SLOVENSKI STANDARD
SIST EN ISO 22476-2:2005

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Geotehniļ no preiskovanje in preskuġanje - Preskuġanje na terenu ï 2. del: Dinamiļ ni penetracijski preskus

Geotechnical investigation and testing - Field testing - Part 2: Dynamic probing (ISO 22476-2:2005)

Geotechnische Erkundung und Untersuchung - Felduntersuchungen - Teil 2: Rammsondierungen (ISO 22476-2:2005)

Reconnaissance et essais géotechniques - Essais en place - Partie 2: Essai de pénétration dynamique (ISO 22476-2:2005)

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Contents

Foreword

This document (EN ISO 22476-2:2005) 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”.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2005, and conflicting national standards shall be withdrawn at the latest by July 2005.

EN ISO 22476 *Geotechnical investigation and testing - Field testing* has the following parts:

— *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 6: Self-boring pressuremeter test*

— *Part 7: Borehole jack test*

— *Part 8: Full displacement pressuremeter test*

— *Part 9: Field vane test*

— *Part 10: Weight sounding test*

— *Part 11: Flat dilatometer test*

— *Part 12: Mechanical cone penetration test*

— *Part 13: Plate loading test*

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard : 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.

1 Scope

This document specifies requirements for indirect investigations of soil by dynamic probing as part of geotechnical investigation and testing according to EN 1997-1 and EN 1997-2.

This document covers the determination of the resistance of soils and soft rocks in situ to the dynamic penetration of a cone. A hammer of a given mass and given height of fall is used to drive the cone. The penetration resistance is defined as the number of blows required to drive the cone over a defined distance. A continuous record is provided with respect to depth but no samples are recovered.

Four procedures are included, covering a wide range of specific work per blow:

— dynamic probing light (DPL): test representing the lower end of the mass range of dynamic equipment;

— dynamic probing medium (DPM): test representing the medium mass range of dynamic equipment;

— dynamic probing heavy (DPH): test representing the medium to very heavy mass range of dynamic equipment;

— dynamic probing super heavy (DPSH): test representing the upper end of the mass range of dynamic equipment.

The test results of this document are specially suited for the qualitative determination of a soil profile together with direct investigations (e.g. sampling according to prEN ISO 22475-1) or as a relative comparison of other in situ tests. They may also be used for the determination of the strength and deformation properties of soils, generally of the cohesionless type but also possibly in fine-grained soils, through appropriate correlations. The results can also be used to determine the depth to very dense ground layers e.g. to determine the length of end bearing piles, and to detect very loose, voided, back-filled or infilled ground.

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 any amendments) applies.

EN 10204, *Metallic products — Types of inspection documents*

prEN ISO 22475-1, *Geotechnical investigation and testing — Sampling by drilling and excavation methods and groundwater measurements — Part 1: Technical principles for execution (ISO/DIS 22475-1:2004)*

3 Terms and definitions

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

3.1
dynamic penetrometer
cone and drive rods

3.2
dynamic probing equipment
penetrometer and all equipment necessary to drive the penetrometer

3.3
anvil or drive head
portion of the drive-weight assembly that the hammer strikes and through which the hammer energy passes into the drive rods

3.4
cushion; damper
placed upon the anvil to minimise damage to the equipment

3.5
hammer
portion of the drive-weight assembly which is successively lifted and dropped to provide the energy that accomplishes the penetration of the cone

3.6
height of fall
free fall of the hammer after being released

3.7
drive-weight assembly
device consisting of the hammer, the hammer fall guide, the anvil and the drop system

3.8
drive rods
rods that connect the drive-weight assembly to the cone

3.9
cone
pointed probe of standard dimensions used to measure the resistance to penetration (see Figure 1)

3.10
actual energy; driving energy
E_{meas}
energy delivered by the drive-weight assembly into the drive rod immediately below the anvil, as measured

3.11
theoretical energy
E_{theor}
energy as calculated for the drive weight assembly,

$$E_{theor} = m \times g \times h$$

where

m is the mass of the hammer;

g is the acceleration due to gravity;

h is the falling height of the hammer.

