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Geotechnical investigation and testing — Sampling methods and groundwater measurements —

Part 1: Technical principles for the sampling of soil, rock and groundwater

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Foreword

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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).

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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 Technical Committee ISO/TC 182, *Geotechnics*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 341, *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 22475-1:2006), which has been technically revised.

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

- clauses on groundwater measurement will be part of ISO 18674-4;
- new sampling categories for soils have been added;
- editorial updates have been made.

A list of all parts in the ISO 22475 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.

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Geotechnical investigation and testing — Sampling methods and groundwater measurements —

Part 1: Technical principles for the sampling of soil, rock and groundwater

1 Scope

This document deals with principles of sampling of soil, rock and groundwater as part of the programme of geotechnical investigation and testing.

NOTE 1 This document fulfils the requirements for sampling of soil, rock and groundwater, and groundwater measurements as part of the programme of geotechnical investigation and testing according to EN 1997-1 and EN 1997-2. The aims of such ground investigations are:

- to recover soil, rock and water samples of a quality appropriate to assess the general suitability of a site for geotechnical engineering purposes and to determine the required ground characteristics in the laboratory;
- to obtain information on the sequence, thickness and orientation of strata and discontinuities;
- to establish the type, composition and condition of strata;
- to obtain information on groundwater conditions and recover water samples for assessment of the interaction of groundwater, soil, rock and construction material.

Soil sampling for the purposes of agricultural and environmental soil investigation is not covered.

NOTE 2 Guidance on soil sampling for these purposes including of contaminated or potentially contaminated sites is provided in the ISO 18400 series. ISO 18400-204 provides in addition guidance on sampling and measurement of soil (ground) gas.

NOTE 3 The sampling methods, presented in this document may not be suitable for all types of soil e.g. peat with strong fibrous structure.

NOTE 4 Some of the sampling methods presented in this document are suitable for both soil and rock.

Water sampling for the purposes of quality control, quality characterisation and identification of sources of pollution of water, including bottom deposits and sludges, is not covered.

NOTE 5 Water sampling for these purposes can be found in the ISO 5667 series.

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

ISO 14689, *Geotechnical investigation and testing — Identification, description and classification of rock*

ISO 3551-1, *Rotary core diamond drilling equipment — System A — Part 1: Metric units*

ISO 3552-1, *Rotary core diamond drilling equipment — System B — Part 1: Metric units*

ISO 10097-1, *Wireline diamond core drilling equipment — System A — Part 1: Metric units*

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

ISO/IEC Guide 98-3:2008/Suppl 1:2008, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995) — Supplement 1: Propagation of distributions using a Monte Carlo method*

ISO/IEC Guide 98-1, *Uncertainty of measurement — Part 1: Introduction to the expression of uncertainty in measurement*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in ISO 14688-1, ISO 14689 and the following 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 <http://www.electropedia.org/>

3.1 Ground investigation methods

3.1.1

trial pit

open excavation constructed to examine the ground conditions in-situ, recover *samples* (3.3.4) or carry out field testing

3.1.2

shaft

open or steeply inclined excavation, typically more than 5 m deep, constructed to examine the ground conditions in-situ, recover *samples* (3.3.4) or carry out field testing

3.1.3

heading

adit

small tunnel driven horizontally or with a slight inclination from a *shaft* (3.1.2) or into sloping ground to examine the ground conditions in-situ, recover *samples* (3.3.4) or carry out field testing

3.1.4

borehole

hole of any predetermined diameter and length formed in any geological formation or manmade material by *drilling* (3.1.5)

Note 1 to entry: Investigations carried out in such a hole can be to recover rock, soil or water *samples* (3.3.4) from a specified depth or to carry out field tests and measurements.

3.1.5

drilling

process by which a *borehole* (3.1.4) is produced in any geological formation by rotary, rotary percussive, percussive, resonance/sonic or thrust methods and in any predetermined direction in relation to the *drill rig* (3.2.3)

3.1.6

small diameter drilling

drilling (3.1.5) in the soil with a diameter greater than 30 mm but less than 80 mm

3.1.7**drilling method**

technique employed to create and stabilise the *borehole* (3.1.4)

3.2 Drilling rigs and equipment**3.2.1****drilling tool**

device, which is attached to, or an integral part of, the drill string that is used for penetrating the geological formation as a cutting tool

3.2.2**drill bit**

device, which is attached to, or an integral part of, the drill string that is used as a cutting tool to penetrate the formation being drilled by the *drilling method* (3.1.7) employed

3.2.3**drill rig**

device which carries out the *drilling* (3.1.5) function

3.2.4**casing**

tubing temporarily or permanently inserted into a *borehole* (3.1.4)

Note 1 to entry: It is used e.g. to stabilise it, to prevent the loss of *flushing medium* (3.2.5) to the surrounding formation or to prevent cross flow between different groundwater horizons.

