SLOVENSKI STANDARD
oSIST prEN ISO 22476-1:2021

01-september-2021

Geotehnično preiskovanje in preskušanje - Preskušanje na terenu - 1. del: Konusni penetracijski preizkus z ali brez merjenja pornih tlakov (ISO/DIS 22476-1:2021)

Geotechnical investigation and testing - Field testing - Part 1: Electrical cone and piezocone penetration test (ISO/DIS 22476-1:2021)

Geotechnische Erkundung und Untersuchung - Felduntersuchungen - Teil 1: Drucksondierungen mit elektrischen Messwertaufnehmern und Messeinrichtungen für den Porenwasserdruck (ISO/DIS 22476-1:2021)

Reconnaissance et essais géotechniques - Essais en place - Partie 1: Essais de pénétration au cône électrique et au piézocône (ISO/DIS 22476-1:2021)

Ta slovenski standard je istoveten z: **prEN ISO 22476-1**

ICS:

93.020	Zemeljska dela. Izkopavanja. Gradnja temeljev. Dela pod zemljo	Earthworks. Excavations. Foundation construction. Underground works

oSIST prEN ISO 22476-1:2021 **en,fr,de**

DRAFT INTERNATIONAL STANDARD

ISO/DIS 22476-1

ISO/TC **182**

Secretariat: **BSI**

Voting begins on:
2021-06-29

Voting terminates on:
2021-09-21

Geotechnical investigation and testing — Field testing —

Part 1:
Electrical cone and piezocone penetration test

Reconnaissance et essais géotechniques — Essais en place —

Partie 1: Essais de pénétration au cône électrique et au piézocône

ICS: 93.020

This document is circulated as received from the committee secretariat.

ISO/CEN PARALLEL PROCESSING

Reference number
ISO/DIS 22476-1:2021(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword v

Introduction vi

1 Scope 1

2 Normative references 1

3 Terms, definitions and symbols 2

3.1 Terms and definitions 2

3.2 Symbols 8

4 Equipment 9

4.1 Cone penetrometer 9

4.2 Tolerances 9

4.3 Surface roughness and hardness 9

4.4 Cone 10

4.5 Friction sleeve 11

4.6 Filter element 12

4.6.1 General filter location 12

4.6.2 Pore pressure u_1 13

4.6.3 Pore pressure u_2 13

4.6.4 Pore pressure u_3 13

4.7 Gaps and soil seals 13

4.8 Pushrods 13

4.9 Measuring system 14

4.9.1 Accuracy 14

4.9.2 Sensors for cone resistance and sleeve friction 14

4.9.3 Sensor for pore pressure 14

4.9.4 Sensor for inclination 14

4.9.5 Sensor for temperature 14

4.9.6 Measuring of penetration length 14

4.9.7 Raw data 15

4.10 Thrust machine 15

5 Test procedures 15

5.1 Selection of equipment, procedures and evaluation of results 15

5.1.1 Calibrations required for determining cone penetrometer class 15

5.1.2 Cone penetrometer class conformity assessment 16

5.2 Position and level of thrust machine 18

5.3 Preparation of the test 18

5.4 Pushing of the cone penetrometer 19

5.5 Use of friction reducing techniques 19

5.6 Frequency of logging parameters 19

5.7 Registration of penetration length 19

5.8 Dissipation test (DPT) 20

5.9 Test completion 20

5.10 Evaluation of CPT/CPTU data and test category 21

5.11 Equipment checks and calibrations 22

5.12 Safety requirements 22

6 Test results 22

6.1 Measured parameters 22

6.2 Correction of parameters 23

6.3 Calculated parameters 24

7 Reporting 25

7.1 General 25

7.2 Reporting of test results 26

7.3 Presentation of test results 27

7.4 Presentation of results and calculated parameters 28
Annex A (informative) **Suitability of test methods** **30**
Annex B (normative) **Maintenance, checks and calibration** **33**
Annex C (Informative) **Calibration report example** **51**
Annex D (normative) **Calculation of penetration depth** **59**
Annex E (informative) **Correction of sleeve friction for water pressure** **60**
Annex F (informative) **Preparation of the piezocone** **61**
Annex G (informative) **Friction reduction Techniques** **62**
Bibliography **63**

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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of 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 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 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).

This second edition cancels and replaces the first edition (ISO 22476-1:2012), which has been technically revised.

