
**Geotechnical investigation and
testing — Field testing —**

**Part 15:
Measuring while drilling**

Reconnaissance et essais — Essais de sol —

Partie 15: Enregistrement des paramètres de forages

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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.

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).

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For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

ISO 22476-15 was prepared by the European Committee for Standardization (CEN) in collaboration with ISO/TC 182, *Geotechnics*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all parts in the ISO 22476 series, published under the general title *Geotechnical investigation and testing — Field testing*, can be found on the ISO website.

Introduction

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 real time and are also recorded for further analysis. Examples for interpretation of the results are presented in [Annex A](#).

The borehole can be used for other applications such as installation of monitoring equipment, geophysical logging or realization of expansion tests. 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.

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Geotechnical investigation and testing — Field testing —

Part 15:

Measuring while drilling

1 Scope

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

It is applicable to top-driven, destructive drilling methods performed by a fully hydraulically powered drill rig and driving device. It is commonly used with destructive drilling techniques but can also be used with core drilling.

The recording of the drilling parameters during soil grouting, drilling of nails, anchors or piles are beyond the scope of this part of ISO 22476.

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 14689-1, *Geotechnical investigation and testing — Identification and classification of rock — Part 1: Identification and description*

ISO 22475-1, *Geotechnical investigation and testing — Sampling methods 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 ISO 22475-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1 drilling parameters

parameters measured and recorded on the drill rig during drilling (mainly hydraulic pressures, depth, penetration rate, rotation speed, fluid pressure and flow, etc.)

3.2 compound parameters

parameters derived from the combination of a number of the drilling parameters

3.3

reflected vibration

acceleration due to elastic rebound of rods compressed by hammer impact

3.4

penetration length

length measured along the axis of the borehole between ground level and the drilling tool

3.5

penetration rate

rate of penetration of drilling tool into the ground

3.6

down thrust pressure

thrust pressure applied to drilling tool

3.7

holdback pressure

pressure limiting penetration rate due to safety requirements

3.8

flushing medium pressure

pressure at the level of the drilling tool

3.9

torque

drill head rotational torque

3.10

rotation speed

drill head rotational speed

3.11

flushing medium circulation rate

rate of output of drilling tool down the hole

4 Symbols

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 torque	kN·m
$C_{R\max}$	maximum measured drill head torque	kN·m
d_o	external diameter of drill bit	mm
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	quantity of rods	—
p	measured hydraulic pressure in feed motor or cylinder	MPa

Symbol	Name	Unit
p_{CR}	measured hydraulic pressure in torque motor	MPa
p_{CRO}	unloaded torque motor pressure	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	raw down-thrust (or feed thrust) applied on drilling tool	MPa
p_{HC}	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/min
Q_O	measured borehole drilling fluid outflow	l/min
R_{SR}	calculated soil-rock resistance	MPa m ⁻¹ s ⁻¹
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	r/min
W_H	weight of rotary head	kN
W_R	weight of drill rod	kN
Z	measured depth	m
r_w	measured ground water table depth	m

5 Equipment

5.1 General

Drilling parameters can be considered as being in one of three categories.

- Parameters imposed by the method (type of drilling tool and diameter, nature of the fluid medium, limits of machine performance and injection system) and unmanaged scalable parameters (tools wear, changes in the composition of the fluid).
- Parameters set by the operator (p_O down-thrust, v_R drill head rotational speed, Q_I flushing medium circulation rate in the case of an incompressible or water based drilling fluid, p_I injection pressure in the case of a compressible air based fluid),
- Parameters depending on the response of the ground (v_A penetration rate, C_R torque, p_I injection pressure in the case of an incompressible or water based fluid, Q_I flushing medium circulation rate in the case of a compressible air-based fluid),

These parameters may be measured directly or calculated using calibration relations. Further compound parameters may be derived by combining a number of drilling parameters (see A.2.)