3.2.5**flushing medium**

liquid or gaseous medium to remove *cuttings* (3.3.8) from the *borehole* (3.1.4), to aid sampling and to lubricate and cool the *drilling tool* (3.2.1)

3.2.6**additive**

substance added to the *flushing medium* (3.2.5) in order to affect or change its properties to improve its functioning and can include *borehole* (3.1.4) stabilization

3.2.7**core lifter**

split, internally slotted or serrated conical spring steel ring fitted to the core barrel to hold and retain the *core sample* (3.3.6) whilst the core barrel is being hoisted from the *borehole* (3.1.4)

3.2.8**sample retainer**

cylindrical device containing flexible spring fingers, hinged wedged-shaped fingers or a hinged flap mounted in a carrier ring and mounted at the lower end of the sampler tube and used to retain the *sample* (3.3.4) in the tube as the sampler is being lifted from the ground

3.3 Sampling**3.3.1****sampling by drilling****continuous sampling**

process by which *samples* (3.3.4) are obtained by the *drilling tools* (3.2.1) as the *borehole* (3.1.4) proceeds

Note 1 to entry: The *drilling* (3.1.5) process is designed to obtain complete samples of the length of the borehole. The drilling tools are used as sampling tools.

3.3.2

sampling using sampler

process by which *samples* (3.3.4) are obtained by samplers from *trial pits* (3.1.1), *headings* (3.1.3), *shafts* (3.1.2) or *boreholes* (3.1.4) at selected positions

3.3.3

soil sampling by small diameter drilling

sampling by drilling (3.3.1) in soils using *drilling tools* (3.2.1) with a diameter greater than 30 mm but less than 80 mm

3.3.4

sample

representative specimen of rock, soil or groundwater recovered from a recorded location

3.3.5

sampling category

category of equipment and procedures to enable a certain quality class of soil or rock *samples* (3.3.4) to be obtained

3.3.6

core

core sample

cylindrical *sample* (3.3.4) of soil or rock obtained from a *borehole* (3.1.4)

3.3.7

block sample

sample (3.3.4) of soil or rock cut out by special techniques to minimise disturbance

3.3.8

cuttings

particles of geological formations formed in the *borehole* (3.1.4) by the cutting action of the *drilling tool* (3.2.1) and carried to the surface by the *flushing medium* (3.2.5) or by an appropriate device

3.3.9

suspended matter

abraded ground material in the *flushing medium* (3.2.5) generated by *drilling* (3.1.5), in which the individual particle size cannot be recognised with the naked eye

3.3.10

core run

length of core sampling in an exploratory hole defined by the start and end depths (or other linear measurement) of the sampling tool

3.3.11

core loss

difference between a *core run* (3.3.10) and the length of the *core* (3.3.6) recovered

3.3.12

area ratio

C_a
ratio of the area of soil displaced by the sampler tube in proportion to the area of the *sample* (3.3.4):

$$C_a = \frac{D_2^2 - D_1^2}{D_1^2} \cdot 100$$

Note 1 to entry: See [Figure 1](#).

Note 2 to entry: Area ratio is expressed in %.

Note 3 to entry: Area ratio is one of the factors that determine the mechanical disturbance of the soil.

