SLOVENSKI STANDARD
SIST EN 17096:2019

01-februar-2019

Geosintetika - Preskusna metoda za ugotavljanje utrjevanja modula HDPE geosintetičnih ovir

Geosynthetics - Test method for the determination of the strain hardening modulus of HDPE geosynthetic barriers

Geokunststoffe - Prüfverfahren für die Bestimmung des Kaltverfestigungsmodus von HDPE-Kunststoffdichtungsbahnen

Géosynthétiques - Méthode d'essai pour la détermination du module d'écrouissage des Géomembranes HDPE-HD

Ta slovenski standard je istoveten z: **EN 17096:2018**

ICS:

59.080.70	Geotekstilije	Geotextiles

SIST EN 17096:2019 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 17096

November 2018

ICS 59.080.70

English Version

Geosynthetics - Test method for the determination of the strain hardening modulus of PE-HD geosynthetic barriers

Géosynthétiques - Méthode d'essai pour la détermination du module d'écrouissage des Géomembranes HDPE

Geokunststoffe - Prüfverfahren für die Bestimmung des Dehnverfestigungsmodul von HDPE-Kunststoffdichtungsbahnen

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

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Ref. No. EN 17096:2018 E

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European foreword

This document (EN 17096:2018) has been prepared by Technical Committee CEN/TC 189 “Geosynthetics”, the secretariat of which is held by NBN.

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of an identical text or by endorsement, at the latest by May 2019, and conflicting national standards shall be withdrawn at the latest by May 2019.

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1 Scope

This document specifies a test method for the measurement of the strain hardening modulus which is used as a measure for the resistance to slow crack growth of polyethylene. The strain hardening modulus is obtained from true stress versus draw ratio curves on PE-HD geosynthetic barrier samples.

This standard specifies how measurement is performed and how the strain hardening modulus is determined. Details of the required equipment, precision and sample preparations are given.

This test method is suitable for all PE-HD types of GBR-P.

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.

EN 1849-2:2009, *Flexible sheets for waterproofing - Determination of thickness and mass per unit area - Part 2: Plastic and rubber sheets*

EN ISO 9863-1:2016, *Geosynthetics - Determination of thickness at specified pressures - Part 1: Single layers (ISO 9863-1:2016)*

EN ISO 527-1, *Plastics - Determination of tensile properties - Part 1: General principles (ISO 527-1)*

EN ISO 7500-1, *Metallic materials - Calibration and verification of static uniaxial testing machines - Part 1: Tension/compression testing machines - Calibration and verification of the force-measuring system (ISO 7500-1)*

EN ISO 9513, *Metallic materials - Calibration of extensometer systems used in uniaxial testing (ISO 9513)*

3 Terms and definitions

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

Note 1 to entry: The symbols, their terms and definitions, as given below, are in line with EN ISO 527-1 and/or ISO 18488.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
gauge length
l_0
initial distance between the gauge marks on the central part of the test specimen

Note 1 to entry: Gauge length is expressed in mm.

3.2
thickness
d
initial dimension of the cross-section perpendicular to the plane in the central part of a test specimen

Note 1 to entry: Thickness is expressed in mm.

3.3
width
b
initial dimension of the cross-section in the central part of a test specimen

Note 1 to entry: Width is expressed in mm.

3.4
test speed
v
rate of separation of the gripping jaws

Note 1 to entry: Test speed is expressed in mm/min.

3.5
length
l
distance between the gauge marks on the central part of the test specimen at any given moment

Note 1 to entry: Length is expressed in mm.

3.6
stress
σ
normal force per unit area of the original cross-section within the gauge length

Note 1 to entry: Stress is expressed in MPa.

3.7
yield stress
σ_y
stress at the strain at yield

Note 1 to entry: Stress at yield is expressed in MPa.

3.8
true stress
σ_T
draw ratio multiplied with the normal force per unit area of the original cross-section within the gauge length

Note 1 to entry: True stress is expressed in MPa.

3.9
strain
ε
increase in length per unit original length of the gauge

Note 1 to entry: Strain is expressed as a percentage (%).

3.10
strain at yield
ε_y
first occurrence in a tensile test of strain increase without a stress increase

Note 1 to entry: Strain at yield is expressed as a percentage (%).

3.11
draw ratio
λ
actual length per unit original length of the gauge

Note 1 to entry: Draw ratio at yield is expressed as a dimensionless ratio.

3.12
strain hardening modulus
$<G_p>$
slope of the Neo-Hookean constitutive model between a draw ratio of 8 and up to the point of maximum stress but not above 12

Note 1 to entry: Strain hardening modulus is expressed in MPa.

3.13
variation coefficient
C_v
standard deviation of the test results divided by the arithmetic mean of the test results multiplied by 100

Note 1 to entry: Variation coefficient is expressed as a percentage (%).

4 Principle

A stress-strain curve is measured at (80 ± 1) °C sufficiently beyond the natural draw ratio and the strain hardening modulus determined from the slope after the natural draw ratio (see informative Annex A).

5 Apparatus

5.1 Tensile-testing machine

5.1.1 The machine shall comply with EN ISO 527-1. The tensile-testing machine shall be capable of maintaining a test speed of (10 ± 2) mm/min.

5.1.2 **Load cell**, which shall comply with class 1 as defined in EN ISO 7500-1.

Due to measurement at elevated temperature of (80 ± 1) °C, the measured forces are low. Therefore, a load cell with a range of 250 N is recommended.

5.1.3 **Non-contact extensometer**, which shall comply with the same accuracy requirements as given for contact extensometers in EN ISO 9513. A non-contact extensometer shall be used because the test is

performed at an elevated temperature of (80 ± 1) °C. The traverse displacement shall not be used as to measure strain.

5.1.4 Temperature chamber, to control the temperature at (80 ± 1) °C.

A switch to enable closing and opening the clamps without opening the temperature chamber is recommended but not necessary, if the testing device is able to hold force of zero.

5.2 Devices for measuring the thickness and width of the test specimens

5.2.1 Thickness (*d*) shall be measured according to EN ISO 9863-1:2016, Annex A.

5.2.2 Width (*b*) shall be measured with an optical device with an accuracy of 0,01 mm, according to EN 1849-2:2009, 5.4.3. Three additional specimens, which are not used for determination of strain hardening modulus but which are punched using the identical punch die tool as for the test specimens tested for strain hardening modulus shall be measured optically. A cutting of the cross section area perpendicular to the axis of the specimen within the gauge length of each of the three specimens shall be prepared. The widest width as well as the narrowest width of each specimen's cutting shall be determined and recorded. The mean value of all six values regarding width (two measured values per specimen) will be applied for all test specimens tested for strain hardening modulus for calculation of stress.

The dimensions of the cross section area have a great influence on the value of strain hardening modulus. Due to the punching, the width of specimens might be conical shaped. The dimensions close to the bottom surface of the geosynthetic barrier and close to the top surface of the geosynthetic barrier might be significantly different. Mechanical measurement of width cannot take this into account. Therefore, special attention has to be payed to determination of width by performing optical measurements instead of mechanical measurements.

5.3 Punch die tool

A punch die tool for the specimen geometry specified in 6.1 shall be used.

5.4 Device for application of the gauge marks

A suitable device for the application of the gauge marks for the non-contact extensometer shall be used. The gauge mark shall be suitable for the optical sensor system used.

6 Test specimen

6.1 Dimensions and figure of the test specimen

The specimen geometry as shown in Figure 1 shall be used.

A large clamping area of the specimen to avoid slippage in the clamps is required to accurately measure the strain hardening regime.