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Geotechnical investigation and testing — Field testing —

Part 11:
Flat dilatometer test

Reconnaissance et essais géotechniques — Essais en place —
Partie 11: Essai au dilatomètre plat

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Foreword

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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).

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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.

ISO 22476-11 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 341, *Geotechnical investigating and testing*, in collaboration with ISO Technical Committee TC 182, *Geotechniques*, in accordance with the agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition of ISO 22476-11 cancels and replaces ISO/TS 22476-11:2005, which has been technically revised.

A list of all parts in the ISO 22476 series can be found on the ISO website.

Geotechnical investigation and testing — Field testing —

Part 11: Flat dilatometer test

1 Scope

This document establishes guidelines for the equipment requirements, execution of and reporting on flat dilatometer tests.

NOTE This document fulfils the requirements for flat dilatometer tests as part of the geotechnical investigation and testing according to EN 1997-1 and EN 1997-2.

The basic flat dilatometer test consists of inserting vertically into the soil a blade-shaped steel probe with a thin expandable circular steel membrane mounted flush on one face and determining two pressures at selected depth intervals: the contact pressure exerted by the soil against the membrane when the membrane is flush with the blade and, subsequently, the pressure exerted when the central displacement of the membrane reaches 1,10 mm.

Results of flat dilatometer tests are used mostly to obtain information on soil stratigraphy, *in situ* state of stress, deformation properties and shear strength. It is also used to detect slip surfaces in clays. The flat dilatometer test is most applicable to clays, silts and sands, where particles are small compared to the size of the membrane.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and symbols

3.1 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 http://www.electropedia.org/

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

3.1.1
dilatometer blade
dilatometer probe
blade-shaped steel probe that is inserted into the soil to perform a flat dilatometer test

3.1.2
membrane
thin circular steel diaphragm that is mounted flush on one face of the blade and is expanded by applying a gas pressure at its back

3.1.3
switch mechanism
apparatus housed inside the blade, behind the membrane, capable of switching on and off an electric contact when the membrane expands and reaches two preset deflections equal, respectively, to 0,05 mm (*A-pressure* (3.1.10) reading) and 1,10 mm (*B-pressure* (3.1.11) reading)

3.1.4
signal
activation (signal on) or disconnection (signal off) by the switch mechanism between the blade and the membrane to detect two preset positions of the membrane equal to 0,05 mm and 1,10 mm

3.1.5
pneumatic-electric cable
cable that connects the control unit to the blade, delivers gas pressure at the back of the membrane and provides electric continuity between the control unit and the switch mechanism

3.1.6
control and calibration unit
set of suitable devices capable of supplying gas pressure to the back of the membrane and measuring the pressure when the switch mechanism activates and disconnects the electric contact behind the membrane

3.1.7
earth wire
wire connecting the control unit to the earth

3.1.8
pressure source
pressurized gas tank filled with any dry non-flammable and non-corrosive gas incorporating a pressure regulator

3.1.9
dilatometer sounding
sequence of dilatometer tests executed from the same station at ground level in a vertical direction at closely spaced intervals with depth increments ranging from 100 mm to 300 mm

3.1.10
A-pressure
A
pressure that is applied to the back of the membrane to expand its centre 0,05 mm against the soil

3.1.11
B-pressure
B
pressure that is applied to the back of the membrane to expand its centre 1,10 mm against the soil

3.1.12
C-pressure
C
pressure that is applied to the back of the membrane when the centre of the membrane returns to the A-pressure position during a controlled, gradual deflection following the B-pressure

3.1.13
A-membrane-calibration-pressure
ΔA
suction recorded as a positive value that is applied to the back of the membrane to retract its centre to the 0,05 mm deflection in air

3.1.14
B-membrane-calibration-pressure
ΔB
pressure that is applied to the back of the membrane to expand its centre to the 1,10 mm deflection in air

3.1.15
zero gauge value
Z_M
pressure gauge deviation from zero when venting the blade to atmospheric pressure

3.1.16
<*A*> soil pressure
p_0
corrected *A-pressure* (3.1.10)

Note 1 to entry: The term “contact pressure” is also used.

3.1.17
<*B*> soil pressure
p_1
corrected *B-pressure* (3.1.11)

3.1.18
<*C*> soil pressure
p_2
corrected *C-pressure* (3.1.12)

3.1.19
***in situ* pore water pressure**
u_0
water pressure prior to blade insertion at the depth of the centre of the membrane

3.1.20
***in situ* effective vertical stress**
σ'_{vo}
vertical stress prior to blade insertion at the depth of the centre of the membrane

3.1.21
dilatometer material index
I_D
index used to classify soils according to their response to the test

3.1.22
dilatometer
horizontal stress
index
K_D
index related to the *in situ* horizontal stress

3.1.23
dilatometer modulus
E_D
parameter related to the stiffness of the soil

3.1.24
pore pressure index
U_D
index related to the permeability of the soil

3.1.25
contraflexure time
t_{flex}
time corresponding to the inflection point of a dissipation curve