3.3.13 inside clearance ratio

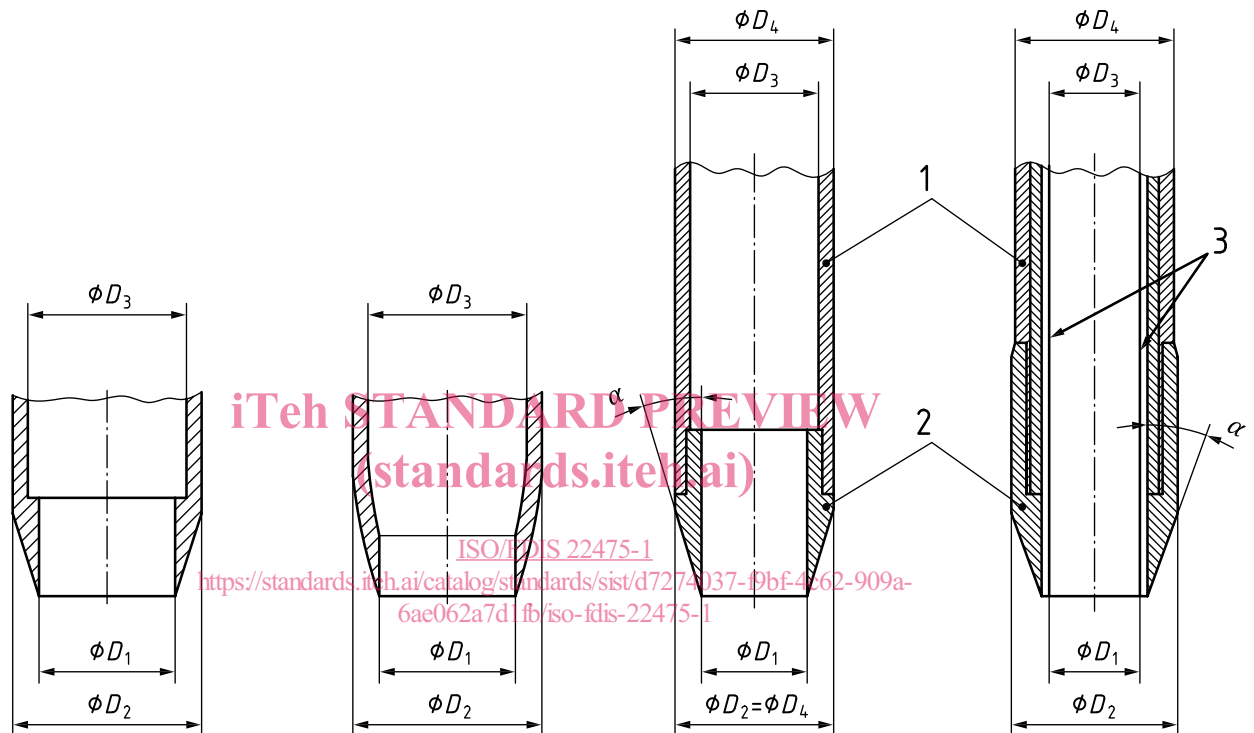
 C_i

$$C_i = \frac{D_3 - D_1}{D_1} \cdot 100$$

Note 1 to entry: See [Figure 1](#).

Note 2 to entry: Inside clearance ratio is expressed in %.

Note 3 to entry: Inside clearance ratio is one of the factors that determine the mechanical disturbance of the *sample* ([3.3.4](#)) caused by the friction on the inside wall of sample tube or of the liner.



Key

| | | | |
|-------|---|----------|------------------|
| D_1 | inside diameter of the cutting shoe | α | taper angle |
| D_2 | greatest outside diameter of the cutting shoe | 1 | sample tube |
| D_3 | inside diameter of the sample tube or liner | 2 | cutting shoe |
| D_4 | outside diameter of the sample tube | 3 | liner (optional) |

Figure 1 — Definitions of the diameters D_1 , D_2 , D_3 and D_4

3.3.14 total core recovery in rock

TCR

total length of *core sample* ([3.3.6](#)) recovered (solid and non-intact), expressed as a percentage of the length of the *core run* ([3.3.10](#))

Note 1 to entry: See [Figure 2](#).

3.3.15
rock quality designation
RQD

summed length of solid core pieces recovered in the *core run* (3.3.10) where each piece is at least 100 mm long between natural fracture, expressed as a percentage

Note 1 to entry: See Figure 2.

