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# Geotechnical investigation and testing — Field testing —

# Part 12: **Mechanical cone penetration test (CPT)**

*Reconnaissance et essais géotechniques — Essais en place —*

*Partie 12: Essai de pénétration statique au cône à pointe mécanique*

ICS 93.020



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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.

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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 22476-12 was prepared by Technical Committee ISO/TC 182, *Geotechnics*, Subcommittee SC 1, and by Technical Committee CEN/TC 341, *Geotechnical investigation and sampling* in collaboration.

The Cone Penetration Test (CPT) consists of pushing a cone penetrometer using a series of push rods into the soil at a constant rate of penetration. During penetration, measurements of cone resistance, total penetration resistance and/or sleeve friction can be recorded. The piezocone penetration test (CPTU) also includes the measurement of pore pressures at or close to the cone. The test results may be used for interpretation of stratification, classification of soil type and evaluation of engineering soil parameters. This standard is split in two parts: EN ISO 22476-1 describes electrical CPT and CPTU practice EN ISO 22476-15 describes mechanical CPT practice.



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

— *Part 1: Electrical cone penetration tests*

— *Part 2: Dynamic probing*

— *Part 3: Standard penetration test*

— *Part 4: Menard pressuremeter test*

— *Part 5: Flexible dilatometer test*

— *Part 6: Self-boring pressuremeter test*

— *Part 7: Borehole jack test*

— *Part 8: Full displacement pressuremeter*

— *Part 9: Field vane test*

— *Part 10: Weight sounding test*

— *Part 11: Flat dilatometer test*

— *Part 12: Mechanical cone penetration test (CPT)*

— *Part 13: Plate loading test*



 

# Ground investigation and testing — Field testing — Part 12: Mechanical cone penetration test (CPT)

## 1 Scope

This International Standard specifies equipment requirements, the execution of and reporting on mechanical cone penetration tests. The planning and evaluation of an investigation program and the application of its results to design is covered by EN 1997-1 and EN 1997-2.

The test results of this document are specially suited for the qualitative and/ or quantitative 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.



The results from a cone penetration test can in principle be used to evaluate:

- stratification;
- soil type;
- soil density and in situ stress conditions;
- mechanical soil properties;
- shear strength parameters;
- deformation and consolidation characteristics.

This standard specifies the following features:

- the type of cone penetration test, according to Table 1;
- the Application Class, according to Table 2;
- the achievable penetration length or penetration depth;
- the elevation of the ground surface or the underwater ground surface at the location of the cone penetration test with reference to a Datum;
- the location of the cone penetration test relative to a reproducible fixed location reference point;
- if applicable, the method of back filling of the hole in the soil resulting from the cone penetration test;
- if applicable, the depths and duration of the pore pressure dissipation tests.

## 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 1997-2, *Eurocode 7 — Geotechnical design — Part 2: Ground investigation and testing*

ISO 8503:1998, *Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-clean steel substrates*

ISO 10012-1:1992, *Quality Assurance Requirements for Measuring Equipment — Part 1: Metrological Confirmation System for Measuring Equipment*

ISO 14688-2: *Geotechnical investigation and testing — Identification and classification of soil — Part 2: Classification principles*

## 3 Terms and definitions

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



**3.1**
**average surface roughness**
$R_a$
average deviation between the real surface of the probe and a medium reference plane placed along the surface of the probe

**3.2**
**cone**
conical shaped bottom part of the cone penetrometer; when pushing the penetrometer into the ground, the cone resistance is transferred through the cone by inner rods to the measuring device at ground level

**3.3**
**cone penetration test CPT**
pushing of a cone penetrometer at the end of a series of cylindrical push rods into the ground at a constant rate of penetration

**3.4**
**cone penetrometer**
assembly containing the cone, optionally the friction sleeve, the connection to the push rods, and the measuring devices for the determination of the cone resistance, if applicable the total resistance and/or the local side friction

**3.5**
**continuous penetration testing**
testing method in which cone resistance is measured whilst cone and push rods are moving continuously, until the stop for adding a push rod

**3.6**
**discontinuous penetration testing**
testing method in which cone resistance and optionally sleeve friction are measured during a penetration stop of the push rods

**3.7**
**force acting on the friction sleeve**
$F_s$
obtained by subtracting the measured force on the cone, from the force on cone and friction sleeve

 

**3.8**
**friction ratio**
$R_f$
ratio, expressed as a percentage, of the sleeve friction to the cone resistance measured at the same depth

NOTE In some cases the inverse of the friction ratio, called the friction index, is used.

