



SLOVENSKI STANDARD
oSIST prEN 16416:2012
01-junij-2012

Geosintetične glinene pregrade - Ugotavljanje indeksa vodnega pretoka - Metoda s permeametrom (merilnikom prepustnosti) z gibko steno pri konstantnem vodnem tlaku

Geosynthetic clay barriers - Determination of water flux index - Flexible wall permeameter method at constant head

Geosynthetische Tondichtungsbahnen - Bestimmung der Durchflussrate - Triaxialzellen-Methode mit konstanter Druckhöhe

Barrières géosynthétiques argileuses - Détermination de l'indice eau par analyse en flux - Méthode au perméamètre à paroi flexible de charge constante

Ta slovenski standard je istoveten z: prEN 16416

ICS:

59.080.70	Geotekstilije	Geotextiles
91.100.50	Veziva. Tesnilni materiali	Binders. Sealing materials

oSIST prEN 16416:2012

en,fr,de

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

DRAFT
prEN 16416

March 2012

ICS 59.080.70; 91.100.50

English Version

**Geosynthetic clay barriers - Determination of water flux index -
Flexible wall permeameter method at constant head**

Barrières géosynthétiques argileuses - Détermination de
l'indice eau par analyse en flux - Méthode au perméamètre
à paroi flexible de charge constante

Geosynthetische Tondichtungsbahnen - Bestimmung der
Durchflussrate - Triaxialzellen-Methode mit konstanter
Druckhöhe

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 189.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

This draft European Standard was established by CEN in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Warning : This document is not a European Standard. It is distributed for review and comments. It is subject to change without notice and shall not be referred to as a European Standard.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: Avenue Marnix 17, B-1000 Brussels

Contents

Page

Foreword.....	3
1 Scope	3
2 Normative references	3
3 Terms and definitions	3
4 Apparatus	4
4.1 Constant head hydraulic system	4
4.1.1 System de-airing	4
4.1.2 Back pressure system.....	4
4.2 Flow Measurement System.....	4
4.2.1 Accuracy of inflow and outflow.....	4
4.2.2 De-airing and compliance of the system.....	4
4.3 Permeameter cell pressure system	4
4.4 Permeameter Cell.....	5
4.5 Top cap and base.....	5
4.6 Flexible membranes	6
4.7 Porous end pieces	6
4.8 Filter paper	7
4.9 Devices for measuring the dimensions of the specimen	7
4.10 Equipment for mounting the specimen	7
4.11 Vacuum pump	7
4.12 Temperature maintaining device.....	7
5 Permeant water	7
6 Specimen sampling and preparation.....	7
7 Procedure	8
7.1 General.....	8
7.2 Head loss of apparatus	8
7.3 Specimen set-up	8
7.4 Consolidation and Backpressure Saturation.....	8
7.5 Permeation	9
7.6 Termination Criteria.....	9
8 Calculation.....	9
9 Report	10
Annex A (informative) Hydraulic conductivity calculation.....	11
Annex B (informative) Permittivity calculation based on ASTM D 4491	12
Bibliography	13

Foreword

This document (prEN 16416:2012) has been prepared by Technical Committee CEN/TC 189 “Geosynthetics”, the secretariat of which is held by NBN.

This document is currently submitted to the CEN Enquiry.

1 Scope

This European Standard describes an index test method that covers laboratory measurement of water flux through saturated geosynthetic clay barrier (GBR-C) specimens using a flexible wall permeameter at constant head.

This test method is applicable to GBR-C products with no additional sealing layers attached.

This test method provides a measurement of flux under a prescribed set of conditions that can be used for manufacturing quality control. The test method can also be used to check conformance.

The flux value determined using this test method is not considered to be representative of the in-service flux of a GBR-C.

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.