3.12
energy ratio
E_r
ratio of the actual energy E_{meas} and the theoretical energy E_{theor} of the hammer expressed in percentage

3.13
N_{xy}-value
number of blows required to drive the penetrometer over a defined distance x (expressed in centimetres) by the penetrometer y

3.14
specific work per blow
$\boldsymbol{E_n}$
value calculated by

$$E_n = m \times g \times h/A = E_{theor}/A$$

where

m is the mass of the hammer;

g is the acceleration due to gravity;

h is the falling height of the hammer;

A is the nominal base area (calculated using the base diameter D);

E_{theor} is the theoretical energy.

4 Equipment

4.1 Driving device

Dimensions and masses of the components of the driving device are given in Table 1. The following requirements shall be fulfilled:

a) hammer shall be conveniently guided to ensure minimal resistance during the fall;

b) automatic release mechanism shall ensure a constant free fall, with a negligible speed of the hammer when released and no induced parasitic movements in the drive rods;

c) steel drive head or anvil should be rigidly connected to the top of the drive rods. A loose connection can be chosen;

d) guide to provide verticality and lateral support for that part of the string of rods protruding above the ground should be part of the driving device.

If a pneumatic system for lifting a hammer is used, it shall be supplied with inspection documents as stipulated by EN 10204 because the driving energy is not always ensured.

4.2 Anvil

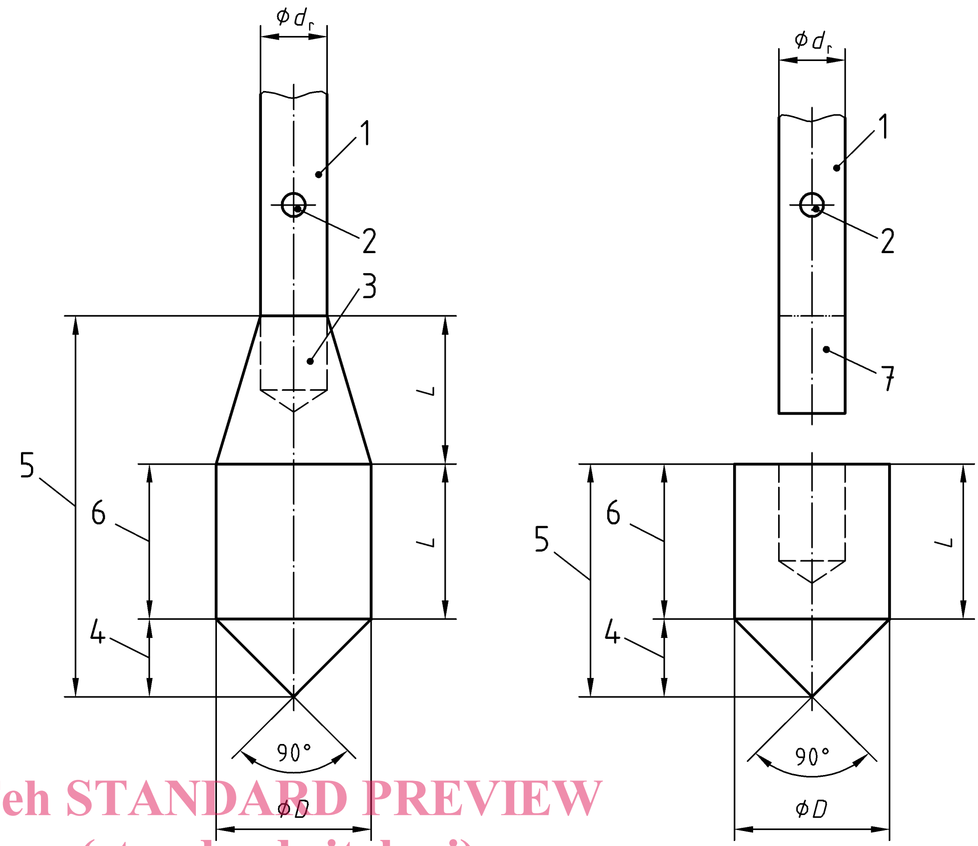
The anvil shall be made of high strength steel. A damper or cushion may be fitted between the hammer and anvil.

