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Geotechnical investigation and testing — Field testing —

Part 7: Borehole jack test

Reconnaissance et essais géotechniques — Essais en place —
Partie 7: Essai au dilatomètre rigide diamétral

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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 22476-7 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 test*

— *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 borehole jack tests are used for ground deformation calculations provided that the range of stresses applied in the test are representative of the stresses caused by the proposed foundation. Local experience normally improves the application of the results.

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. In addition, 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 7:
Borehole jack test

1 Scope

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

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

This part of ISO 22476 specifies the procedure for conducting a borehole jack test in ground stiff enough not to be adversely affected by the drilling operation. Two diametral cylindrical steel loading plates are placed in the ground and opened by pressure. Pressure applied to, and associated opening of the probe are measured and recorded so as to obtain a stress-displacement relationship of the ground for the range of the expected design stress.

This part of ISO 22476 applies to test depths of $\leq$ 100 m and to testing 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*

ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

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
equipment for borehole jack test
borehole jack, hydraulic pump, measuring unit and cables to connect the borehole jack to the measuring unit and the hydraulic pump

3.1.2
borehole jack sounding
series of successive operations necessary to perform borehole jack testing at a given location, i.e. forming a borehole and performing borehole jack tests in this borehole

3.1.3
pocket for jack test
circular cylindrical cavity drilled in a borehole in which to insert the borehole jack device

3.1.4
borehole jack
circular cylindrical instrument in which two diametrically opposed curved plates on the outside are forced apart by the application of hydraulic pressure to one or more small jacks located between them

3.1.5
borehole jack test
process of jacking two cylindrical loading plates diametrically outwards against the borehole wall and measuring their associated expansion as a function of pressure and time

NOTE 1 See Figure 1.

NOTE 2 When testing in a borehole where the hydraulic head in the instrument supply line is likely to exceed the hydraulic head of the fluid in the borehole, consideration must be given to restricting the expansion of the instrument before it enters the pocket and at the conclusion of the test.

3.1.6
depth of test
distance between the ground level and the centre of the loading plates measured along the borehole axis

NOTE See Figure 2.

3.1.7
operator
qualified person who carries out the test

3.2 Symbols and abbreviations

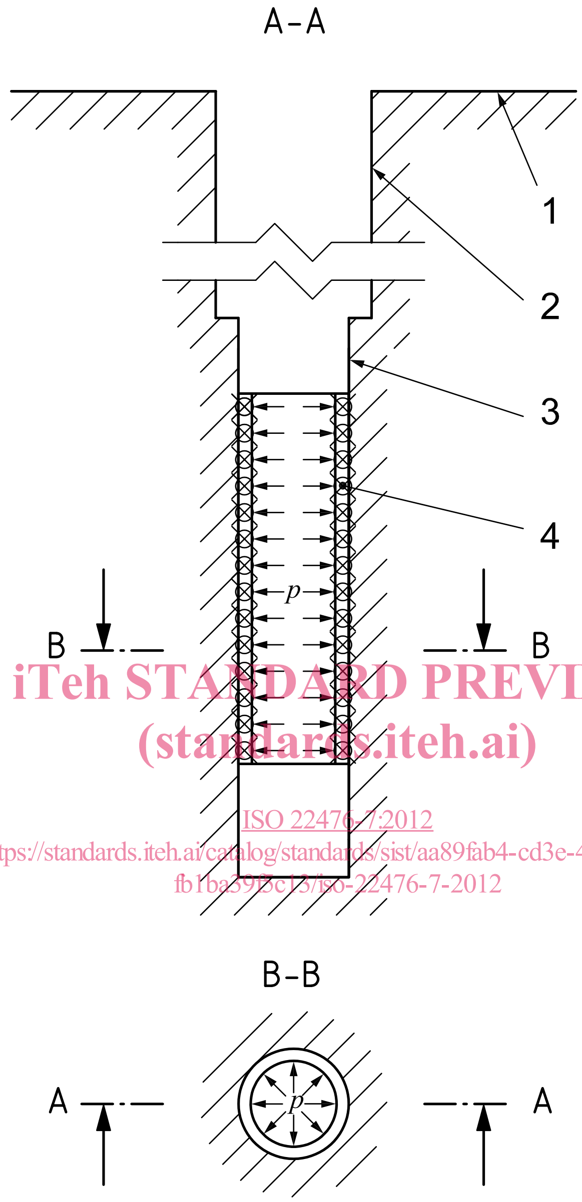
For the purposes of this International Standard the symbols and abbreviations of Table 1 apply.

Table 1 — Symbols

Symbol	Description	Unit
A	Projected area of the cylindrical loading plates on the plane normal to the axis of expansion	m^2
A_c	Cross section area in one jack cylinder	m^2
b	Width of the loading plates	mm
d	Design diameter of the jack	mm
d_0	Initial diameter of test pocket	mm
d_c	Current diameter of test pocket	mm
d_s	Diameter of the pocket at the start of the test	mm
e	Associated loading plate expansion	mm
e_1	Loading plates expansion at time t_1 or pressure p_1	mm
e_2	Loading plates expansion at time t_2 or pressure p_2	mm
Δe_i	Loading plates expansion change equals diametral displacement of borehole wall	mm
E_B	Modulus of borehole jack test for loading condition	MPa
E_U	Modulus of borehole jack test for unloading condition	MPa
f	Specific device factor	–
k_f	time-dependent strain parameter	mm
l	axial length of loading plates	mm
l_T	transducer centre-to-centre length	mm
p	applied pressure	MPa
p_c	calculated average contact stress	MPa
p_{max}	maximum contact stress	MPa
p_s	initial contact pressure	MPa
p_1	pressure at time t_1	MPa
p_2	pressure at time t_2	MPa
q	hydraulic pressure in a jack	MPa
q_{max}	maximum hydraulic pressure to be used	MPa
q_s	starting pressure of the test	MPa
r_c	friction resistance in one jack cylinder	MPa
t	time	min
t_1	time 1 of a constant stress test	min
t_2	time 2 of a constant stress test	min
z	test depth	m
z_w	groundwater depth	m
α	tilt angle of the loading plates	°
β	opening angle of loading plates	°
Δp_c	change of calculated average contact stress	MPa
ν	Poisson's ratio	–

4 Equipment

The principle of the borehole jack test is shown in Figure 1.

