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Geotechnical investigation and testing — Field testing —

Part 5: Flexible dilatometer test

Reconnaissance et essais géotechniques — Essais en place —

Partie 5: Essai au dilatomètre flexible

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 22476-5 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*, Subcommittee SC 1, *Geotechnical investigation and testing*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

ISO 22476 consists of the following parts, under the general title *Geotechnical investigation and testing — Field testing*:

- *Part 1: Electrical cone and piezocone penetration tests*
- *Part 2: Dynamic probing*
- *Part 3: Standard penetration test*
- *Part 4:Ménard pressuremeter test*
- *Part 5: Flexible dilatometer test*
- *Part 7: Borehole jack test*
- *Part 9: Field vane test*
- *Part 10: Weight sounding test* [Technical Specification]
- *Part 11: Flat dilatometer test* [Technical Specification]
- *Part 12: Mechanical cone penetration test (CPTM)*

Introduction

The results of dilatometer tests are used for deformation calculations provided that the range of stresses applied in the test are representative of the stresses to be applied by the proposed structure. Local experience normally improves the application of the results. In addition, for identification and classification of the ground, the results of sampling (according to ISO 22475-1) from each borehole are available for the evaluation of the tests. Identification and classification results (ISO 14688-1 and ISO 14689-1) are available from every separate ground layer within the desired investigation depth (see EN 1997-2:2007, 2.4.1.4(2)P, 4.1(1)P and 4.2.3(2)P).

Geotechnical investigation and testing — Field testing —

Part 5: Flexible dilatometer test

1 Scope

This part of ISO 22476 specifies the equipment requirements, execution of and reporting on flexible dilatometer tests.

NOTE This part of ISO 22476 fulfils the requirements for flexible dilatometer tests as part of geotechnical investigation and testing according to EN 1997-1 [1] and EN 1997-2 [2].

This part of ISO 22476 is applicable to tests in ground stiff enough not to be adversely affected by the drilling operation.

This part of ISO 22476 is applicable to four procedures for conducting a test with the flexible dilatometer.

This part of ISO 22476 applies to tests performed up to 1 800 m depth. Testing can be conducted either on land or off-shore.

2 Normative references

The following referenced documents are 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 amendments) applies.

ISO 10012, *Measurement management systems — Requirements for measurement processes and measuring equipment*

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

ISO 14689-1, *Geotechnical investigation and testing — Identification and classification of rock — Part 1: Identification and description*

ISO 22475-1, *Geotechnical investigation and testing — Sampling methods and groundwater measurements — Part 1: Technical principles for execution*

EN 791, *Drill rigs — Safety*

EN 996, *Piling equipment — Safety requirements*

ENV 13005:1999, *Guide to the expression of uncertainty in measurement*

3 Terms, definitions and symbols

3.1 Terms and definitions

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

3.1.1
flexible dilatometer
cylindrical flexible probe which can be expanded by the application of hydraulic pressure or pressurized gas and which contains transducers for the measurement of the displacements of the flexible membrane and of the internal pressure

3.1.2
equipment for flexible dilatometer test
complete equipment which is necessary to carry out a flexible dilatometer test: the probe, a hydraulic pump or high-pressure gas in bottles, a measuring unit and cables to connect the probe to the measuring unit and the hydraulic pump or the gas bottle

NOTE The parts which are necessary to bring the flexible dilatometer probe to the testing point are not included.

3.1.3
dilatometer sounding
whole series of successive operations in a given borehole, i.e. forming dilatometer pockets and performing dilatometer tests in them

3.1.4
dilatometer test pocket
cylindrical cavity with circular cross-section drilled into the ground to receive the dilatometer probe

3.1.5
flexible dilatometer test
process of expanding the flexible dilatometer so as to press the flexible membrane against the pocket wall and so measure the associated expansion as a function of pressure and time (see Figure 1)

3.1.6
nominal diameter of the pocket
diameter of the pocket at the time of application of the seating pressure

3.1.7
seating pressure
pressure during the expansion of the dilatometer at which the dilatometer membrane contacts the pocket wall

3.1.8
pressure increment
fixed increase of pressure in the flexible dilatometer, according to a pre-determined programme and recorded in the control unit

NOTE It can also be a decrement.

