SLOVENSKI STANDARD
oSIST prEN ISO 18674-2:2015

01-september-2015

Geotehnično preiskovanje in preskušanje - Geotehnične meritve - 2. del: Meritve iztisnin vzdolž merilne linije: ekstenzometer (ISO/DIS 18674-2:2015)

Geotechnical investigation and testing - Geotechnical monitoring by field instrumentation - Part 2: Measurement of displacements along a line: Extensometers (ISO/DIS 18674-2:2015)

Geotechnische Erkundungen und Untersuchungen - Geotechnische Messungen - Teil 2: Verschiebungsmessungen entlang einer Messlinie: Extensometer (ISO/DIS 18674-2:2015)

Reconnaissance et essais géotechniques - Mesures géotechniques - Partie 2: Mesure de déplacement le long d'une ligne par extensomètre (ISO/DIS 18674-2:2015)

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ICS:

13.080.20	Fizikalne lastnosti tal	Physical properties of soils
17.040.30	Merila	Measuring instruments
93.020	Zemeljska dela. Izkopavanja. Gradnja temeljev. Dela pod zemljo	Earthworks. Excavations. Foundation construction. Underground works

oSIST prEN ISO 18674-2:2015 **en**

DRAFT INTERNATIONAL STANDARD

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Geotechnical investigation and testing — Geotechnical monitoring by field instrumentation —

Part 2: Measurement of displacements along a line: Extensometers

Reconnaissance et essais géotechniques – Mesures géotechniques —

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

ICS: 13.080.20; 93.020

ISO/CEN PARALLEL PROCESSING

This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO 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.

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Foreword

This document (TC 341 WI 0034xxxxx) has been prepared by Technical Committee CEN/TC 341 “Geotechnical investigation and testing”, the secretariat of which is held by BSI.

This document is a working document.

EN ISO 22474-2 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).

EN ISO 18674 consists of the following parts, under the general title *Geotechnical investigation and testing – Geotechnical monitoring by field instrumentation:*

- *Part 1: General rules*
- *Part 2: Displacement measurements along a line: Extensometer*
- *Part 3: Displacement measurements across a line: inclinometers and deflectormeter*
- *Part 4: Piezometers*
- *Part 5: Total pressure cells*
- *Part 6: Hydraulic settlement gauges*
- *Part 7: Strain gauges*
- *Part 8: Load cells*
- *Part 9: Geodetic monitoring instruments*
- *Part 10: Vibration monitoring instruments*

NOTE Parts 3 – 10 are currently in preparation

1 Scope

This Standard applies to the measurement of displacements along a line by means of extensometers carried out for geotechnical monitoring. It is to be applied in conjunction with EN ISO 22474-1.

Specifically, this Standard applies to

- investigating soils and rocks;
- checking geotechnical design values in connection with the Observational Design method;
- deriving geotechnical design values (e.g. pile load test; trial tunnelling);
- evaluating stability ahead of, during or after construction (e.g. natural slopes, slope cuts, embankments, excavation walls, foundations, dams, refuse dumps, tunnels).

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 ISO 22474-1, *Geotechnical investigation and testing – Geotechnical monitoring by field instrumentation – Part 1: General rules*

EN ISO 22474-3, *Geotechnical investigation and testing – Geotechnical monitoring by field instrumentation – Part 3: Displacement measurements across a line: Inclinometers and deflectometers*

NOTE Further parts on piezometers, total pressure cells, hydro-static settlement gauges, strain gauges, load cells, geodetic monitoring instruments and vibration monitoring instruments are in preparation.

ISO 22475-1, *Geotechnical investigation and testing – Sampling by drilling and excavation methods and groundwater measurements – Part 1: Technical principles for execution*

3 Terms and symbols

3.1 Terms

For the purpose of this document the terms and definitions of EN ISO 22474-1 apply, as well as the following terms and definitions:

3.1.1
extensometer
field instrument for monitoring changes of distance between two or more measuring points located along a measuring line.

NOTE 1 Monitoring of such changes allows the determination of displacements of measuring points acting in the direction of the measuring line.

NOTE 2 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 4.1.6).

NOTE 3 In the ground the measuring points are typically installed in boreholes. The measuring line then coincides with the axis of the borehole.