4.3 Cone

The cone of steel shall have an apex angle of 90° and an upper cylindrical extension mantle and transition to the extension rods as shown in Figure 1 and with the dimensions and tolerances given in Table 1. The cone may be either retained (fixed) for recovery or disposable (lost). When using a disposable cone the end of the drive rod shall fit tightly into the cone. Alternative specifications for the cones are given in Figure 1.

Key

1 Extension rod
2 Injection hole (optional)
3 Thread mounting
4 Cone tip
5 Cone
6 Mantle
7 Point mounting
L Mantle length
D Base diameter
d_r Rod diameter



a) Cone Type 1 shown as retained (fixed)

b) Cone Type 2 shown as disposable (lost)

Figure 1 – Alternative forms of cones for dynamic probing (for L, D and d_r see Table 1)

4.4 Drive rods

The rod material shall be of a high-strength steel with the appropriate characteristics for the work to be performed without excessive deformations and wear. The rods shall be flush jointed, shall be straight and may have spanner flats. Deformations shall be capable of being corrected. The deflection at the mid point of an extension rod measured from a straight line through the ends shall not exceed 1 in 1 000, i.e. 1 mm in 1 m. Dimensions and masses of the drive rods are given in Table 1.

Hollow rods should be used.

4.5 Torque measuring device

The torque necessary to turn the driving rods is measured by means of a torque wrench or similar measuring device. The apparatus shall be able to measure a torque of at least 200 Nm and be graduated to read at least in 5 Nm increments.

A sensor for recording the torque may be used.

The spanner flat in the drive rods can be used to fix the torque wrench or measuring device.

4.6 Optional equipment

4.6.1 Blow counter

A device to count the number of blows of the hammer by measuring mechanical or electric impulses can be placed on the system.

4.6.2 Penetration length measuring device

The penetration length is measured either by counting on a scale on the rods or by recording sensors. In this latter case, resolution shall be better than 1/100 of the measure length.

4.6.3 Injection system

The injection system includes:

— hollow rods;

— solid end of the lowest when using disposable (lost) cone;

— pump with mud connected to a device fixed under the anvil and intended to ensure the filling of the annular space between the ground and the drive rods created by the enlarged cone.

The flow of the pump is such that it will always ensure that the annular space between the ground and the drive rods is filled.

NOTE 1 Mud, for example, can be a mixture of bentonite and water with a mass ratio of dry particles and water of 5 % to 10 %.

NOTE 2 The mud circulation towards the surface is not obligatory. The pressure of injection is that corresponding, after deduction of the head losses, to the hydrostatic pressure due to mud on the level of the cone.

A manual pump may be used.

4.6.4 Apparatus for measuring the dimensions of the cone

The measurement of the diameter and length of the cone is made by means of a slide calliper to the 1/10 of mm or by an equivalent system.

4.6.5 Device to control rod string deviation from the vertical

A system or guide for supporting the protruding part of the rods should be in place to ensure and check that the drive rods are maintained in a vertical alignment.

Table 1 — Dimensions and masses for the four types of dynamic probing apparatus

Dynamic Probing Apparatus	Sym-bol	Unit	DPL (light)	DPM (medium)	DPH (heavy)	DPSH (super heavy)	
						DPSH-A	DPSH-B
Driving device							
hammer mass, new	m	kg	10 ± 0,1	30 ± 0,3	50 ± 0,5	63,5 ± 0,5	63,5 ± 0,5
height of fall	h	mm	500 ± 10	500 ± 10	500 ± 10	500 ± 10	750 ± 20
Anvil							
diameter	d	mm	$50<d<D_h$ [a]	$50<d<D_h$ [a]	$50<d<0{,}5\ D_h$ [a]	$50<d<0{,}5\ D_h$	$50<d<0{,}5\ D_h$ [a]
mass (max.)	m	kg	6	18	18	18	30
(guide rod included)							
90° Cone							
nominal base area	A	cm^2	10	15	15	16	20
base diameter, new	D	mm	35,7 ± 0,3	43,7 ± 0,3	43,7 ± 0,3	45,0± 0,3	50,5 ± 0,5
base diameter, worn (min.)		mm	34	42	42	43	49
mantle length (mm)	L	mm	35,7 ± 1	43,7 ± 1	43,7 ± 1	90,0 ± 2 [b]	51 ± 2
length of cone tip		mm	17,9 ± 0,1	21,9 ± 0,1	21,9 ± 0,1	22,5 ± 0,1	25,3 ± 0,4
tip max. permissible wear		mm	3	4	4	5	5
Drive rods [c]							
mass (max)	m	kg/m	3	6	6	6	8
diameter OD (max)	d_r	mm	22	32	32	32	35
rod deviation [d]:							
lowermost 5 m		%	0,1	0,1	0,1	0,1	0,1
remainder		%	0,2	0,2	0,2	0,2	0,2
Specific work per blow	mgh/A E_n	kJ/m^2	50	100	167	194	238