The main changes compared to the previous edition are as follows:

— Dimensional tolerances of cone penetrometer

— Accuracy class scheme has been replaced by cone penetrometer class and test category classification scheme

— Addition of normative requirements for the calibration of cone penetrometers

— Minor updates to figures and text

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The electrical cone penetration test (CPT) consists of pushing a cone penetrometer using a series of pushrods into the soil at a constant rate of penetration. During penetration, measurements of cone resistance and sleeve friction are recorded. The piezocone penetration test (CPTU) also includes the measurement of pore pressures around the cone. The test results can be used for interpretation of stratification, classification of soil type and evaluation of engineering soil parameters. Two International Standards define cone penetration tests: ISO 22476-1 defines CPT and CPTU practice using electronic transducers; ISO 22476 12 defines CPT practice using mechanical measuring systems.

“Cone resistance” is the term used in practice and also in this part of ISO 22476, although “cone penetration resistance” is a more correct description of the process.

The test results of this part of ISO 22476 are especially suited for the qualitative and/or quantitative determination of a soil profile together with direct investigations (e.g. sampling according to ISO 22475-1 [2]) or as a relative comparison of other in situ tests.

- The results from a cone penetration test are typically used to evaluate: stratification;
- soil behaviour type;
- geotechnical parameters such as:
  - soil density;
  - shear strength parameters
  - deformation and consolidation characteristics
  - Hydraulic conductivity and ground water pressure
  - The results from a cone penetration test may also be used directly in geotechnical design calculations.

Geotechnical investigation and testing — Field testing —

Part 1: Electrical cone and piezocone penetration test

1 Scope

This part of ISO 22476 deals with equipment requirements, the execution of and reporting on electrical cone and piezocone penetration tests.

NOTE 1 This part of ISO 22476 fulfils the requirements for electrical cone and piezocone penetration tests as part of geotechnical investigation and testing according to EN 1997 (all parts)

Within the electrical cone and piezocone penetration test, two subcategories of the cone penetration test are considered:

— electrical cone penetration test (CPT), which includes measurement of cone resistance and sleeve friction.

— electrical piezocone test (CPTU), which is a cone penetration test with the additional measurement of pore pressure.

The CPTU is performed like a CPT with the measurement of the pore pressure at one or several locations on the penetrometer surface.

NOTE 2 CPT or CPTU can also be used without measurement of sleeve friction, but this is not covered in this part of ISO 22476.

This part of ISO 22476 specifies the following features:

a) type of cone penetration test;

b) Cone penetrometer class according to Table 1;

c) Test categories according to Table 2;

d) penetration length or penetration depth;

e) elevation of the ground surface or the underwater ground surface at the location of the cone penetration test with reference to a datum;

f) location of the cone penetration test relative to a reproducible fixed location reference point; and

g) pore pressure dissipation tests.

NOTE 3 This part of ISO 22476 covers onshore and nearshore CPT. For requirements for offshore CPT, see ISO 19901-8.

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 17025, *General requirements for the competence of testing and calibration laboratories*

3 Terms, definitions and symbols

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:

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

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

3.1 Terms and definitions

3.1.1
average surface roughness
Ra
average deviation between the real surface of the cone penetrometer and a medium reference plane placed along the surface of the cone penetrometer

3.1.2
cone
conical shaped bottom part of the cone penetrometer and the cylindrical extension

Note 1 to entry: When pushing the penetrometer into the ground, the cone resistance is transferred through the cone to the load sensor.

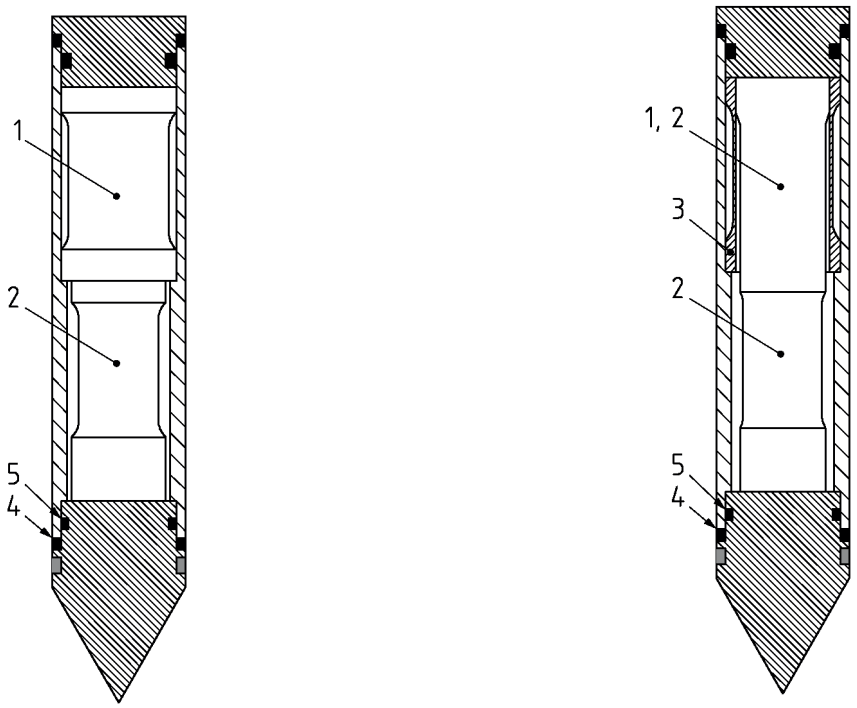
Note 2 to entry: This part of ISO 22476 assumes that the cone is rigid, so when loaded its deformation is very small relative to the deformation of other parts of the cone penetrometer.