3.1.2
in-place extensometer (see Figure 1))
permanently installed extensometer, essentially consisting of anchor(s), connecting element(s) and at least one measuring head.

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

NOTE 2 Measuring heads are commonly located at one end of the measuring line. When carrying out the measurements they function as reference measuring points.

3.1.2.1
rod extensometer (see Figure 1a))
in-place extensometer where the connecting element is a rod

NOTE Common rod materials are steel or fiberglass.

3.1.2.2
wire extensometer (see Figure 1b))
in-place extensometer where the connecting element is a wire

3.1.2.3
single extensometer (see Figure 1b))
in-place extensometer with one anchor only

3.1.2.4
multiple-point extensometer (see Figure 1a))
in-place extensometer with more than one anchor

NOTE Up to six anchor points are common in geo-engineering practice.

3.1.2.5
chain extensometer (see Figure 1c))
in-place extensometer formed of a series of single extensometer elements

3.1.3
probe extensometer (see Figure 2))
extensometer where the connecting element is a moveable unit.

NOTE Probe extensometers can be developed as single-point (see 3.1.3.1) or double-point probe extensometers (see 3.1.3.2).

3.1.3.1
single-point probe extensometer (see Figure 2a))
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 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 Because of its design, function and usual geotechnical application, the single-point probe extensometer is commonly designated as a “magnetic extensometer” or a “magnet settlement probe”.

3.1.3.2
double-point probe extensometer (see Figure 2b))
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 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 Because of its design and function, the double-point probe extensometer is commonly designated as an “incremental extensometer” or a “sliding micrometer”.

3.1.3.3
measuring base
L
spacing of the two measuring units which are part of the double-point extensometer probe and which are interacting with the corresponding measuring marks.

NOTE *L* is commonly 1.0 m

3.1.4
tape extensometer (see Figure 3))
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 (see 3.1.4.1) and of a readout unit.

NOTE 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”.

3.1.4.1
convergence bolts
measuring bolts fitting to the type of tape extensometer used.

3.2 Symbols

For the purpose of this document, the symbols of Table 1 apply.

Table 1 — Symbols

Symbol	Name	Unit
d	depth of borehole	m
d_i	distance of measuring point i from measuring head	m
F	subscript for follow-up measurement	-
H	height of measuring head above sea level	m
i	number of a measuring point	-
K_T	temperature correction term	-
L	measuring base 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 double-point 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	K
t	elapsed time	s
u, v, w	displacement component in x-, y-, z-direction, respectively	m
w_0	absolute displacement component of the measuring head in z-direction	m
$w_{i\ rel}$	relative displacement component of a measuring point i in z-direction	m
$\Delta w_{i,\ i-1}$	relative displacement between two measuring points	m
x, y, z	local co-ordinates 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 co-ordinate	-

NOTE Symbols with more than one meaning (e.g. d, L) are distinguishable in the context of their use

4 Instruments

4.1 General

4.1.1 It should be distinguished between the following types of extensometer: in-place, probe and tape (see Table 2 and Figures 1 to 3).

Table 2 — Extensometer types

Extensometer			Feature	Automatic data acquisition
No.	Type	Sub-type		
1	in-place (see 4.2)	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 4.3)	single-point / double-point probe extensometer	measuring unit sequentially moved into measuring positions	not common
3	tape (see 4.4)	steel / wire tape extensometer		

4.1.2 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.

