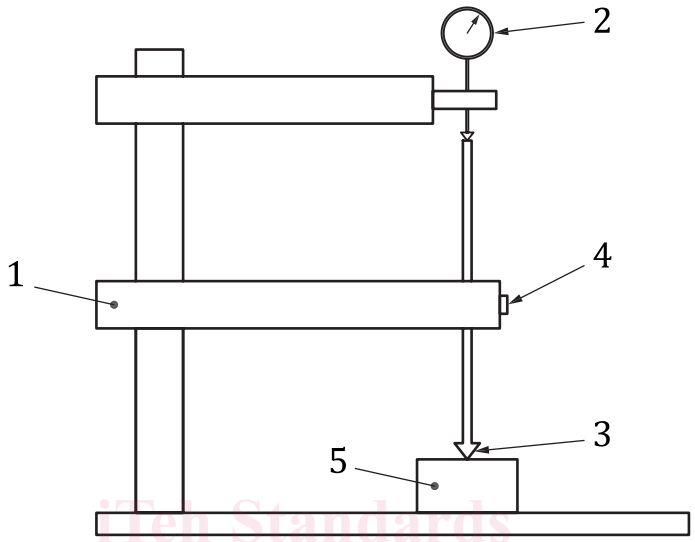
4.1.4.5 **Flat mixing plate, for example glass**.

4.1.4.6 **Metal straightedge about 100 mm long**.

4.2 Fall cone method

4.2.1 Fall cone apparatus.

4.2.1.1 The fall cone apparatus is shown schematically in Figure 1. It shall permit the cone to be held firmly initially and to be released instantaneously to fall freely in a vertical direction into the soil specimen.



Key

1 vertical adjustment mechanism
2 penetration measurement device
3 fall cone
4 lock/release button
5 specimen cup

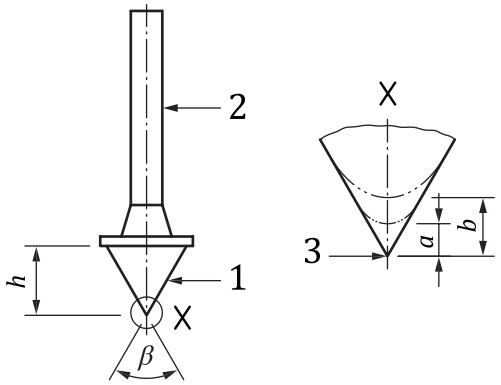
Figure 1 — Schematic of a fall cone apparatus

4.2.1.2 The fall cone apparatus shall have a vertical adjustment mechanism which allows the cone to be raised or lowered and adjusted so that the tip of the cone just touches the surface of the specimen before the cone is released.

4.2.1.3 The fall cone apparatus shall be equipped with a method of measuring the penetration of the cone into the specimen after release to a resolution of 0,1 mm (or better), within the range 5 mm to 20 mm if the 60 g/60° cone is used, or within the range 10 mm to 30 mm if the 80 g/30° cone is used.

4.2.2 Cones.

4.2.2.1 A typical cone is shown schematically in Figure 2.



Key

1 cone
2 shaft
3 cone tip
a deviation from the geometrical tip at manufacturing
b maximum tip wear
h height of the conical tip
β tip angle

Figure 2 — Example of liquid limit fall cone penetrometer (60° cone)

4.2.2.2 Either a 60 g/60° cone or a 80 g/30° cone complying with the requirements of Table 1 may be used as it has been shown that both cones give essentially the same value for the liquid limit. Other cone devices may be adopted provided they can be shown to give comparable results to those obtained from the tests described herein.

Table 1 — Set of fall cones — Typical manufacturing specifications for masses and dimensions

Mass of cone plus shaft	g	60 ± 0,06	80 ± 0,08
Tip angle *β*	°	60 ± 0,2	30 ± 0,2
Height of the cone tip *h*	mm	≥20	≥30
The deviation a from the geometrical tip at manufacturing	mm	<0,1	<0,1

4.2.2.3 The cone shall be manufactured of or coated with a corrosion resistant material such as stainless steel or chromium, and should have smooth polished surfaces with an average roughness Ra of less than 0,8 µm as a manufacturing specification. The cone surface has to remain smooth with use, and should be replaced if the smooth surface is noticeably damaged.

4.2.2.4 The maximum wear *b* shall be less than 0,3 mm (see Figure 2).

4.2.3 Sample cup.

The sample cup shall be made of non-corrodible and rigid material, spherical or cylindrical in shape. If cylindrical, it shall have a base parallel to the rim with a diameter of at least 50 mm and a depth of at least 25 mm if the 60 g/60° cone is used and a depth of at least 40 mm if the 80 g/30° cone is used.

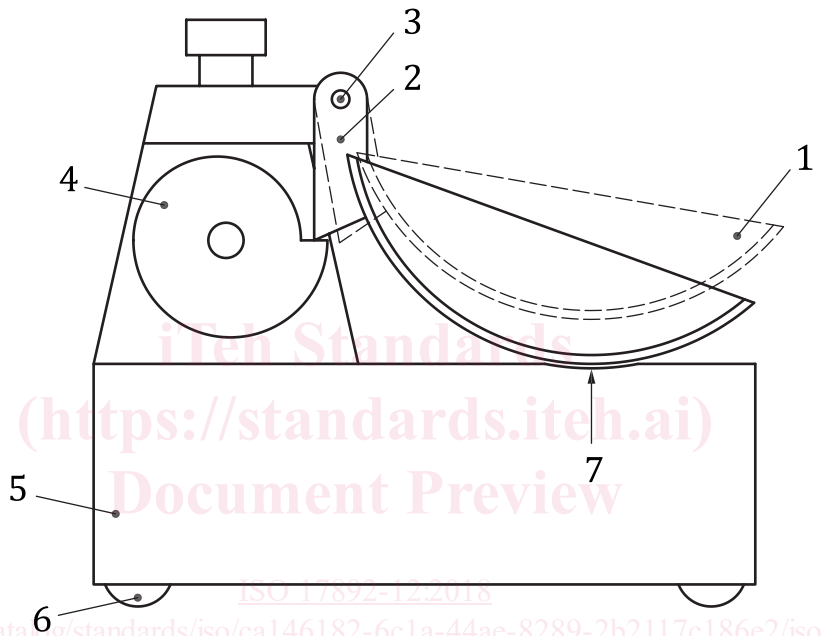
4.2.4 Timing device.

A clock or stop-watch, or similar, capable of being read to the nearest 1 s.

4.3 Casagrande method

4.3.1 Casagrande apparatus.

The Casagrande apparatus is shown schematically in Figure 3. The apparatus consists of a specimen cup which is raised by a cam and then dropped a specified distance onto a base. The device may be operated by either a hand crank or electric motor. Dimensions, manufacturing specifications and tolerances are included in Annex A. A Casagrande apparatus and grooving tool in accordance with other specifications may be adopted provided it can be shown to give comparable results.



Key

1 specimen cup (= bowl)
2 hanger
3 carriage with pin
4 cam (turned by handle or motor)
5 base
6 rubber feet
7 point of contact

Figure 3 — Schematic of the Casagrande apparatus

4.3.2 Base and rubber feet.

The base and feet shall be made of rubber complying with the requirements of Table 2. The feet supporting the base, are designed to provide isolation of the base from the work surface.

Table 2 — Base and feet — Rubber requirements

Hardness of the feet	Hardness of the base	Resilience of the base
Shore A value between 62 and 65	Shore D value of at least 80	Resilience (rebound value) between S = 0,80 and S = 0,90