3.1.3
base of the cone
cylindrical part of the cone directly behind the conical part of the cone tip

3.1.4
cone penetration test
CPT
pushing of a cone penetrometer at the end of a series of pushrods into the ground at a constant rate of penetration and forces are measured electrically in the cone penetrometer

3.1.5
cone penetrometer
assembly containing the cone, friction sleeve, any other sensors and measuring systems as well as the connection to the pushrods

Note 1 to entry: An example of a cone penetrometer is shown in Figure 1, for other filter locations, see Figure 2.



a) Cone resistance and sleeve friction load cells in compression

b) Subtraction type cone penetrometer

Key

1 sleeve load cell
2 cone load cell
3 thread
4 soil seal
5 water seal

Figure 1 — Cross-section of an example of a cone penetrometer

3.1.6
cone resistance
cone penetration resistance

3.1.7
corrected cone resistance
q_t
measured cone resistance, q_c, corrected for pore pressure effects

Note 1 to entry: Also called total cone resistance.

3.1.8
corrected friction ratio
R_{ft}
ratio of the measured or corrected sleeve friction to the corrected cone resistance measured at the same depth

Note 1 to entry: Usually, the measured sleeve friction is used, however, if available, the corrected sleeve friction is used.

3.1.9
corrected sleeve friction
f_t
measured sleeve friction, f_s, corrected for pore pressure effects

3.1.10
dissipation test
measurement of the pore pressure change with time, during a pause in pushing while holding the cone penetrometer stationary

3.1.11
excess pore pressure
Δu_1, Δu_2, Δu_3
pore pressure in excess of the ambient pore pressure at the level of the filter caused by the penetration of the cone penetrometer into the ground:

$$\Delta u_1 = u_1 - u_0 \quad (1)$$

$$\Delta u_2 = u_2 - u_0 \quad (2)$$

$$\Delta u_3 = u_3 - u_0 \quad (3)$$

3.1.12
filter element
porous element in the cone penetrometer that transmits the pore pressure to the pore pressure sensor, maintaining the geometry of the cone penetrometer

Note 1 to entry: Slotted filter may be used as the filter element for measurements of u_2, in certain soil conditions.

3.1.13
friction ratio
R_f
ratio of the measured sleeve friction to the measured cone resistance at the same depth

3.1.14
friction reducer
device used to reduce friction along the push rod

3.1.15
friction sleeve
section of the cone penetrometer where friction between the soil and the sleeve is developed and the load is transferred to the sleeve load cell.

3.1.16
***in situ* pore pressure**
u_o
original *in situ* pore pressure

3.1.17
inclination
angular deviation of the cone penetrometer from the vertical

3.1.18
initial pore pressure
u_i
measured pore pressure at the start of the dissipation test

3.1.19
measured cone resistance
q_c
quotient of the measured force on the cone, Q_c, and cross-sectional projected area of the cone A_c:

$$q_c = Q_c / A_c \quad (4)$$

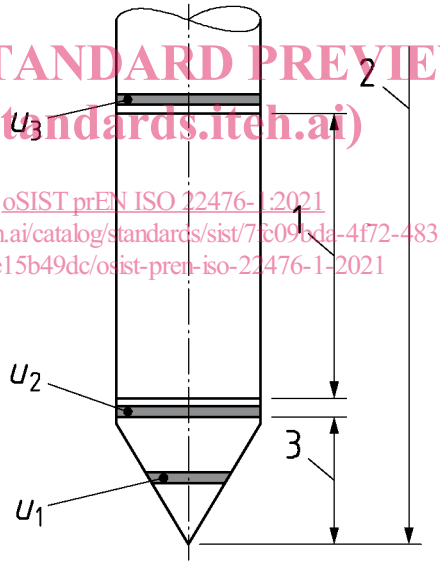
3.1.20
measured pore pressure
u_1, u_2, u_3
pressure measured in filter element during penetration, dissipation testing and pore pressure observation test

Note 1 to entry: The pore pressure can be measured at several locations as follows (see Figure 2):

u_1 on the face of the cone;

u_2 on the cylindrical section of the cone (in the gap between the cone and the sleeve;

u_3 just behind the friction sleeve.