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

4.1.4 The point onto which the extensometer measurements are related shall be denoted “reference point”.

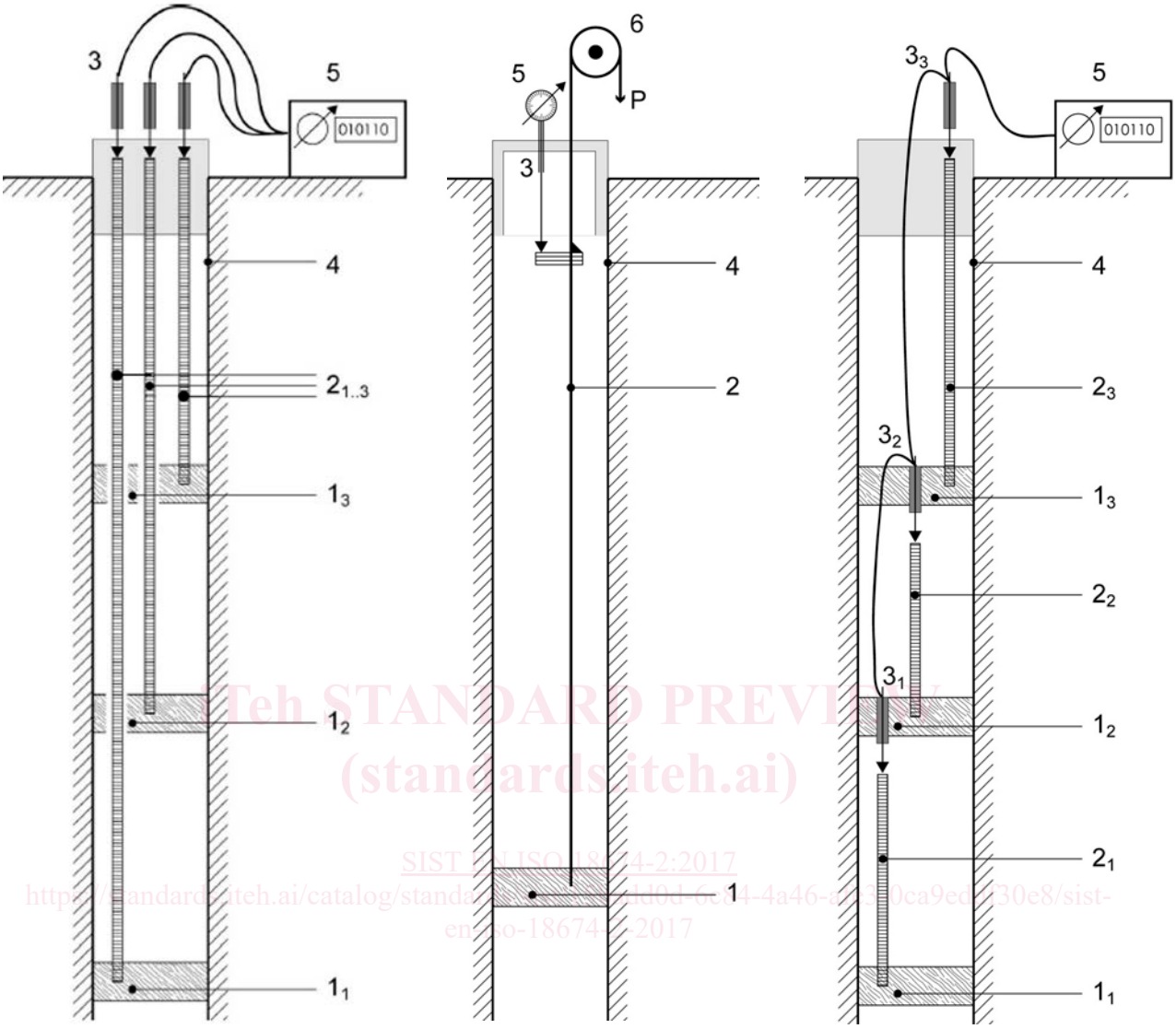
4.1.5 For absolute measurements the co-ordinates of the reference point shall be independently determined or assumed and verified as fixed.

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

4.1.6 Extensometer measuring points shall be marked by devices such as anchors, rings or bolts. The measuring points of these devices shall be defined 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).

4.1.7 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.

4.1.8 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 (see EN ISO 22474-1, Sections 5.1 and 5.2).



a) Rod extensometer

Key

$1_{1..3}$ anchors 1 to 3
$2_{1..3}$ connecting elements 1 to 3
3 measuring head
4 borehole wall
5 read-out device

EXAMPLE Triple-point rod extensometer with electrical displacement transducers

b) Wire extensometer

Key

1 anchor
2 connecting element (wire)
3 measuring head
4 borehole wall
5 read-out device
6 pulling device
P tension force

