SLOVENSKI STANDARD
oSIST prEN ISO 22476-15:2014

01-maj-2014

Geotehnično preiskovanje in preskušanje - Preskušanje na terenu - 15. del: Meritve ob vrtanju (ISO/DIS 22476-15:2014)

Geotechnical investigation and testing - Field testing - Part 15: Measuring while drilling (ISO/DIS 22476-15:2014)

Geotechnische Erkundung und Untersuchung - Felduntersuchungen - Teil 15: Aufzeichnung der Bohrparameter (ISO/DIS 22476-15:2014)

Reconnaissance et essais - Essais de sol - Partie 15: Enregistrement des paramètre de forages (ISO/DIS 22476-15:2014)

Ta slovenski standard je istoveten z: **prEN ISO 22476-15**

ICS:

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

oSIST prEN ISO 22476-15:2014 **en,fr,de**

DRAFT INTERNATIONAL STANDARD

ISO/DIS 22476-15

ISO/TC **182**/SC **1** Secretariat: **DIN**

Voting begins on: **2014-02-20**

Voting terminates on: **2014-07-20**

Geotechnical investigation and testing — Field testing —

Part 15: Measuring while drilling

Reconnaissance et essais — Essais de sol —

Partie 15: Enregistrement des paramètre de forages

ICS: 93.020

ISO/CEN PARALLEL PROCESSING

This draft has been developed within the European Committee for Standardization (CEN), and processed under the **CEN lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five month enquiry.

Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month approval vote in ISO and formal vote in CEN.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

Reference number
ISO/DIS 22476-15:2014(E)

Contents

Page

1 Scope 1
2 Normative references 2
3 Terms and definitions 2
4 Symbols and abbreviated terms 4
5 Equipment 6
5.1 Drilling equipment 6
5.2 Measuring system 7
5.2.1 Sensors for hydraulic pressures 7
5.2.2 Measuring system for penetration length 7
5.2.3 Measuring system for flushing medium flow 8
5.2.4 Measuring system for rotational speed 8
5.2.1 Measuring of hammering energy 8
5.2.5 Reflected vibrations 8
5.2.2 Time 8
6 Specific requirements for MWD measurements 9
6.1 Selection of measured parameters 9
6.2 Selection of equipment and procedures 10
6.2.1 MWD Class 1 11
6.2.2 MWD Class 2 11
6.2.3 MWD Class 3 11
6.3 Factors influencing MWD results 12
6.3.1 Tool influence 12
6.3.2 Drilling rig influence 13
6.3.3 Operator influence 13
7 Test procedures 13
7.1 General 13
7.2 Position and level of drilling machine 13
7.3 Preparation of the measurement 13
7.4 Drilling procedure 14
7.5 Frequency of logging parameters 14
7.6 Registration of penetration length 15
7.7 Test completion 15
7.8 Equipment checks and calibrations 16
7 Test results 16
7.9 General 16
7.10 Calculated parameters 16
7.10.1 Penetration rate 16
7.10.2 Down-thurst pressure 16
7.10.3 Net down-thrust pressure 16
7.10.4 Flushing medium pressure 17
7.10.5 Drill head rotational torque 17
8 Reporting 17
8.1 General 17
8.2 General reporting of test results 18
8.2.1 General information 18
8.2.2 Location of the test 18
8.2.3 Test equipment 18
8.2.4 Test procedure 19

8.2.5 Measured parameters **19**

Annex A (normative) **Calibrations and field check** **20**
A.1 Calibration **20**
A.1.1 Sensor calibrations **20**
A.1.2 Functional verification **20**
A.2 Field check **21**

Annex B (informative) **Positioning of sensors** **22**
B.1 General **22**
B.2 Down-thrust and torque pressures **22**
B.3 Holdback pressure **22**
B.4 Flushing medium pressure **23**
B.5 Flushing medium circulation rate **23**
B.6 Penetration length **23**
B.7 Drill head rotational speed **24**
B.8 Reflected vibrations **24**

Annex C (informative) **Application of drilling parameters** **27**
C.1 The drilling parameters interpretation **27**
C.1.1 Penetration rate **27**
C.1.2 Net down-thrust **27**
C.1.3 Flushing medium pressure **27**
C.1.4 Torque **28**
C.1.5 Conclusion **28**
C.2 Compound parameters **29**
C.2.1 Penetration resistance **29**
C.2.2 Alteration index **30**
C.2.3 Somerton Index **30**
C.2.4 Energy **31**
C.2.5 Computerized interpretation **33**

Annex D (informative) **Graphical presentation of drilling parameter** **35**
D.1 Choice of axis scaling **35**
D.2 Presentation of test results **35**

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-X 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 01, *Geotechnical 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 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*

— *Part 13: Plate loading test*

— *Part X: Measuring while drilling*

Introduction

ISO 22476-X specifies the technical principles for measuring equipment requirements, the execution and reporting on the parameters of investigation drilling process for geotechnical purposes.