3.1.9
diametral pocket displacement
displacement of pocket wall caused by an increase or decrease of any pressure

3.1.10
diameter increase/decrease
change in flexible dilatometer diameter and in pocket wall displacement caused by a pressure increment/decrement, and recorded in the measurement unit

3.1.11
flexible dilatometer curve
graphical plot of pressure versus the associated pocket wall displacement

3.1.12
flexible dilatometer shear modulus, G_{FDT}
shear modulus calculated from the slope over various intervals of pressure and pocket wall displacement

3.1.13
flexible dilatometer modulus, E_{FDT}
Young's modulus calculated from the slope over various intervals of pressure and pocket wall displacement

3.1.14
depth of test
distance between the ground level and the centre of the expanding length of the dilatometer measured along the borehole axis (see Figure 2)

3.1.15
operator
qualified person who carries out the test

3.2 Symbols and abbreviations

For the purposes of this document, the symbols given in Table 1 apply.

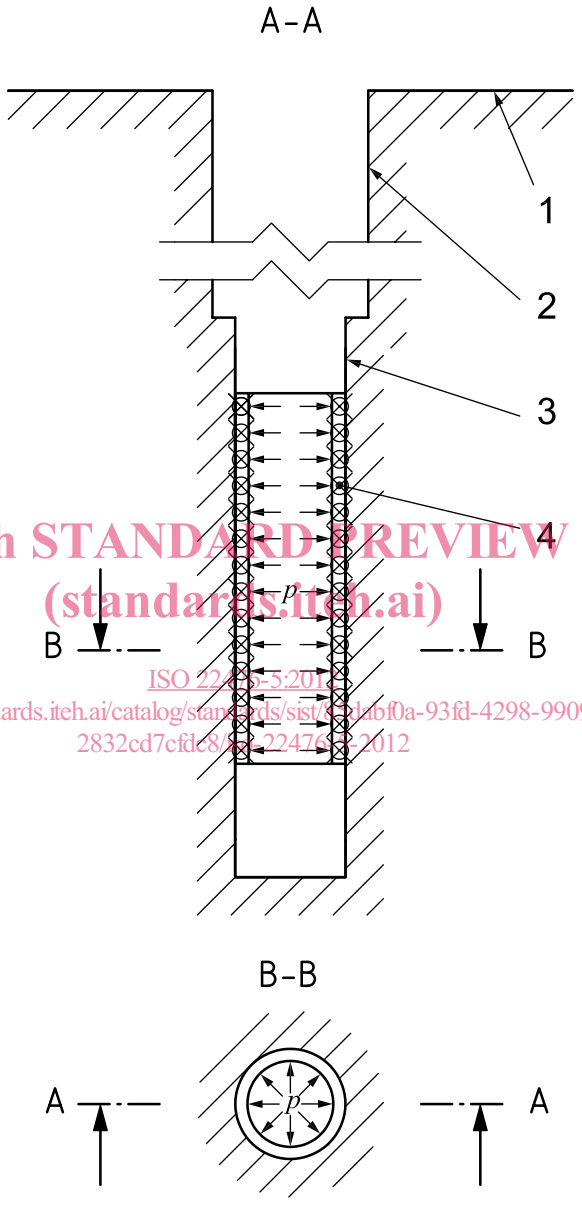
Table 1 — Symbols

Symbol	Description	Unit
a	Membrane compression coefficient in variant B dilatometer	$mm.MPa^{-1}$
d	Corrected pocket diameter	mm
d_1	Corrected pocket diameter at time t_1	mm
d_2	Corrected pocket diameter at time t_2	mm
d_c	Compression calibration cylinder diameter	mm
d_d	External diameter of the dilatometer	mm
d_r	Pocket diameter as read at the measuring unit	mm
d_s	Nominal diameter of the pocket after application of the seating pressure	mm
E_{FDT}	Young's Modulus of flexible dilatometer test	MPa
G_1	Loading shear modulus in procedure C	MPa
G_{FDT}	Shear modulus of flexible dilatometer test	MPa
G_L	Loading shear modulus of flexible dilatometer test	MPa
G_R	Reloading shear modulus of flexible dilatometer test	MPa
G_U	Unloading shear modulus of flexible dilatometer test	MPa
G_{UR}	Unloading/reloading shear modulus of flexible dilatometer test	MPa
k_f	Creep parameter	mm
L_{FD}	Length of the expanding part of the probe	mm
L_g	Axial distance between transducer or LVDT section and membrane clamping ring	mm
L_d	Length of the measuring segment of the dilatometer	mm
p	Applied pressure after correction	MPa
$p_{1.1}$	Constant full relief pressure for loops in procedure A	MPa
p_1	Pressure at reversal point at first loop	MPa
p_2	Pressure at reversal point at second loop	MPa
p_3	Pressure at reversal point at third loop	MPa
p_{max}	Maximum applied pressure during a test	MPa
p_m	Pressure loss associated with membrane stiffness	MPa
p_{Li}	Range of applied pressure in loading phase no. i	MPa
p_{Ri}	Range of applied pressure in reloading phase no. i	MPa
p_{Ui}	Range of applied pressure in unloading phase no. i	MPa
p_r	Pressure as read at the measuring unit	MPa
p_s	Seating pressure	MPa
p_y	Yield pressure during dilatometer test in procedure C	MPa
t	Time	min
t_1	Time 1 of a constant pressure test	min
t_2	Time 2 of a constant pressure test	min
z	Test depth	m
Δd_r	Increase of diametral displacement of the pocket	mm
Δd	Corrected increase of diametral pocket displacement	mm
Δp_r	Increment of applied pressure as read on the control unit	MPa
Δp	Corrected increment of applied pressure	MPa
ν	Poisson's ratio	–