EXAMPLE Single-point wire extensometer with dial gauge read-out

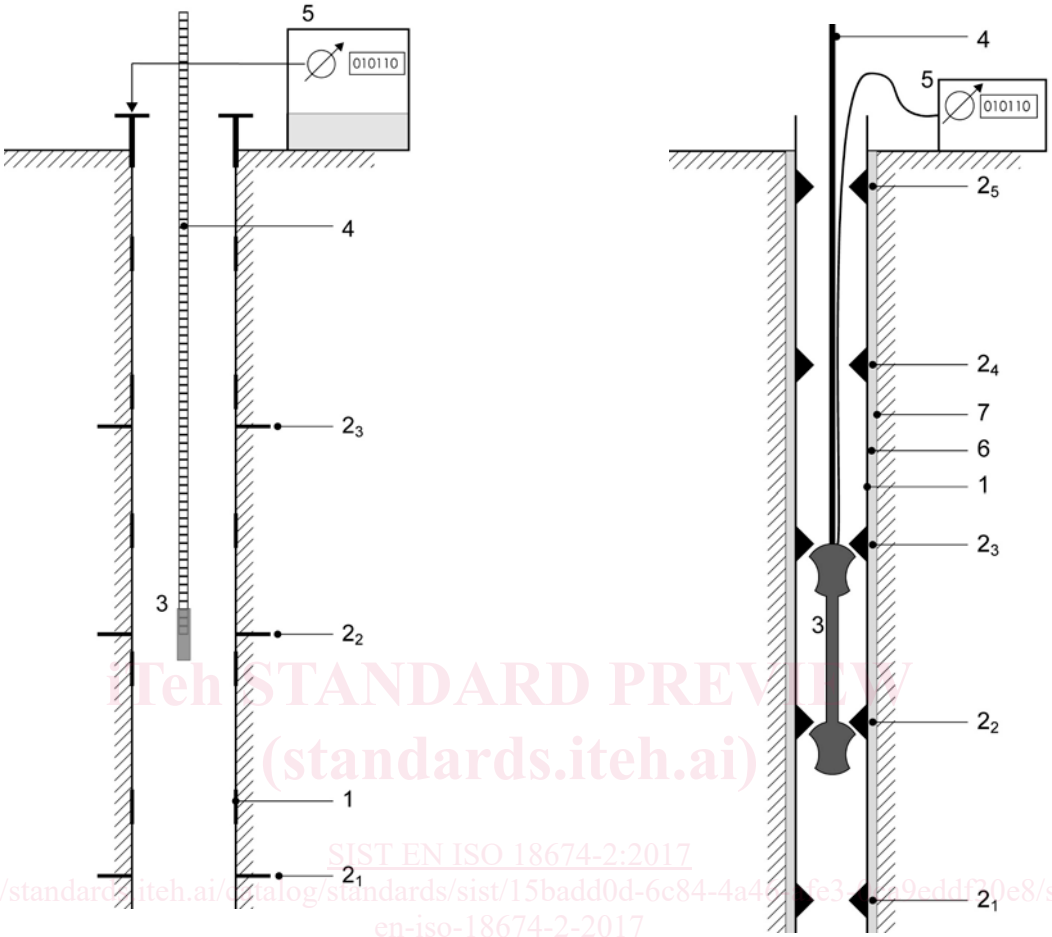
c) Chain extensometer

Key

$1_{1..3}$ anchors 1 to 3
$2_{1..3}$ connecting elements 1 to 3
$3_{1..3}$ local measuring heads 1 to 3
4 borehole wall
5 read-out device (signal receiver)

EXAMPLE Triple-point chain extensometer with electrical displacement transducers

Figure 1 – Examples of in-place extensometer types



a) Single-point probe extensometer

Key

1	measuring tube
$2_{1...3}$	anchor plates 1 to 3 (with external measuring rings)
3	probe (in measuring position with anchor Plate No. 2)
4	measuring tape
5	measuring head with reference mark

EXAMPLE Magnetic probe extensometer in telescopic tubing

b) Double-point probe extensometer

Key

1	measuring tube
$2_{0...4}$	measuring rings 0 to 4
3	probe (in measuring position with rings No. 2 and 3)
4	setting rods (or pulling rope)
5	readout unit
6	backfill
7	borehole wall

Figure 2 – Examples of probe extensometer types