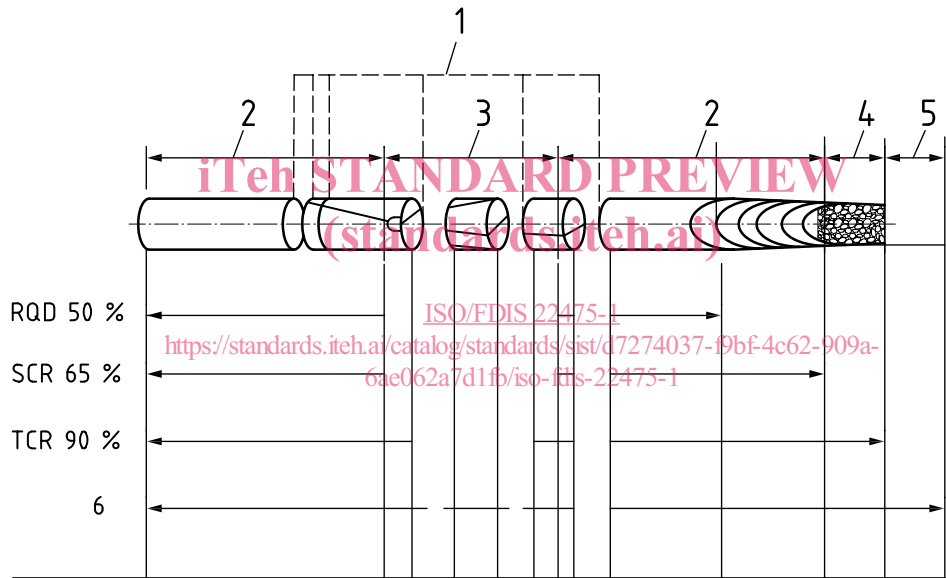
3.3.16
solid core recovery
SCR

length of solid *core* (3.3.6) recovered in the *core run* (3.3.10), where solid core has at least one full diameter, expressed as a percentage of the length of the core run

Note 1 to entry: See Figure 2.

Note 2 to entry: A solid core has a full diameter, uninterrupted by natural discontinuities, but not necessarily a full circumference and is commonly measured along the core axis or other scan line.

Note 3 to entry: Core without at least one full diameter is termed non-intact.



Key

- | | | | |
|---|---|-----|--|
| 1 | <i>drilling</i> (3.1.5) induced fractures | RQD | <i>rock quality designation</i> (3.3.15) |
| 2 | at least one full diameter | SCR | <i>solid core recovery</i> |
| 3 | no single full diameter | TCR | <i>total core recovery</i> (3.3.14) |
| 4 | non-intact | | |
| 5 | no recovery | | |
| 6 | core run | | |

NOTE All features shown are natural discontinuities unless stated otherwise.

Figure 2 — Application of fracture state terms for rock cores

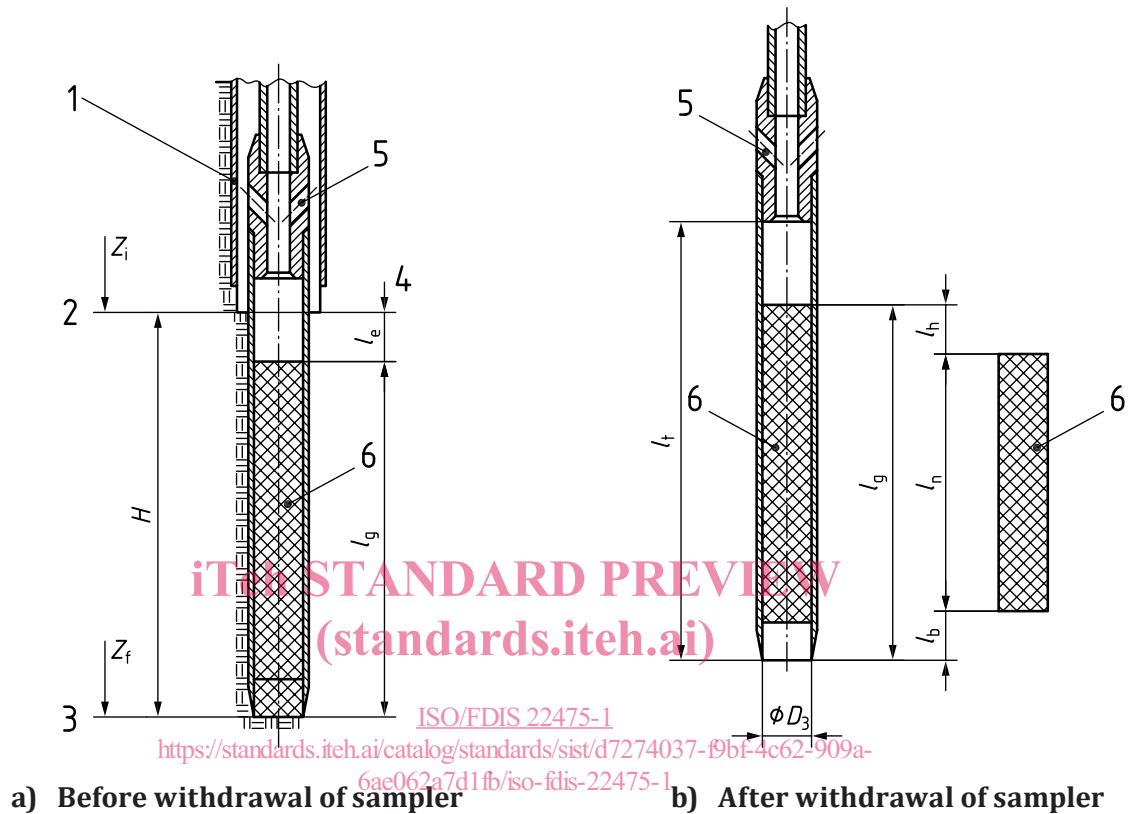
3.3.17
sample recovery ratio in soil
TC

ratio of the length of the *sample* (3.3.4) l_g to the length of the sample run H

Note 1 to entry: See Figure 3.