EN ISO 9862, Geosynthetics – Sampling and preparation of test specimens (ISO 9862)

EN ISO 9863-1, Geosynthetics — Determination of thickness at specified pressures – Part 1: Single layers (ISO 9863-1)

EN ISO 10318, Geosynthetics — Terms and definitions (ISO 10318)

ISO 554, Standard atmospheres for conditioning and/or testing — Specifications (ISO 554)

ISO 11465, Soil quality – Determination of dry matter and water content on a mass basis – Gravimetric method (ISO 11465:1993, Cor. 1:1994)

3 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

3.1

Flux

The volumetric flow rate per unit area normal to the plane of the product at a defined head (EN ISO 10318)

3.2.**Geosynthetic clay barrier**

A factory-assembled structure of geosynthetic materials in the form of a sheet, which acts as a barrier. The barrier function is essentially fulfilled by clay. It is used in contact with soils and/or other materials in geotechnical and civil engineering applications (EN ISO 10318).

4 Apparatus**4.1 Constant head hydraulic system**

The system shall be capable of maintaining constant hydraulic pressures to within $\pm 2,5$ % and shall include means to measure the hydraulic pressures to within the prescribed tolerance. In addition, the system shall be capable of maintaining a constant head loss across the test specimen to within ± 5 % and shall include means to measure the head loss with the same accuracy or better.

4.1.1 System de-airing

The hydraulic system shall be designed to facilitate rapid and complete removal of free air bubbles from flow lines.

4.1.2 Back pressure system

The hydraulic system shall have the capability to apply back pressure to the specimen to facilitate saturation. The system shall be capable of maintaining the applied back pressure throughout the duration of the test. The back pressure system shall be capable of applying, controlling, and measuring the back pressure to within $\pm 2,5$ % of the applied pressure. The back pressure may be provided by a compressed gas supply, a deadweight acting on a piston, or any other method capable of applying and controlling the back pressure to the tolerance specified in this paragraph.

NOTE 1—Application of gas pressure directly to a liquid will dissolve gas in the liquid. A variety of techniques are available to minimize dissolution of gas in the back pressure liquid, including separation of gas and liquid phases with a bladder and frequent replacement of the liquid with de-aired water.

4.2 Flow Measurement System**4.2.1 Accuracy of inflow and outflow**

Both inflow and outflow volumes shall be measured unless the lack of leakage, continuity of flow, and cessation of consolidation or swelling can be verified by other means. Required accuracy for the flow measured over an interval of time is ± 5 %.

4.2.2 De-airing and compliance of the system

The flow-measurement system shall contain a minimum of dead space and be capable of complete and rapid de-airing. Rigid tubing shall be used so that volume change of the system in response to changes in pressure is minimized.

4.3 Permeameter cell pressure system

The system for pressurizing the permeameter cell shall be capable of applying and maintaining the cell pressure to within $\pm 2,5$ % of the applied pressure. However, the effective stress on the test specimen shall be maintained to the desired value with an accuracy of ± 5 %. The device for pressurizing the cell may consist of a reservoir connected to the permeameter cell and partially filled with de-aired water, with the upper part of the reservoir connected to a compressed gas supply or other source of pressure (see NOTE 2).

NOTE 2—De-aired water is commonly used for the cell liquid to minimize potential for diffusion of air through the membrane into the specimen. Other liquids, such as oils, which have low gas solubilities, are also acceptable, provided they do not react with components of the permeameter and the flexible membrane. Also, use of a long (approximately 5 to 7 m) tube connecting the pressurized cell liquid to the cell helps to delay the appearance of air in the cell liquid and to reduce the flux of dissolved air into the cell.

4.4 Permeameter Cell

An apparatus shall be provided in which the specimen and porous end pieces, enclosed by a flexible membrane sealed to the cap and base, are subjected to controlled liquid pressures. A schematic diagram of a typical cell is shown in Fig. 1.