3.2 Symbols

Symbol	Name	Unit
E_D	dilatometer modulus	kPa
I_D	dilatometer material index	—
K_D	dilatometer horizontal stress index	—
U_D	pore pressure index	
A	A-pressure	kPa
B	B-pressure	kPa
C	C-pressure	kPa
p_0	corrected A-pressure	kPa
p_1	corrected B-pressure	kPa
p_2	corrected C-pressure	kPa
t_{flex}	contraflexure time	s
u_0	*in situ* pore pressure	kPa
Z_M	zero gauge value	kPa
ΔA	A-membrane-calibration-pressure	kPa
ΔB	B-membrane-calibration-pressure	kPa
σ'_{vo}	*in situ* effective vertical stress	kPa

4 Equipment

4.1 Dilatometer equipment

The equipment shall comprise the following items:

a) dilatometer blade with suitable threaded adaptor to connect to push rods;

b) membrane;

c) control and calibration unit;

d) pressure source;

e) pneumatic-electrical cable;

f) earth wire;

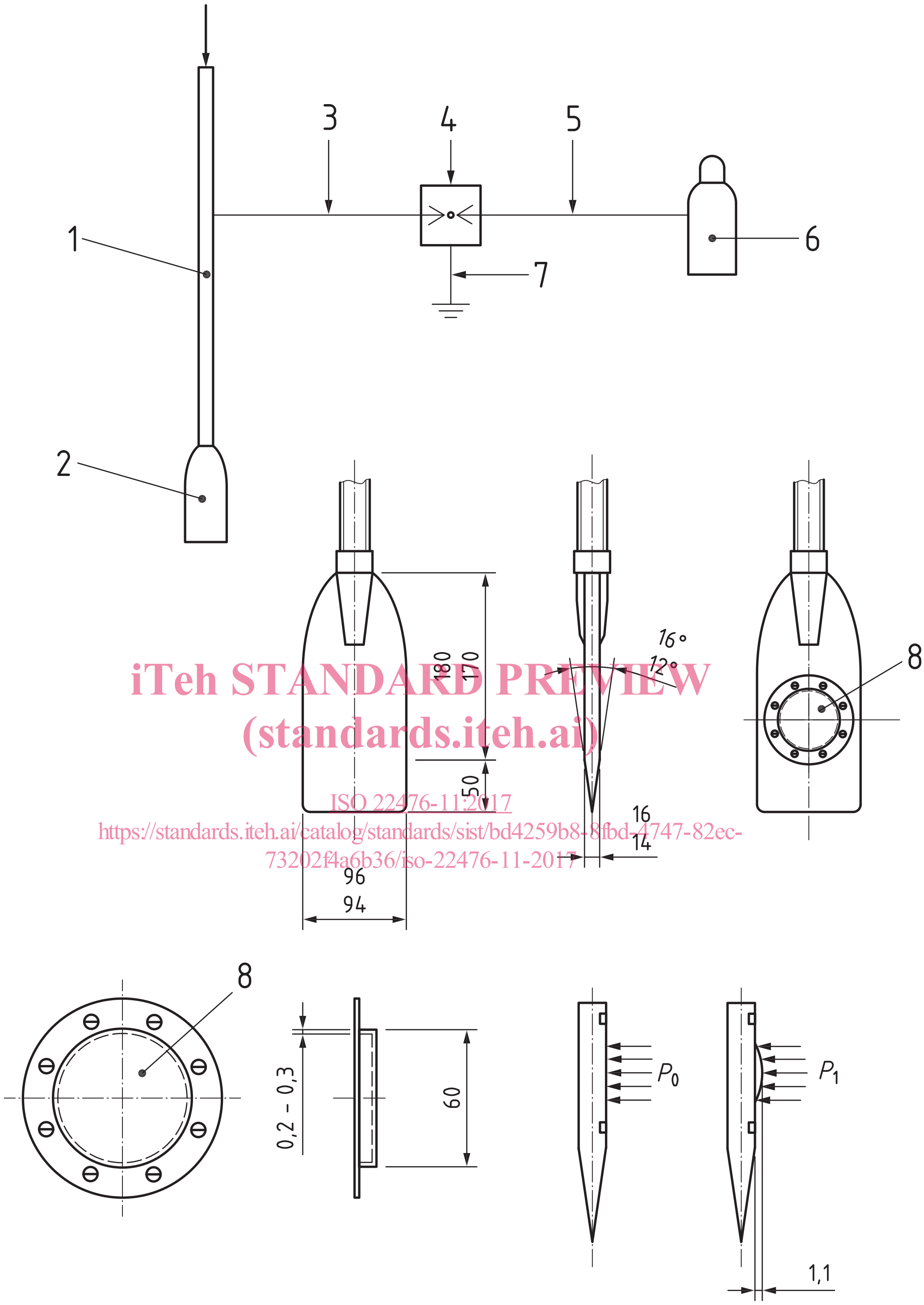
g) calibration syringe;

h) (optional) automated data acquisition system;

i) (optional) load cell.

The dimensions of the blade, the membrane and the apex angle of the penetrating edge shall be within the limits shown in Figure 1.

