SLOVENSKI STANDARD
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Geotehnično preiskovanje in preskušanje - Geotehnične meritve - 2. del: Meritve pomikov vzdolž merilne linije: ekstenzometer (ISO 18674-2:2016)

Geotechnical investigation and testing - Geotechnical monitoring by field instrumentation - Part 2: Measurement of displacements along a line: Extensometers (ISO 18674-2:2016)

Geotechnische Erkundung und Untersuchung - Geotechnische Messungen - Teil 2: Verschiebungsmessungen entlang einer Messlinie: Extensometer (ISO 18674-2:2016)

Reconnaissance et essais géotechniques - Mesures géotechniques - Partie 2: Mesure de déplacement le long d'une ligne par extensomètre (ISO 18674-2:2016)

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Geotechnische Erkundung und Untersuchung - Geotechnische Messungen - Teil 2: Verschiebungsmessungen entlang einer Messlinie: Extensometer (ISO 18674-2:2016)

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European foreword

This document (EN ISO 18674-2:2016) has been prepared by Technical Committee ISO/TC 182 “Geotechnics” in collaboration with Technical Committee CEN/TC 341 “Geotechnical Investigation and Testing” the secretariat of which is held by BSI.

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Geotechnical investigation and testing — Geotechnical monitoring by field instrumentation —

Part 2: Measurement of displacements along a line: Extensometers

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Partie 2: Mesure de déplacement le long d'une ligne par extensomètre

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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).

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The committee responsible for this document is ISO/TC 182, *Geotechnics*.

A list of all part in the ISO 18674 series, published under the general title *Geotechnical investigation and testing – Geotechnical monitoring by field instrumentation*, can be found on the ISO website.

Geotechnical investigation and testing — Geotechnical monitoring by field instrumentation —

Part 2: Measurement of displacements along a line: Extensometers

1 Scope

This document specifies the measurement of displacements along a line by means of extensometers carried out for geotechnical monitoring. General rules of performance monitoring of the ground, of structures interacting with the ground, of geotechnical fills and of geotechnical works are presented in ISO 18674-1.

If applied in conjunction with ISO 18674-3, this document allows the determination of displacements acting in any direction.

This document is applicable to:

— monitoring the behaviour of soils, fills and rocks;

— checking geotechnical designs in connection with the Observational Design procedure;

— deriving geotechnical key parameters (e.g. from results of pile load tests or trial tunnelling);

— evaluating stability ahead of, during or after construction (e.g. stability of natural slopes, slope cuts, embankments, excavation walls, foundations, dams, refuse dumps, tunnels).

NOTE This document fulfils the requirements for the performance monitoring of the ground, of structures interacting with the ground and of geotechnical works by the means of extensometers as part of the geotechnical investigation and testing in accordance with References [5] and [6].

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 18674-1:2015, *Geotechnical investigation and testing — Geotechnical monitoring by field instrumentation — Part 1: General rules*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 18674-1 and the following apply.

3.1
extensometer <geotechnical>
field instrument for monitoring changes of distance between two or more measuring points located along a measuring line

Note 1 to entry: Monitoring of such changes allows the determination of displacements of measuring points acting in the direction of the measuring line.

Note 2 to entry: At a measuring point, the movements of the medium (e.g. soil, rock, concrete and steel structures) being investigated are transferred to the measuring point by devices such as anchors, rings or bolts (see 5.1.6).

Note 3 to entry: In the ground, the measuring points are typically installed in boreholes. The measuring line then coincides with the axis of the borehole.

3.2
in-place extensometer
permanently installed extensometer, essentially consisting of anchor(s), connecting element(s) and at least one measuring head

Note 1 to entry: Each connecting element is affixed to an anchor and free to move along the measuring line.

Note 2 to entry: Measuring heads are commonly located at one end of the measuring line. When carrying out the measurements, they function as reference measuring points.

Note 3 to entry: For in-place extensometers in boreholes, see Reference [7].

Note 4 to entry: See Figure 1.

3.3
rod extensometer
in-place extensometer where the connecting element is a rod

Note 1 to entry: Common rod materials are steel or fibreglass.

Note 2 to entry: See Figure 1 a).

3.4
wire extensometer
in-place extensometer where the connecting element is a wire

Note 1 to entry: See Figure 1 b).

3.5
single extensometer
in-place extensometer with one anchor only

Note 1 to entry: See Figure 1 b).

3.6
multiple-point extensometer
in-place extensometer with more than one anchor

Note 1 to entry: Up to six anchor points are common in geo-engineering practice.

Note 2 to entry: See Figure 1 a).

3.7
chain extensometer
in-place extensometer formed of a series of single extensometer elements

Note 1 to entry: See Figure 1 c).

3.8
probe extensometer
extensometer where the connecting element is a moveable unit

Note 1 to entry: Probe extensometers can be developed as *single-point probe extensometer* (3.9) or *double-point probe extensometer* (3.10).

Note 2 to entry: See Figure 2.

