SLOVENSKI STANDARD
SIST EN ISO 18674-4:2020

01-september-2020

Geotehnično preiskovanje in preskušanje - Geotehnične meritve - 4. del: Meritve tlaka porne vode: piezometri (ISO 18674-4:2020)

Geotechnical investigation and testing - Geotechnical monitoring by field instrumentation - Part 4: Measurement of pore water pressure: Piezometers (ISO 18674-4:2020)

Geotechnische Erkundung und Untersuchung - Geotechnische Messungen - Teil 4: Porenwasserdruckmessungen: Piezometer (ISO 18674-4:2020)

Reconnaissance et essais géotechniques - Surveillance géotechnique par instrumentation in situ - Partie 4: Mesure de la pression interstitiell (ISO 18674-4:2020)

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ICS:

13.080.05	Preiskava tal na splošno	Examination of soils in general
17.100	Merjenje sile, teže in tlaka	Measurement of force, weight and pressure
93.020	Zemeljska dela. Izkopavanja. Gradnja temeljev. Dela pod zemljo	Earthworks. Excavations. Foundation construction. Underground works

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Geotechnical investigation and testing - Geotechnical monitoring by field instrumentation - Part 4: Measurement of pore water pressure: Piezometers (ISO 18674-4:2020)

Reconnaissance et essais géotechniques - Surveillance géotechnique par instrumentation in situ - Partie 4: Mesure de la pression interstitiell (ISO 18674-4:2020)

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European foreword

This document (EN ISO 18674-4:2020) 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.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2021, and conflicting national standards shall be withdrawn at the latest by January 2021.

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Geotechnical investigation and testing — Geotechnical monitoring by field instrumentation —

Part 4: Measurement of pore water pressure: Piezometers

Reconnaissance et essais géotechniques — Surveillance géotechnique par instrumentation in situ —

Partie 4: Mesure de la pression interstitielle: Piézomètres

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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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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).

A list of all parts in the ISO 18674 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.

Geotechnical investigation and testing — Geotechnical monitoring by field instrumentation —

Part 4:
Measurement of pore water pressure: Piezometers

IMPORTANT — The electronic file of this document contains colours which are considered to be useful for the correct understanding of the document. Users should therefore consider printing this document using a colour printer.

1 Scope

This document specifies the measurement of pore water pressures and piezometric levels in saturated ground by means of piezometers installed 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 18674-5, the procedures described in this document allow the determination of effective stresses acting in the ground.

This document is applicable to:

— monitoring of water pressures acting on and in geotechnical structures (e.g. quay walls, dikes, excavation walls, foundations, dams, tunnels, slopes, embankments, etc.);

— monitoring of consolidation processes of soil and fill (e.g. beneath foundations and in embankments);

— evaluating stability and serviceability of geotechnical structures;

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

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 piezometers, installed as part of the geotechnical investigation and testing in accordance with References [4] and [5] This document relates to measuring devices, which are installed in the ground. For pore water pressure measurements carried out in connection with cone penetration tests, see ISO 22476-1.

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

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 definitions

For the purposes of this document, the terms and definitions given in ISO 18674-1 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
piezometer
field instrument system for measuring *pore water pressure* (3.2) or *piezometric level* (3.4) where the *measuring point* (3.15) is confined within the ground or geotechnical fill so that the measurement responds to the fluid pressure around the measuring zone/point and not to fluid pressures at other elevations

Note 1 to entry: The system consists of a sealed *reservoir* (3.1.2) filled with fluid, a *filter* (3.1.3) and a *measuring device* (3.1.7).

Note 2 to entry: The system is either an *open piezometer system* (3.6) or a *closed piezometer system* (3.7).

3.1.1
intake zone
zone confined by *seals* (3.1.6), between which water in the ground can flow to the measuring device, thus defining the *measuring point* (3.15)

Note 1 to entry: See Figure 1.

Note 2 to entry: It is assumed that a hydrostatic *pore water pressure* (3.2) distribution is established along the intake zone.

Note 3 to entry: The constant of proportionality between flow into or out of a *piezometer* (3.1) and the change of pore water pressure is called the intake factor *F*.