Dimensions in millimetres



Key

1 push rods
2 blade
3 pneumatic electric cable
4 control and calibration cable unit
5 pressure tube
6 pressure source
7 earth wire
8 membrane

Figure 1 — Dilatometer equipment and soil pressure definition

The control and calibration unit shall have the following features:

— a socket for earthing;

— ability to control the rate of gas flow while monitoring and measuring the gas pressure transmitted from the control unit to the membrane;

— ability to perform controlled venting of the pneumatic circuit;

— ability to signal the instants when the electric switch changes from on to off and vice versa;

— pressure measurement devices able to determine the pressure applied to the membrane with intervals of 10 kPa and a reproducibility of 2,5 kPa at least for pressures lower than 500 kPa;

— pressure gauges having an accuracy of at least 0,50 %.

The pressure source shall be provided with a suitable regulator, valves and pressure tubing to connect to the control unit. The pressure regulator should not exceed the maximum allowable pressure of the gage.

The pneumatic-electrical cable shall have metal connectors with wire insulators to prevent short circuit and washers to prevent gas leakage.

The calibration syringe is used for calibration of membrane rigidity, at the beginning and at the end of the test.

If the equipment incorporates a system for automatic data acquisition, such system will

— register the gas pressure and the status of the electroacustical signal,

— have transducers with linearity and hysteresis error of no more than ±0,50 %,

— have an analog-to-digital conversion of at least 14 bit, and

— have an acquisition frequency of no less than 50 Hz.

4.2 Insertion apparatus

The equipment for inserting the dilatometer blade shall comprise

— a thrust machine to insert and advance the dilatometer blade into the soil;

— push rods with suitable adaptor to connect to the blade;

— hollow slotted adaptors for lateral exit of the pneumatic-electrical cable.

The thrust machine shall be capable of advancing the blade vertically with no significant horizontal or torsional forces. Drill rigs and CPT/CPTU rigs are frequently employed for the purpose. To increase the capacity of penetration, suitable dead loads and/or anchors may be used.

Push rods are required to transfer the thrust from the surface insertion equipment and shall be straight and resistant against buckling. Rods are also required to carry the pneumatic-electrical cable from the surface control unit to the dilatometer blade. It is recommended to use rods of 1 m length. Above the ground level, the rods should be guided to avoid buckling.

Frequently, push rods are the same as those used to push CPT/CPTu (see ISO 22476-1:2012) but other solutions are also possible.

To release the system of friction against the rods during the penetration phase, friction reducers may be used. Friction reducers are local increases in rod diameter. They are usually located in the first rod attached to the blade and shall be at least 200 mm above the membrane centre.

Penetration rates in the range of 10 mm/s to 30 mm/s should be applied, wherever it is possible. Driving may be used when advancing the blade through stiff or strongly cemented layers which cannot be penetrated by static push.

A suitable load cell may be placed between the blade and the push rods. Such cell would measure the thrust applied during the blade penetration. This measurement is not necessary for common interpretations of the test result but it may facilitate interpretation when using both DMT and CPT soundings on a site.

5 Test procedure

5.1 Maintenance and checks

All the control, connecting and measuring devices shall be periodically checked, at least once per year. In addition, measuring devices shall be periodically calibrated against a suitable reference instrument to ensure that they provide reliable and accurate measurements.

The parts of the instrument inside the membrane shall be kept perfectly clean to ensure proper electrical contacts. In particular, these components shall be completely free from dirt, grains, tissue or rust.

The dilatometer blade and membrane shall be checked before penetrating in the soil. The blade shall be mounted axially with the rods. It shall be planar and coaxial and have a sharp penetration edge. The membrane shall be clean of soil particles, free of any deep scratches, wrinkles or dimples and expand smoothly in air upon pressurization.

The maximum out of plane deviation of the blade, defined as the maximum clearance under a 150 mm long straight edge placed along the blade parallel to its axis, shall not exceed 0,5 mm; the maximum coaxiality error of the blade, defined as the deviation of the penetration edge from the axis of the rods to which the blade is attached, shall not exceed 1,5 mm.

The blade, the control unit and the pneumatic-electrical cable shall be checked for leaks before starting a sequence of dilatometer soundings by plugging the blade end of the pneumatic-electrical cable and checking for any pressure drop in the system. Leakage in excess of 100 kPa/min under 400 kPa pressure shall be considered unacceptable and shall be repaired before testing begins.

Continuity of the electrical circuit shall be checked, verifying that the off-on switch signal is sharply detected.

With the dilatometer equipment assembled and ready for testing, the switch mechanisms should be checked by hand pushing the membrane flush with the blade verifying that the audio and/or visual signals on the control unit are activated.

Before the test is carried out, the linearity of the push rods should be checked by one of the following methods:

— Holding the rod vertically and rotating it. If the rod appears to wobble, the straightness is not acceptable.

— Rolling the rods on a plane surface. If the rod appears to wobble, the straightness is not acceptable.

— Sliding a straight hollow tube which is slightly longer than the rod over the rod. If the rod can pass through the tube without jamming, the straightness is acceptable.

If any indications of bending appear, the use of the rods should be suspended.

Other methods of checking rod straightness may be used if they consistently result in similar results to those suggested above.