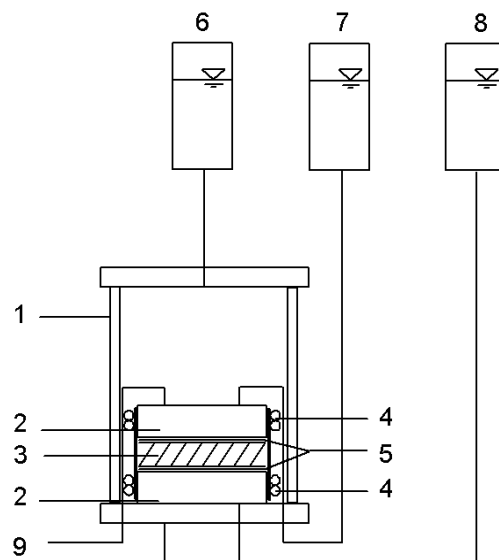
The permeameter cell shall allow for observation of changes in height of the specimen, either by observation through the cell wall using a suitable instrument or by monitoring of either a loading piston or an extensometer extending through the top plate of the cell bearing on the top cap and attached to a suitable measuring device. The piston or extensometer – if used – shall pass through a bushing and seal incorporated into the top plate and shall be loaded with sufficient force to compensate for the cell pressure acting over the cross-sectional area of the piston where it passes through the seal. If deformations are measured, the deformation indicator shall be graduated to 0,3 mm or better and shall have an adequate travel range.

To facilitate gas removal, and thus saturation of the hydraulic system, four drainage lines leading to the specimen, two each to the base and top cap, are recommended. The drainage lines shall be controlled by no-volume-change valves, such as ball valves, and shall be designed to minimize dead space in the lines.

4.5 Top cap and base

An impermeable, rigid top cap and base shall be used to support the specimen and provide for transmission of permeant liquid to and from the specimen. The base shall prevent leakage, lateral motion, or tilting, and the top cap shall be designed to receive the piston or extensometer, if used, such that the piston-to-top cap contact area is concentric with the cap.

The surface of the base and top cap that contacts the membrane to form a seal shall be smooth and free of scratches.



Key

- | | |
|----------------------|------------------------------------|
| 1. Permeameter cell | 6. Back pressure system |
| 2. Porous end pieces | 7. Inflow volume measuring device |
| 3. Specimen | 8. Outflow volume measuring device |
| 4. Rubber o-rings | 9. Vent lines |
| 5. Filter paper | |

Figure 1 – Permeameter cell and test set-up

4.6 Flexible membranes

The flexible membrane used to encase the specimen shall provide reliable protection against leakage. The membrane shall be carefully inspected prior to use and if any flaws or pinholes are evident, the membrane shall be discarded. To minimize restraint of the specimen, the diameter or width of the unstretched membrane shall be between 90 and 95 % of that of the specimen. The membrane shall be sealed to each of the specimen base and cap with 2 rubber O-rings for which the unstressed, inside diameter or width is less than 90 % of the diameter or width of the base and cap, or by any other method that will produce an adequate seal.

NOTE 3—Membranes can be tested for flaws by placing them around a form sealed at both ends with rubber O-rings, subjecting them to a small air pressure on the inside, and then dipping them into water. If air bubbles come up from any point on the membrane, or if any visible flaws are observed, the membrane should be discarded.

4.7 Porous end pieces

The porous end pieces shall be of material that is not attacked by the specimen or permeant liquid. The end pieces shall have plane and smooth surfaces and be free of cracks, chips, and non-uniformities. They shall be checked regularly to ensure that they are not clogged.

The porous end pieces shall have a diameter no greater than 100 mm and no less than 98 mm, and their thickness shall be sufficient to prevent breaking.

The hydraulic conductivity of the porous end pieces shall be substantially greater than that of the specimen to be tested such that there is no significant impedance of flow. Including the porous end pieces in the procedures described in 7.1 will ensure that no significant impedance occurs.

4.8 Filter paper

To prevent intrusion of material into the pores of the porous end pieces, one or more sheets of filter paper shall be placed between the top and bottom porous end pieces and the specimen. The hydraulic conductivity of the filter paper shall be substantially greater than that of the specimen to be tested such that there is no significant impedance of flow. Including the filter paper in the procedures set forth in 7.1 will ensure that no significant impedance occurs.

4.9 Devices for measuring the dimensions of the specimen

Devices used to measure dimensions of the specimen other than the thickness shall be capable of measuring with an accuracy of 0.3 mm or better and shall be constructed such that their use will not disturb the specimen.

4.10 Equipment for mounting the specimen

Equipment for mounting the specimen in the permeameter cell shall include a membrane stretcher or cylinder and ring for expanding and placing O-rings on the base and top cap to seal the membrane.