3.1.2
reservoir
space between the ground and the *measuring device* (3.1.7), occupied by a fluid, which allows the *pore water pressure* (3.2) to act on the sensing element of the measuring device

Note 1 to entry: The pores within the *filter* (3.1.3) are an integral part of the reservoir.

Note 2 to entry: In *open piezometer systems* (3.6), the water-filled part of the standpipe is part of the reservoir.

3.1.3
filter
permeable section of a *piezometer* (3.1) defining the *intake zone* (3.1.1), which allows water to enter and at the same time restricts soil particles entering the standpipe or *measuring device* (3.1.7)

Note 1 to entry: The filter can be a combination of elements, such as a sand pocket, a perforated pipe, a geotextile sleeve, a filter tip (3.1.4) and grout backfill in specific cases.

3.1.4
filter tip
filter (3.1.3) element which is a common part of a *closed piezometer system* (3.7)

Note 1 to entry: Filter tips are formed of a material with purpose-designed pore diameters, i.e. *HAE filter* (3.1.4.1) or *LAE filter* (3.1.4.2).

3.1.4.1
high air entry filter
HAE filter
filter tip (3.1.4) with comparatively small pores giving a higher resistance to the passage of air than to the passage of water

Note 1 to entry: Commonly, high air entry filter tips have pore diameters of between 1 µm and 3 µm.

Note 2 to entry: HAE filter tips are used when it is intended to keep gas out of the *measuring device* (3.1.7).

Note 3 to entry: In unsaturated soil or when negative *pore water pressures* (3.2) are to be measured (i.e. suction; see Annex F), the pressure of the gaseous phase is always higher than that of the pore water. The required pore diameter of the HAE filter tip depends on the difference between the pore air pressure and the pore water pressure.

3.1.4.2
low air entry filter
LAE filter
filter tip (3.1.4) with comparatively large pores giving a lower resistance to the passage of air readily allowing the passage of both air and water

Note 1 to entry: Commonly, low air entry filter tips have pore diameters of between 20 µm and 50 µm.

3.1.5
filter pack
permeable material, placed around a slotted section of an open *piezometer* (3.1) or around the *filter tip* (3.1.4), allowing water to reach the *measuring device* (3.1.7)

3.1.6
seal
layer in a borehole, made with a material that has a permeability suitable for hydraulical separation of two *aquifers* (3.10)

Note 1 to entry: Seals are generally used to confine an *intake zone* (3.1.1).

3.1.7
measuring device
part of the *piezometer* (3.1) system used to measure the *piezometric level* (3.4) in an *open system* (3.6) or the *pore water pressure* (3.2) in a *closed system* (3.7)

Note 1 to entry: For an *open piezometer system* (3.6), the measuring device is commonly a *water level meter* (3.1.7.1) for manual measurements or a pressure transducer for automatic measurements.

Note 2 to entry: For a *closed piezometer system* (3.7), the measuring device is typically a diaphragm pressure transducer (see 7b in Figure 1 b)). The diaphragm separates a *reservoir* (3.1.2) and an inner chamber in the transducer. The deflection of the diaphragm is a function of the *pore water pressure* (3.2) (see Figure 3).

Note 3 to entry: For closed piezometer systems, the measuring device is often synonymously termed a piezometer in a narrow sense.

3.1.7.1
water level meter
measuring device with a marked length measuring tape and a tip that activates a signal (light, sound) when it comes into contact with water

Note 1 to entry: A water level meter is commonly used for manual measurements in *open systems* (3.6) or during the installation procedure of *piezometers* (3.1).

3.1.7.2
electric piezometer
piezometer (3.1) where the *measuring device* (3.1.7) has a diaphragm and the deflection of the diaphragm due to *pore water pressure* (3.2) is measured by an electric sensor

Note 1 to entry: Electric piezometers are commonly based on strain gauge, piezo-electric, vibrating wire or capacitive sensors. Data acquisition devices exist which accommodate all types of electric piezometers.

Note 2 to entry: See Figure 3.

3.1.7.3
fibre optic piezometer
piezometer (3.1) where the pressure *measuring device* (3.1.7) has a diaphragm and the deflection of the diaphragm is measured by an optical sensor

Note 1 to entry: Fibre optic piezometers do not require electrical connection between read-out unit and sensor.

Note 2 to entry: Fibre optic piezometers require a dedicated read-out unit.