The measuring while drilling (MWD) method deals with the recording of the machine parameters during the drilling process. This can be done manually or with the use of computerized systems which monitor a series of sensors installed on rotary and/or percussive drilling equipment. These sensors continuously and automatically collect data on all aspects of drilling, in real time, without interfering with the drilling progress. The data are displayed in realtime and are also recorded for further analysis. Examples for interpretation of the results are presented in an annex.

The method shall be used for its own purpose and the borehole can be used for other application such as installation of monitoring equipments or realisation of expansion test. The interpretation of the MWD results can be done in relation with the information provided by sampling.

It should be noted that measured and calculated drilling parameters are relative and dependant of the test conditions, procedures and equipment.

The recording of the drilling parameters during soil grouting, drilling of nails, anchors or piles are out of the scope of this standard.

Geotechnical investigation and testing — Field testing — Part X: Measuring while drilling

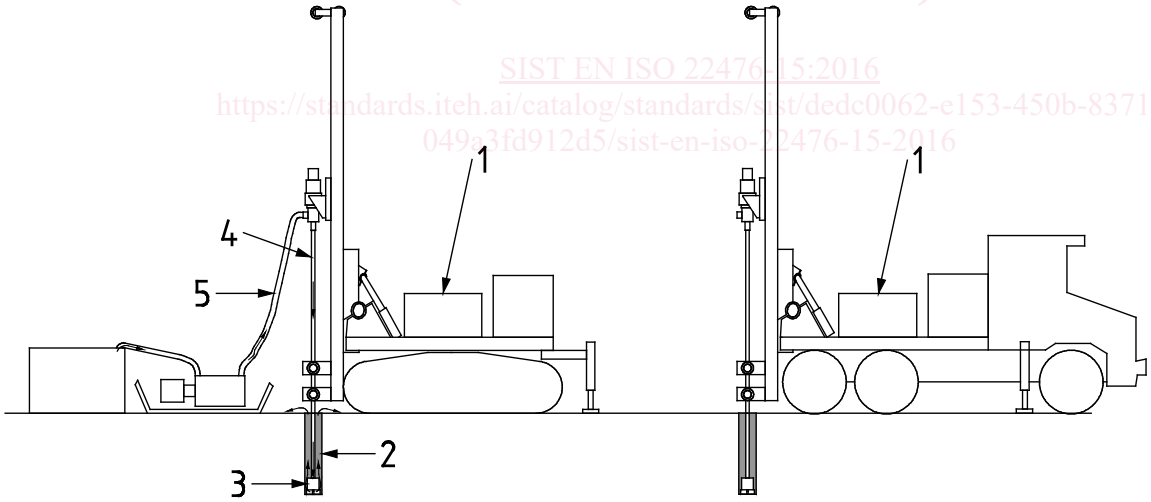
1 Scope

This document deals with technical principles for measuring equipment requirements, the execution of and reporting on the parameters of measuring while drilling method as part of geotechnical investigation and testing according to EN 1997-1 and EN 1997-2 (for the drilling process, see figure 1).

The measured, calculated and derived drilling parameters (e.g. depth, advancement rate, pull down pressure, torque, rotation rate, mud pressure, mud flow, vibration, penetration resistance, soil-rock resistance) can produce useful data about the lithology of the layers for a reliable geotechnical model, their density or weathering, the localisation of voids or faults in the ground, the depth to rock and other properties like permeability.

The present document describes the procedure for the logging (measuring versus depth) of drilling parameters and how to report them for subsurface characterization. It applies in natural soils, treated or untreated fills and in soft and hard rocks, either on land or off-shore.

After the MWD test, the borehole can be used for other purpose such as installation of monitoring equipments.



Key

1 drill rig
2 borehole
3 drilling tool
4 drill rods
5 flushing medium circulation system

Figure 1 — Principle of a drilling process

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 791 *: Drill rigs — Safety.*

ISO 710 Graphical symbols for use on detailed maps, plans and geological cross-sections - Part 1: General rules of representation

ISO 710-2 Graphical symbols for use on detailed maps, plans and geological cross-sections -- Part 2: Representation of sedimentary rocks

ISO 710-3 Graphical symbols for use on detailed maps, plans and geological cross-sections -- Part 3: Representation of magmatic rocks

ISO 1219-1 Fluid power systems and components - Graphic symbols and circuit diagrams - Part 1: Graphic symbols for conventional use and data-processing applications

EN 1997-1, Eurocode 7: Ground investigation and testing – *Part 1: General rules.*

EN 1997-2, Eurocode 7: Ground investigation and testing – *Part 2: Design assisted by laboratory and field testing*.

