SLOVENSKI STANDARD
SIST EN ISO 11276:2014

01-maj-2014

Kakovost tal - Določanje tlaka vode v porah - Tenziometrijska metoda (ISO 11276:1995)

Soil quality - Determination of pore water pressure - Tensiometer method (ISO 11276:1995)

Bodenbeschaffenheit - Bestimmung des Porenwasserdrucks - Tensiometerverfahren (ISO 11276:1995)

Qualité du sol - Détermination de la pression d'eau dans les pores - Méthode du tensiomètre (ISO 11276:1995)

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Soil quality - Determination of pore water pressure - Tensiometer method (ISO 11276:1995)

Qualité du sol - Détermination de la pression d'eau dans les pores - Méthode du tensiomètre (ISO 11276:1995)

Bodenbeschaffenheit - Bestimmung des Porenwasserdrucks - Tensiometerverfahren (ISO 11276:1995)

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Foreword

The text of ISO 11276:1995 has been prepared by Technical Committee ISO/TC 190 “Soil quality” of the International Organization for Standardization (ISO) and has been taken over as EN ISO 11276:2014 by Technical Committee CEN/TC 345 “Characterization of soils” the secretariat of which is held by NEN.

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of an identical text or by endorsement, at the latest by September 2014, and conflicting national standards shall be withdrawn at the latest by September 2014.

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Endorsement notice

The text of ISO 11276:1995 has been approved by CEN as EN ISO 11276:2014 without any modification.

INTERNATIONAL STANDARD

ISO 11276

First edition
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Soil quality — Determination of pore water pressure — Tensiometer method

Qualité du sol — Détermination de la pression d'eau dans les pores — Méthode du tensiomètre

Reference number
ISO 11276:1995(E)

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.

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.

International Standard ISO 11276 was prepared by Technical Committee ISO/TC 190, *Soil quality*, Subcommittee SC 5, *Physical methods*.

Annex A forms an integral part of this International Standard. Annexes B, C, D, E and F are for information only.

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Soil quality — Determination of pore water pressure — Tensiometer method

1 Scope

This International Standard specifies methods for the determination of pore water pressure in both unsaturated and saturated soil using tensiometers. The methods are applicable for *in situ* pore water pressure measurements in the field, as well as for monitoring pore water pressure in, for example, plant containers or soil cores used in experimental procedures.

At normal atmospheric pressures, i.e. about 100 kPa, the application of these methods is limited to a range of pressures down to about − 85 kPa. The range is reduced at lower atmospheric pressures. Tensiometers will not function if sub-zero temperatures occur at the measurement depth. Their accuracy is influenced by soil and air temperature fluctuations. Tensiometer response time ranges from a few seconds to several days. To obtain reliable measurements under field conditions, tensiometers require frequent servicing.

A tensiometer provides point measurements of pore water pressure. To measure pore water pressure at different depths, several tensiometers will be necessary. In the field, replicate sets of instruments will be required if the spatial variability of the soil is to be allowed for.

2 Definitions

For the purposes of this International Standard, the following definitions apply.

NOTE 1 Additional definitions are given in E.2, for information only.

2.1 pore water pressure: The sum of matric and pneumatic pressures.

NOTES

2 Pore water pressure is also referred to as tensiometer pressure.

3 The pore water pressure represents the sum of the pressures due to interfacial forces acting between the water, air and solid phases of the soil (matric pressure), the part of the mass of overlying material not carried by the soil skeleton and therefore carried by the soil water (overburden pressure; this pressure is often considered as part of the matric pressure) and the local air pressure within the soil (pneumatic pressure). Under most circumstances, the overburden and pneumatic pressures are zero.

2.2 matric pressure: The amount of work that must be done in order to transport reversibly and isothermally an infinitesimal quantity of water, identical in composition to the soil water, from a pool at the elevation and the external gas pressure of the point under consideration, to the soil water at the point under consideration, divided by the volume of water transported.

2.3 pneumatic pressure: The amount of work that must be done in order to transport reversibly and isothermally an infinitesimal quantity of water, identical in composition to the soil water, from a pool at atmospheric pressure and at the elevation of the point under consideration, to a similar pool at an external gas pressure of the point under consideration, divided by the volume of water transported.

NOTE 4 Soil water pressure can be considered as a pressure equivalent of soil water potential. The same applies to the soil water head, the head equivalent of soil water potential.

The relationship between these is

$$\Psi \cdot \rho_w = p - h \cdot g \cdot \rho_w$$

where

Ψ is the soil water potential, in joules per kilogram on a mass basis;

p is the pressure equivalent of soil water potential, in joules per cubic metre on a volume basis $\left(1\ \mathrm{J/m^3} = 1\ \mathrm{N/m^2} = 1\ \mathrm{Pa}\right)$;

h is the head equivalent of soil water potential, in joules per newton on a force basis (1 J/N = 1 m);

ρ_w is the density of water, in kilograms per cubic metre;

g is the acceleration due to gravity, in metres per second squared.

In this International Standard pressure equivalents and soil water potentials are used. The corresponding unit of measurement is the pascal (Pa). Table 1 provides conversions between soil water potential and its pressure and head equivalents.