[a] D_h diameter of the hammer, in case of rectangular shape, the smaller dimension is assumed to be equivalent to the diameter.

[b] disposable cone only

[c] maximum rod length shall not exceed 2 m

[d] rod deviation from the vertical

NOTE Tolerances given are manufacturing tolerances.

5 Test procedure

5.1 Equipment checks and calibrations

Prior to each test, a check of dimensions shall be made to ensure that they are within the values given in Table 1. The straightness of the rods shall be checked once on each new site and at least every 20 penetration tests at that site. After each test, a visual check of the straightness of the rods shall be made.

At the test site, the rate of blows, the height of fall, the friction free fall of the hammer, the proper condition of the anvil and the mechanical release devices shall be checked for satisfactory operation which is to be ensured for the whole test series. In addition, the proper functioning of the recording device has to be checked in case automatic recording equipment is used.

The precision of the measuring instruments – if applicable – shall be checked after any damage, overloading or repair and at least once every six months, unless the manufacturer's manual requires shorter inspection intervals. Faulty parts shall be replaced. Calibration records shall be kept together with the equipment.

To check pneumatic dynamic penetrometers, the driving energy per impact (actual energy E_{meas}) shall be measured directly. When divided by the area of the cone then this shall not deviate from the theoretical value of specific work per blow as specified in Table 1 by more than 3 %. The driving energy per impact shall be checked every six months.

Energy losses occur e.g. due to friction at the hammer (velocity loss compared to the free fall) or due to energy losses during the hammer impact on the anvil. Therefore, for each new driving device the actual energy transmitted to the drive rods should be determined.

NOTE A recommended method to determine the actual energy is given in Annex C.

5.2 Test preparation

In general, dynamic probing is performed from the ground surface.

Dynamic probing test equipment shall be set up with the penetrometer vertical, and in such a way that there will be no displacement during testing. The inclination of the driving mechanism and the driving rod projecting from the ground shall not deviate by more than 2 % from the vertical. If this is not the case, the dynamic probing test shall be stopped. In difficult ground conditions deviations up to 5 % may be allowed and shall be reported.

Trailer-mounted dynamic probing test equipment shall be supported in such a way that the suspension travel of the support trailer cannot influence the test.

The equipment shall be set up with appropriate clearance from structures, piles, boreholes etc., in order to be certain that they will not influence the result of the dynamic probing test.

When carrying out dynamic probing in situations where the rods are free to move laterally, for instance over water or in boreholes, the rods shall be restrained by low-friction supports spaced not greater than 2,0 m apart in order to prevent bending during driving.

5.3 Test execution

The drive rods and the cone shall be driven vertically and without undue bending of the protruding part of the extension rods above the ground.

No load shall be applied to anvil and rods during lifting of the hammer.

The penetrometer shall be continuously driven into the ground. The driving rate shall be kept between 15 and 30 blows per minute. All interruptions longer than 5 minutes shall be recorded.

The rods shall be rotated 1½ turns or until maximum torque is reached at least every 1,0 m penetration. The maximum torque required to turn the rods shall be measured using a torque measuring wrench or an equivalent device and shall be recorded.

During heavy driving, the rods shall be rotated 1½ turns after every 50 blows to tighten the rod connections.

To decrease skin friction, drilling mud or water may be injected through horizontal or upwards holes in the hollow rods near the cone. A casing may be sometimes used with the same purpose.

The number of blows shall be recorded every 100 mm penetration for the DPL, DPM and DPH and every 100 mm or 200 mm penetration for the DPSH-A and DPSH-B.