Key
1 friction sleeve
2 cone penetrometer
3 cone

Figure 2 — Locations of pore pressure filters

3.1.21
measured sleeve friction
f_s
division of the measured force acting on the friction sleeve, F_s, by the area of the sleeve, A_s:

$$f_s = F_s / A_s \quad (5)$$

3.1.22
measuring system
all sensors and auxiliary parts used to transfer and/or store the electrical signals generated during the cone penetration test

Note 1 to entry: The measuring system normally includes components for measuring force (cone resistance, sleeve friction), pressure (pore pressure), inclination, clock time and penetration length.

3.1.23
net area ratio of the cone
a
ratio of the cross-sectional area of the load cell or shaft, A_{st}, of the cone penetrometer above the cone at the location of the gap where fluid pressure can act, to the nominal cross-sectional area of the base of the cone, A_c

Note 1 to entry: See Figure 6.

3.1.24
net area ratio of the friction sleeve
b
ratio of the difference between cross-sectional area of the bottom of the sleeve friction, A_{sb}, and the top of the sleeve friction, A_{st}, to the area of friction sleeve, A_s .

3.1.25
net cone resistance
q_n
measured cone resistance corrected for the total overburden soil pressure and pore pressure

3.1.26
net friction ratio
R_{fn}
ratio of the sleeve friction to the net cone resistance measured at the same depth

3.1.27
normalized excess pore pressure
U
excess pore pressure during a dissipation test compared to the initial excess pore pressure

Note 1 to entry: See 7.4.

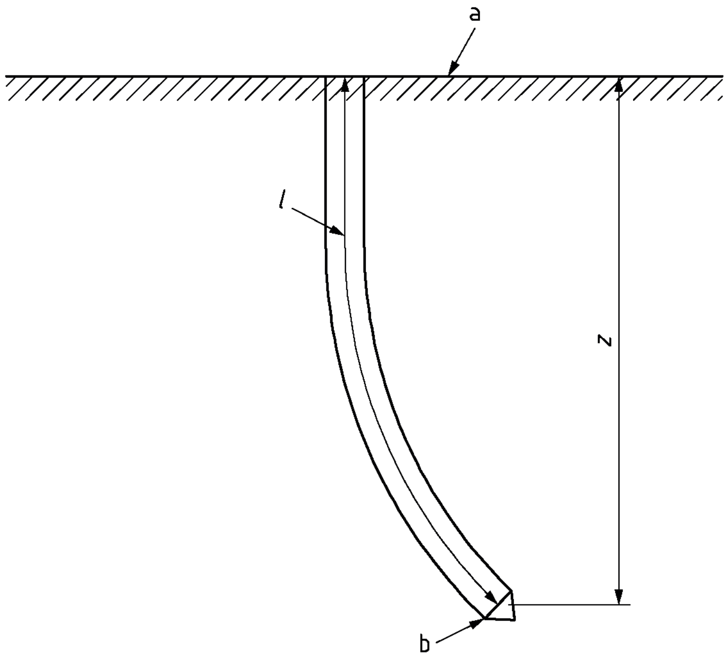
3.1.28
penetration depth
z
vertical depth of the base of the cone, relative to a fixed point

Note 1 to entry: See Figure 3.

3.1.29
penetration length
l
sum of the lengths of the pushrods and the cone penetrometer, reduced by the height of the conical part, relative to a fixed horizontal plane

Note 1 to entry: See Figure 3.

Note 2 to entry: The fixed horizontal plane usually corresponds to the level of the ground surface (on shore or offshore). This can be different from the starting point of the test.



Key

a fixed horizontal plane

b base of conical part of cone

l penetration length

z penetration depth

Figure 3 — Penetration length and penetration depth (schematic only)

3.1.30
piezocone penetration test
CPTU
electrical cone penetration test with measurement of the pore pressures around the cone

3.1.31
pore pressure ratio
B_q
ratio of the excess pore pressure at the u_2 filter position to the net cone resistance

3.1.32
pushrod
part of a string of rods for the transfer of forces to the cone penetrometer

3.1.33
reference reading
stable output of a measuring system reading of a sensor just before the penetrometer penetrates the ground or just after the penetrometer leaves the ground

Note 1 to entry: With tests starting onshore from the ground surface, the reference reading equals the zero reading.

3.1.34
thrust machine
equipment that pushes the cone penetrometer and rods into the ground at a constant rate of penetration