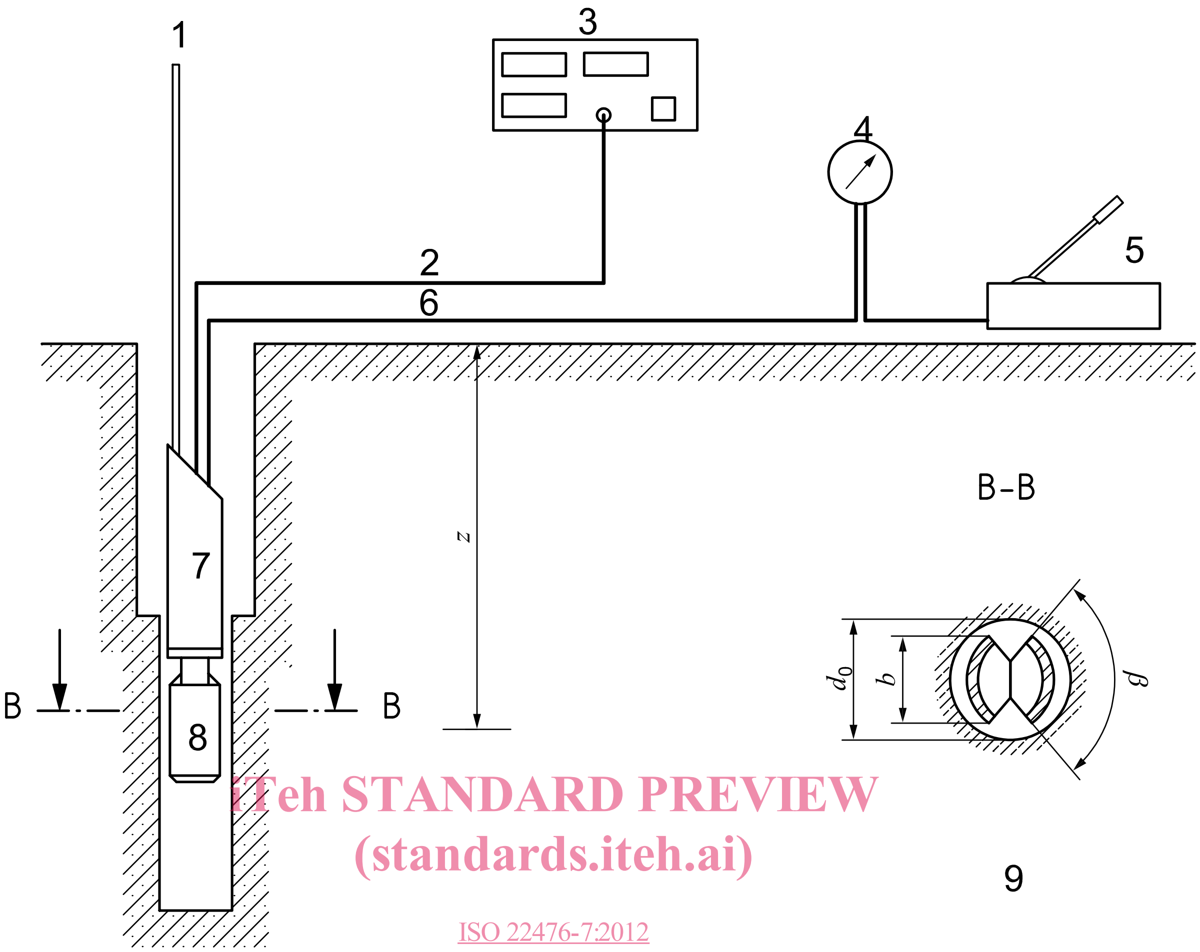


Key

1 ground surface
2 borehole
3 test pocket
4 loading plates
p applied pressure
A-A axial section
B-B cross section

Figure 1 — Example of a borehole jack test

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



Key

1 setting rods
2 signal cable
3 measuring unit
4 pressure gauge
5 hydraulic pump
6 pressure line
7 sediment collection tube
8 borehole jack
9 loading plate
β opening angle
d_0 initial diameter of test pocket
b width of loading plate
z test depth
B-B cross section

Figure 2 — Diagram of borehole jack equipment (depth less than 100 m)

The following components are obligatory:

— borehole jack (No. 8 in Figure 2);

— pressure line (No. 6 in Figure 2);

— signal cable (No. 2 in Figure 2);

— measuring unit (No. 3 in Figure 2);

— hydraulic pump (No. 5 in Figure 2);

— pressure gauge (No. 4 in Figure 2);

The following components are recommended:

— sediment collection tube to protect from caving (No. 7 in Figure 2);

— setting rods (No. 1 in Figure 2).

The nominal diameter of the borehole shall be some millimetres larger than the external diameter of the closed borehole jack.

NOTE In the case of a borehole diameter of 101 mm, a borehole jack with an external diameter of 95 mm has been shown to be suitable.

Annex A shows the geometrical parameters for various instruments.

The hydraulic pressure applied to the jacking cylinders between the loading plates shall be measured by an electric transducer in the instrument (see Figure 3). The pressure may be recorded by a suitable measuring device at the ground surface.