4.11 Vacuum pump

To assist with de-airing of permeameter system and saturation of specimens.

4.12 Temperature maintaining device

Testing shall be carried out at ambient temperature that shall not vary more than $\pm 3^\circ\text{C}$. This temperature shall be periodically measured and recorded, at a minimum at the beginning of the permeation phase and at the end of the permeation phase of the test.

SIST EN 16416:2013

5 Permeant water

The permeant water is the liquid used to permeate the test specimen and is also the liquid used in back-pressurizing the specimen. The flux through a GBR-C specimen can be substantially influenced by the permeating liquid. De-aired de-ionized water shall be used in this test method. To prevent solution of air back into water, de-aired water shall not be exposed to air for prolonged periods.

6 Specimen sampling and preparation

Take specimens from the sample in accordance with EN ISO 9862.

Inspect the bulk GBR-C sample to be tested and choose a representative section of the sample without any disturbance, irregularity, or damage to obtain the specimen for testing.

Place a template with a known area (for example, 0,3 m by 0,3 m) on the selected section. Cut the bulk GBR-C sample to the exact size of the template with a sharp utility knife or other suitable instrument. Carefully remove, with little or no loss of bentonite.

Carefully place the GBR-C sample on a flat smooth surface. Cut a specimen from it with a circular cutter (100 ± 1 mm diameter). The following measures shall be taken to prevent loss of bentonite from the perimeter of the specimen when removing the cutter: The specimen shall be taken from the central part of the above sample; a minimum amount of water shall be added to the cut circumference and left for 1 minute before the specimen is removed.

prEN 16416:2012 (E)

Examine the exposed edge of the specimen to verify that geotextile fibres from the upper and lower geotextile backings are not interconnected. To ensure that fibres from the upper and lower geotextile backings are not interconnected, the edge of the geotextile backings may be slightly trimmed using a pair of sharp scissors.

The diameter of the specimen shall be equal to the diameter of the porous end pieces of the permeameter cell $\pm 5\%$.

NOTE 4 – If measurement of the initial water content is required bentonite shall be taken from the remainder of the sample after the specimen has been removed. This bentonite shall not be taken from the area of the sample to which water has been added.

7 Procedure**7.1 General**

The test shall be undertaken at a temperature in accordance with ISO 554.

7.2 Head loss of apparatus

Head loss in the tubes, valves, porous end pieces, and filter paper may lead to error. To guard against such errors, the permeameter shall be assembled with no specimen inside and then the hydraulic system filled. The hydraulic pressures or heads that will be used in testing a specimen shall be applied, and the rate of flow measured with an accuracy of $\pm 5\%$. This rate of flow shall be at least 1×10^{-5} m/s at the same hydraulic pressures or heads applied.

7.3 Specimen set-up

Cut two filter paper discs with the same diameter as the porous end pieces. Soak the two porous end pieces and filter paper discs, if used, in a container of permeant water.

Place the membrane on the membrane expander. Apply a thin coat of silicon high-vacuum grease to the sides of the end caps. Place a porous end piece on the permeameter base cap, followed by a disc of filter paper, followed by the test specimen. Place a disc of filter paper on top of the specimen, followed by a porous end piece and the top cap. Place the membrane around the specimen, and using equipment in accordance with clause 4.11 place two o-rings on each end cap to seal the membrane.

Attach flow tubing to the top cap, if not already attached, assemble the permeameter cell, and fill it with permeant water. Attach the cell pressure reservoir to the permeameter cell line and the hydraulic system to the influent and effluent lines. Fill the cell pressure reservoir with water, or other suitable liquid, and the hydraulic system with permeant water.

7.4 Consolidation and Backpressure Saturation

Increase the cell pressure to 105 kPa and the backpressure to 70 kPa on both ends of the specimen. Carefully flush permeant water through the drainage lines until all visible air bubbles have been removed.

Increase the cell pressure and backpressure simultaneously in increments of 70 kPa in 1-min intervals until a final cell pressure of 550 kPa and a backpressure of 515 kPa are obtained.

Maintain the cell pressure of 550 kPa and backpressure of 515 kPa for a period not less than 48 h to allow consolidation/swell, saturation, and hydration to occur.