3.3.18**net sample recovery ratio****IC**ratio of the net length of the sample (3.3.4) l_n to the length of the sample run H

Note 1 to entry: See Figure 3.

**Key**

- | | |
|--|--|
| 1 casing (3.2.4) | l_b length of the lower part of the sample, which was remoulded or lost |
| 2 beginning of coring | l_e difference between the sample run and the actual length of the sample |
| 3 end of coring | l_g total length of the sample after withdrawal of the sampler, measured from the top of the sample to the cutter edge, including the remoulded or lost parts at both ends of the sample |
| 4 bottom of predrilled borehole (3.1.4) | l_h length of the remoulded or polluted upper part of the sample |
| 5 vent-hole | l_n net length of the sample, before its conditioning |
| 6 sample | l_t effective (useful) length of the sampling tube |
| D_3 the inside diameter of the sample tube or liner | |
| H length of the sample run | |
| Z_f depth under the natural ground level of the lower end of the sampler after sampling and before withdrawing the sampler | |
| Z_i depth under the natural ground level of the borehole bottom before sampling, and of the beginning of the following core run (3.3.10) | |

Figure 3 — Lengths of core run and sample**3.3.19****thin-walled**

<soil sampler> having a low area ratio (3.3.12), a low taper angle and a thin edge

3.3.20

thick-walled

<soil sampler> having an *area ratio* ([3.3.12](#)), taper angle and/or edge larger than that of a *thin-walled* ([3.3.19](#)) sampler

3.4 Rock and soil properties

3.4.1

structure

pattern of discontinuities in soil and rock mass which subdivides the mass into individual units

3.4.2

texture

size, shape and arrangement of the grains for soil and rock

3.5 Abbreviated terms

AS disturbed sample from augering

B bulk disturbed samples

BS hand trimmed block sample

CP cable percussion drilling

CPT cone penetration testing

CS rotary core sample

D small disturbed sample

DLDS Deltares large diameter sampler

DT double tube drilling

GS grab sample

HSAS liner sample from hollow stem augering

LS large samplers

OS open-tube samplers

PE percussion

PS piston samplers

PU pushed

RC rotary coring

RO rotary open holing

S-SPT standard penetration test sampler

S-TP disturbed sampling from trial pit

S-BB sampling from borehole bottom

SN resonance/sonic drilling

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| | |
|------|----------------------|
| ST | single tube drilling |
| T/W | thin-walled |
| TK/W | thick-walled |
| TP | trial pitting |
| TT | triple tube drilling |
| WS | window sampler |

4 Equipment

4.1 Requirements for the drilling rigs and equipment

Drilling rigs with appropriate stability, power and equipment such as drill rods, casing, core barrels and bits shall be selected in order that the required sampling and borehole tests can be carried out to the required depth of the borehole and sampling categories.

NOTE [Annex C](#) gives a selection of equipment which is currently used.

If applicable, the drilling and sampling equipment shall be in accordance with ISO 3551-1, ISO 3552-1 and ISO 10097-1.

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4.2 Drilling parameters

The drilling rig and equipment shall allow control of relevant drilling functions listed below. Following drilling parameters should be measured and recorded against depth, if required and applicable:

- drill head rotational torque (Nm); <https://standards.iteh.ai/catalog/standards/sist/d7274037-f9bf-4c62-909a-0ac062a7d1fb/iso-fdis-22475-1>
- drill head rotational speed (rpm);
- feed thrust and pulling force (kN);
- penetration rate (m/min);
- depth of hammering intervals (on/off);
- topographical depth (m);
- azimuth and inclination when inclined drilling (degree);
- drilled length when inclined drilling (m);
- flushing medium pressure at the output of the pump (kPa);
- flushing medium circulation rate (input) (l/min);
- flushing medium recovery rate (l/min).

NOTE Measuring while drilling is covered by ISO 22476-15.

4.3 Safety and special requirements

Precautions regarding the safety on the site and the safety of the working practices for the execution of boreholes, trial pits, heading and shafts shall be taken.

NOTE EN 16228-1 and EN 16228-2 deal with safety matters concerning drill rigs.