3 Principle

A tensiometer comprises a porous cup that is permeable to water connected to a pressure-measuring device. The pores of the wall of the cup are small enough to prevent air passing through when it is wet. The porous cup is filled with water. When the cup is placed in the soil, water within the tensiometer flows through the porous wall to the soil, or soil water flows into the tensiometer, until the pressure of the water on both sides of the porous wall is equal. When equilibrium has been reached, the measured pressure of the water inside the tensiometer, after correction for the difference in height between the pressure sensor and the porous cup equals the pore water pressure of the soil water at the position of the porous cup.

4 Apparatus

4.1 Tensiometer, usually consisting of a porous cup, a connecting tube and/or a body tube, a pressure sensor and a mechanism for expelling any air which accumulates within the tensiometer. The details of the design depend primarily on whether the instrument is intended for field or indoor use and the type of pressure sensor employed; examples are shown in figure 1. Annex B provides information on materials for the construction of tensiometers and on their construction.

4.1.1 Porous cup, made of a porous material of air-entry value (i.e. the pressure required to force air through the water-saturated cup) larger in magnitude than the lowest pore water pressure to be measured and the known hydraulic conductivity. The material shall be rigid and not subject to degradation in soil. Usually unglazed ceramic is used; alternatives are described in annex B.

4.1.2 Connecting and body tubes, made from appropriate materials of low permeability to water and gas and connected by leakproof joints. Rigid or semi-rigid tubing shall be used to connect the tensiometer to the pressure sensor (see annex B). The function of the connecting tube may, in part or totally, be served by the body tube.

The body tube usually fills the hole remaining above or behind the tensiometer cup after inserting it into the soil. It is a rigid tube with the same outside diameter as the porous cup. In many designs, it is filled with water, but in others it forms a casing for smaller tubes connected to the porous cup and/or cables attached to a pressure transducer located behind the cup.

Table 1 — Conversions between soil water potential and its pressure and head equivalents

Parameter to be converted	Pressure equivalent Pa	Head equivalent m	Potential J/kg
Pressure equivalent (Pa)	1	$0{,}102\ 0 \times 10^{-3}$	10^{-3}
Head equivalent (m)	9 807	1	9,807
Potential (J/kg)	10^3	0,102 0	1

NOTES

1 To convert from the potential or its equivalent in the first vertical to another equivalent or potential, multiply by the factor given, for example:

a potential of 1 J/kg has a pressure equivalent of 10^3 Pa and a head equivalent of 0,102 0 m.

2 Acceleration due to gravity = 9,807 $\mathrm{m/s^2}$

Density of water = 1 000 $\mathrm{kg/m^3}$

4.1.3 Pressure sensors. Several forms are used in tensiometers, the most common being mercury manometers, Bourdon gauges and electrical pressure transducers. The use of other types of manometer is permissible. The accuracy of the pressure sensor determines how accurately the pressure of the water within the tensiometer can be measured.

Annex A details the construction and use of mercury manometers for use with tensiometers. The other pressure sensors are described in annex C.

The accuracy of Bourdon gauge and pressure transducer tensiometers shall be verified before installation and at least annually thereafter.

NOTE 5 The accuracy of instruments used in the field may be tested with a mercury manometer reference. The complete tensiometer assembly can be tested in the field by inserting a "T" piece into the connecting tube. When required, another connecting tube is attached to it for connection to a mercury manometer. Should greater accuracy be required for laboratory purposes, specialized testing equipment will be necessary.

4.2 Tensiometer construction

Details of materials for constructing tensiometers and of their construction are given in annex B. Since the interior of a tensiometer installed in unsaturated soil is under a partial vacuum, it is essential that all possible leakage points are made as secure as possible. The number of joints in the system shall be kept to the minimum possible. Adhesive joints shall be made so that the void space between components is filled completely. Joints relying on a tight fit of two materials, for example stoppers, shall be correctly sized, with as large an area of contact as possible.

The system is used in a damp environment. Hence all materials shall be chosen to resist moisture. This applies particularly to adhesives, some kinds of which may soften or swell (leading to failure of cemented parts) in damp conditions.

If a tensiometer assembly of new design or of untried materials is to be used, it shall be tested for leaks under pressure and/or under vacuum before installation. This procedure is recommended for all installations.

5 Procedure

5.1 Installation of tensiometers

Tensiometers may be installed vertically or horizontally, whichever is most suitable for the required purpose. Install each tensiometer so that the centre of the porous cup is at the depth at which measurement is required. Ensure minimal disturbance to the soil that will surround the tensiometer, both at the soil surface and at depth. Maximize the contact between the porous cup and the soil but minimize the smearing of the soil around the cup.

NOTE 6 Usually, a hole of the same diameter as the tensiometer is carefully bored and the tensiometer is inserted into it. Details of alternative procedures for preparing holes in which tensiometers can be inserted in the field are given in annex D. Methods similar to those described in annex D, but scaled down, should usually be chosen when installing tensiometers in plant containers, soil cores, lysimeters, etc.

Care shall be taken to protect the tensiometer system from temperature fluctuations. Fluctuations induce thermal expansion and contraction of parts of the system and the water within, which influence the pressure measurement. In the field, all exposed parts of the tensiometer shall, as far as practicable, be shielded from solar radiation. (This reduces thermal disturbance to the tensiometer reading and also prolongs the life of the components.) Precautions shall also be taken to prevent the percolation of rain or irrigation water down the side of the tensiometer to the cup. All equipment and the area around the tensiometer shall be protected from damage by rodents and other animals.