3.9
single-point probe extensometer
extensometer, essentially consisting of a measuring probe and a guiding tube with measuring marks and in which, at the measuring position, only one measuring mark interacts with the probe

Note 1 to entry: The connecting element is the unit consisting of a measuring cable and a probe. The measured value is the distance between the measuring mark and the reference mark at the head of the guiding tube.

Note 2 to entry: Because of its design, function and usual geotechnical application, the single-point probe extensometer is commonly designated as a "magnetic extensometer," a "magnet settlement probe" or an "inductance probe."

Note 3 to entry: See Figure 2 a).

3.10
double-point probe extensometer
extensometer, essentially consisting of a measuring probe and a guiding tube with measuring marks and in which, at the measuring position, two measuring marks interact with the probe

Note 1 to entry: The connecting element is the measuring probe. The measured value is the distance between the two measuring marks which are in interaction with the probe.

Note 2 to entry: Because of its design and function, the double-point probe extensometer is commonly designated as an "incremental extensometer" or a "sliding micrometer."

Note 3 to entry: See Figure 2 b).

3.11
gauge length
L
nominal distance between the contact points of the double-point extensometer probe

Note 1 to entry: *L* is commonly 1,0 m.

Note 2 to entry: *L* is commonly verified in a calibration of the probe prior to the measurement.

3.12
tape extensometer
extensometer for distance measurements between two accessible measuring points by means of a measuring tape, essentially consisting of a device for tensioning of the tape with a reproducible pulling force, two end pieces for connecting the device to *bolts* (3.13) and of a read-out unit

Note 1 to entry: Traditionally, tape extensometers were used in tunnelling. By means of follow-up measurements, the change of the distances of two tunnel wall measuring points (in tunnelling, termed "convergence") is determined. For this reason, tape extensometers are commonly designated as "convergence tapes."

Note 2 to entry: See Figure 3.

3.13
convergence bolts
measuring bolts fitting to the type of tape extensometer used

4 Symbols

Symbol	Name	Unit
d	depth of borehole	m
d_i	distance between measuring point i and measuring head	m
F	subscript for follow-up measurement	—
h	height of measuring head above sea level	m
i	number of a measuring point	—

Symbol	Name	Unit
K_T	temperature correction term	—
L	gauge length of a double-point probe extensometer	m
L_i	length of the connecting element between measuring head and measuring point *i*	m
l	distance between measuring points	m
l_M	length of a measuring ring for probe extensometer	m
n	total number of measuring points along a measuring line	—
P	pulling force of wire extensometer	kN
R	subscript for reference measurement	—
s	displacement reading	m
T	temperature	°C
t	elapsed time	s
u, v, w	displacement component in x-, y-, z-direction, respectively	m
$w_{i\,rel}$	displacement component of measuring point *i* in z-direction relative to the measuring head	m
w_0	absolute displacement component of the measuring head in z-direction	m
w_i	absolute displacement component of measuring point *i* in z-direction	m
Δw_i	relative displacement between adjacent measuring points *i and i*-1 in z-direction	m
x, y, z	local coordinates of measuring points on a guide tube or in a borehole	m
α_T	coefficient of linear thermal expansion	K^{-1}
ε_z	strain in direction of the z coordinate	—

5 Instruments

5.1 General

5.1.1 The following types of extensometer in-place, probe and tape should be distinguished from each other (see Table 1 and Figures 1 to 3).

Table 1 — Extensometer types

Extensometer			Feature	Automatic data acquisition
No.	Type	Subtype		
1	in-place (see 5.2)	Single-point/multiple-point in-place extensometer rod/wire extensometer	all instrument components are permanently installed in the ground or at accessible surfaces	possible
2	probe (see 5.3)	single-point/double-point probe extensometer	measuring unit sequentially moved into measuring positions	not common
3	tape (see 5.4)	steel/wire tape extensometer		

5.1.2 Changes of the distances between measuring points shall be monitored by comparison of the measured values with those of the reference measurement. Displacements of the measuring points along the measuring line shall be deduced in accordance with Annex A.

5.1.3 An increase of the distance between two measuring points (=extension) shall be assigned a positive value.

5.1.4 The point onto which the extensometer measurements are related shall be denoted the "reference point."

5.1.5 For absolute measurements, the coordinates of the reference point shall be independently determined or assumed and verified as fixed.

NOTE If the reference point is assumed to be at the deepest anchor, surveying of the measuring head can serve as a check.

5.1.6 Extensometer measuring points shall be marked by devices such as anchors, rings or bolts. The measuring points of these devices shall be specified as follows:

— for anchors, the centre of an anchor;

— for rings, the centre of a ring;

— for bolts, the centre of a contact butt (for screwed couplings) or the centre of an eye (for eye/hook couplings).

5.1.7 It shall be secured that the device, marking a measuring point, is set in such a way that it is solidly connected to the medium so that any movement of the medium at the measuring point is fully transferred to the device.

5.1.8 Instruments shall not significantly affect the conditions of the medium under investigation and, in turn, shall not be significantly affected in their functionality by the medium (in accordance with ISO 18674-1:2015, 5.1 and 5.2).