**3.9**
**friction reducer**
local and symmetrical enlargement of the diameter of a push rod to reduce the friction along the push rods

**3.10**
**friction sleeve**
section of the cone penetrometer where sleeve friction is measured

**3.11**
**inner rods**
solid rods sliding inside the push rods and transferring the forces from the cone, and optionally the friction sleeve, to the measuring system

**3.12**
**measured cone resistance**
$q_c$
division of the measured force on the cone $Q_c$, by the cross-sectional area $A_c$:

$$q_c = \frac{Q_c}{A_c}$$

NOTE The measured cone resistance, especially in tertiary clays, can be higher than the cone resistances measured with an electrical cone penetrometer.



**3.13**
**measured sleeve friction**
$f_s$
division of the measured force acting on the friction sleeve $F_s$, by the area of the sleeve $A_s$:

$$f_s = \frac{F_s}{A_s}$$

NOTE The measured sleeve friction obtained from a mechanical CPT test is higher than the value obtained from an electrical CPT test, due to the force on the shoulders of the friction sleeve.

**3.14**
**measured total penetration resistance**
$Q_t$
force needed to push cone and push rods together into the soil

**3.15**
**measuring system**
all measuring devices, sensors and ancillary parts used to transfer and/or measure the forces which are generated during the cone penetration test

NOTE The force on the cone and if applicable the total penetration resistance and / or the sleeve friction are measured with manometers or with electrical load sensors.

**3.16**
**mechanical CPT**
CPT where forces are measured mechanically or electrically at ground level

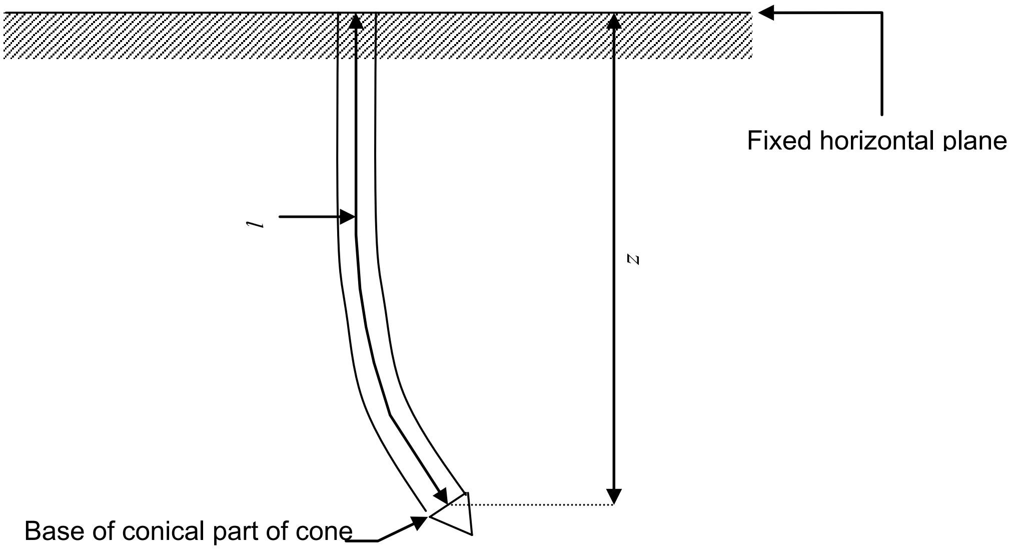


**Figure 1 — Penetration length and penetration depth**

**3.17**
**penetration depth**
*z*
depth of the base of the cone, relative to a fixed horizontal plane (Figure 1)

NOTE The fixed horizontal plane usually corresponds with a horizontal plane through the (underwater) ground surface at the location of the test.

**3.18**
**penetration length**
sum of the length of the push rods and the cone penetrometer, reduced by the height of the conical part, relative to a fixed horizontal plane (Figure 1)

NOTE If executing mechanical CPT only penetration length can be determined, as there is no inclinometer measurement for depth correction.



**3.19**
**penetrometer tip**
terminal body at the end of a series of push rods, comprising the active elements sensing the cone resistance and if applicable the local side friction, at the interface with the soil during penetration

**3.20**
**push rods**
string of rods used for pushing the penetrometer tip into the soil

**3.21**
**thrust machine**
equipment that pushes the cone penetrometer tip and rods into the soil along a vertical axis at a constant rate of penetration

NOTE Required reaction for the thrust machine may be supplied by dead weights and/or soil anchors.

**3.22**
**reference reading**
reading of a sensor just before the penetrometer penetrates the ground or just after the penetrometer leaves the ground

NOTE With tests starting on shore from the ground surface the reference reading equals the zero reading.

 