4 Equipment

4.1 General

The test with the flexible dilatometer is performed by the expanding of a flexible dilatometer membrane placed in the ground (see Figure 1). The pressure applied to, and the associated expansion of the probe are measured and recorded so as to obtain a stress-displacement relationship for the ground as tested.

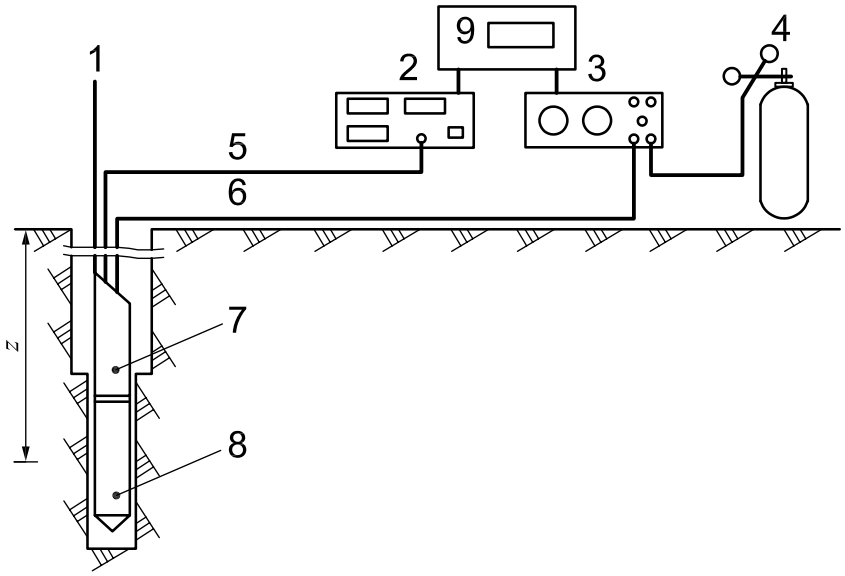


Key

1	ground surface
2	borehole wall
3	pocket
4	expanding dilatometer probe
p	applied pressure
A-A	axial section
B-B	cross section

Figure 1 — Example of a flexible dilatometer test

The equipment to carry out dilatometer tests shall consist of the components shown in Figure 2.



Key

1 setting rods (optional)
2 displacement measuring unit (obligatory)
3 pressure control unit (obligatory)
4 pressure source (obligatory)
5 signal cable (obligatory)
6 pressure line (obligatory)
7 sediment collection tube (optional)
8 flexible dilatometer probe (obligatory)
9 data logger (optional)
z test depth

Figure 2 — Schematic diagram of flexible dilatometer equipment

NOTE Sometimes, setting rods are necessary to push the probe into a tight pocket. They also allow orientation of the instrument. They are also needed in case it becomes difficult to extract the probe at the end of the test and hammering out is required.

Borehole diameters should be 76 mm, 96 mm, and 101 mm, according to ISO 22475-1.

The external diameter d_d of the flexible dilatometer when deflated shall be some 3 mm to 6 mm smaller than the nominal diameter of the borehole.

The pressure applied to the membrane shall be measured by one or more electric transducers in the instrument (see Figure 3).

4.2 Dilatometer probe

The expansion of the borehole shall be monitored by three or more electric transducers.

In variant A, the diametral displacement shall be measured with electric transducers, which shall penetrate the membrane and shall directly bear on the borehole wall (Figure 3, left.). This variant shall be primarily used in rocks (Rock dilatometer, RDT, see EN 1997-2:2007, 4.5).