EN ISO 10012, *Measurement management systems – Requirements for measurement processes and measuring equipment.*

ENV 13005:1999, *Guide to the expression of uncertainty in measurement.*

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.*

EN ISO 22475-1, Geotechnical investigation and testing – Sampling by drilling and excavation and ground water measurements – Part 1: Technical principles for execution.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 22475-1 and the followings apply.

3.1
borehole
hole of any predetermined diameter and length formed in any geological formation or man made material by rotary or percussive drilling tools or a combination of them

NOTE Investigations carried out in such a hole may be to recover rock, soil or water samples from a specified depth or to carry out in situ tests and measurements

3.2
drilling
process by which a borehole is produced in any geological formation by rotary, rotary percussive, percussive or thrust methods and in any predetermined direction in relation to the drill rig

NOTE Cuttings produced by the process are continuously removed by the flushing medium.

3.3
drilling method
technique employed to produce and stabilise the borehole, and at the same time, remove cuttings from the drill bit

3.4
drilling tool
device, which is attached to or an integral part of the drill string, used for penetrating the geological formation as a cutting tool

3.5
drill rig
machine of the appropriate power which, when used in conjunction with the correctly selected in-hole equipment will carry out the drilling function

3.6
flushing medium
fluid medium (air, water or water-air-mixture) continuously supplied to the drilling tool to facilitate the removal of cuttings to the surface, stabilise the borehole, support the preservation of geological information, lubricate and cool the drilling tool

3.7
flushing additive
additive, which when added to the flushing medium will affect or change its physical condition

NOTE Bentonite and polymers are flushing additives for example.

3.8
cuttings
particles of geological formations formed in the borehole by the cutting action of the drilling tool and carried to the surface by the flushing medium.

3.9
drill rig parameters
functional parameters of the drill rig recorded during drilling (mainly hydraulic pressures, penetration rate, rotation speed, fluid pressure and flow, etc.).

3.10
drilling parameters
parameters derived from drill rig parameters characteristics of drilling tool action on the material of the geological formation.

3.11
penetration length
length measured in the axis of the borehole between ground level and the drilling tool.

3.12
penetration rate
rate of penetration of drilling tool in the ground.

3.13
down thrust (feed) pressure
thrust pressure applied on drilling tool.

3.14
holdback (retain) pressure
retain pressure limiting penetration rate due to safety requirements.

3.15
flushing medium pressure
flushing medium pressure at the level of the drilling tool.

3.16
torque
drill head rotational torque

3.17
rotation speed
drill head rotational speed

3.18
flushing medium circulation rate
flushing medium circulation rate output of drilling tool down the hole

3.19
flushing medium recovery rate
flushing medium circulation rate output of borehole

3.20
reflected vibration
acceleration due to elastic rebound of rods compressed by hammer impact

3.21
time
time

3.22
operator
qualified person who carries out the test.

4 Symbols and abbreviated terms

Symbol	Name	Unit
A	measured penetration length	m
α	efficiency coefficient of down-thrust work	-
β	efficiency coefficient of torque work	-
γ	efficiency coefficient of hammering work	-
C_R	measured drill head rotational torque	kN.m
$C_{R\ max}$	maximum measured drill head rotational torque	kN.m
Do	external diameter of drill bit	m
E	calculated drilling energy	J
E_S	calculated specific energy	J

E_R	measured reflected vibrations	J
f	hammer frequency	Hz
F_{max}	maximum down thrust force	kN
H_{max}	maximum hold back force	kN
I_A	calculated alteration index	-
N	measured rods number	-
P	measured hydraulic pressure in feed motor or cylinder	MPa
p_{CR}	measured hydraulic pressure in torque motor	MPa
$p_{CR\ max}$	maximum measured hydraulic pressure in torque motor	MPa
p_H	measured hold back pressure	MPa
P_I	calculated flushing medium pressure at output of the drilling tool	MPa
P_E	calculated net down-thrust (or feed thrust) applied on drilling tool	MPa
P_F	measured flushing medium pressure at output of the pump	MPa
p_M	measured hammering pressure	MPa
p_{max}	maximum measured down-thrust pressure	MPa
P_O	calculated raw down-thrust (or feed thrust) applied on drilling tool	MPa
P_H	calculated holdback pressure	MPa
$p_{H\ max}$	maximum measured holdback pressure	MPa
P_R	penetration resistance	s/0,2 m
Q_I	measured borehole drilling fluid inflow	l/h
Q_O	measured borehole drilling fluid outflow	l/h
R_{SR}	calculated soil-rock resistance	MPa/m/s
S_d	calculated Somerton index	-
S_O	measured area removed by drill bit (=/= drilling tool surface)	m^2
t	measured time	S
V_A	penetration rate	m/h
V_R	measured drill head rotational speed	Rpm
W_H	weight of rotary head	MN