3.1.7.4
pneumatic piezometer
piezometer (3.1) where the pressure *measuring device* (3.1.7) has a valve which is opened pneumatically by a gas pressure, which is applied from the outside via gas-filled tubes and closed by the *pore water pressure* (3.2)

Note 1 to entry: See Figure 4.

3.2
pore water pressure
u
pressure of the water in the voids of the ground or a fill, relative to the atmospheric pressure

Note 1 to entry: The pore water pressure is the difference between the total stress and the effective stress in saturated ground (see References [6] and [7]).

Note 2 to entry: For rocks, the associated term is joint water pressure.

Note 3 to entry: The state of soil or fill where the pores are completely filled with water is referred to as "saturated".

Note 4 to entry: Pore water pressure measurements can yield positive or negative values (see Reference [8] and Annex F). Instruments that directly measure negative pore pressures are sometimes termed 'tensiometers', but are not within the scope of this document (see ISO 11276).

Note 5 to entry: Measurements of the pore water pressure can be affected by changes of the atmospheric pressure (see 5.4.1 and Annex A).

3.3
pressure head
ψ
ratio u/γ_w of the *pore water pressure* u (3.2) and the specific weight of water γ_w, above a point

Note 1 to entry: For an *open piezometer system* (3.6), it is proportional to the elevation difference between the *piezometric level* (3.4) and the level of the *measuring point* (3.15) (see Figure 1).

3.4
piezometric level
z_w
elevation to which water will rise in an *open standpipe piezometer* (3.6.1) and at which the pressure of the water in the ground is equal to that of the ambient atmosphere

Note 1 to entry: The piezometric level z_w is the sum of the geometric elevation z and the *pressure head* ψ (3.3): $z_w = z + u/\gamma_w$.

Note 2 to entry: See Figure 1.

3.5
groundwater table
water table
elevation at which *pore water pressure* u (3.2) is zero

Note 1 to entry: See Figure 1.

Note 2 to entry: An equivalent term is phreatic surface.

Note 3 to entry: The groundwater level is the level of the groundwater table at a geographical coordinate.

3.6
open system
open piezometer system
field instrument system in which the fluid is in direct contact with the atmosphere and the *piezometric level* (3.4) at the *measuring point* (3.15) is measured

3.6.1
open standpipe piezometer
open piezometer system (3.6), consisting of a pipe (installed in the ground) which, at its upper end, is open to the atmosphere and with a perforated section, located in the *intake zone* (3.1.1)

Note 1 to entry: See Figure 1 a).

Note 2 to entry: Typical inner diameters of the pipe are from 19 mm to 60 mm.

3.6.2
Casagrande piezometer
open standpipe piezometer (3.6.1) with one or two comparatively small inner diameter pipes and a porous *filter tip* (3.1.4) at the *measuring point* (3.15)

Note 1 to entry: See 5.2.2.4, Figure 2 and Reference [9].

3.6.3
monitoring well
open standpipe piezometer (3.6.1) with a large inner diameter of the pipe (typically ≥100 mm)

Note 1 to entry: A monitoring well can be used as standpipe *piezometer* (3.1), if the *response time* (3.9) is satisfactory (see Annex D).

Note 2 to entry: A monitoring well is often used for taking samples of the groundwater or for performing pumping tests.

3.6.4
observation well
open pipe within a borehole, where the *intake zone* (3.1.1) is unconfined

Note 1 to entry: Observation wells are often incorrectly termed *open standpipe piezometers* (3.6.1). Observation wells do not classify as *piezometers* (3.1) as they do not have *seals* (3.1.6).

Note 2 to entry: See 5.2.2.3.2.

3.7
closed system
closed piezometer system
measuring system in which the *reservoir* (3.1.2) is not in direct contact with the atmosphere and in which the pressure in the fluid is measured by a pressure *measuring device* (3.1.7)

Note 1 to entry: See Figure 1 b).

Note 2 to entry: Examples for pressure measuring devices, used in closed systems, are electric transducers, fibre optic transducers and pressure valves.

3.7.1
diaphragm piezometer
closed system (3.7) with a *filter tip* (3.1.4), a small *reservoir* (3.1.2) and diaphragm which separates the pore water from the measuring system

Note 1 to entry: The deflection of the diaphragm is measured and the signal is transported through a cable to an accessible location.