SLOVENSKI STANDARD
kSIST-TS FprCEN/TS 17445:2019

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Geosintetika - Standardni preskus za simulacijo erozije, ki jo povzroči dež, na površini pobočja, zaščitenega z geosintetičnimi izdelki za nadzor erozije

Geosynthetics - Standard Test for the Simulation of Rainfall-Induced Erosion on the surface of a slope protected by Geosynthetic Erosion Control Products

Geokunststoffe - Prüfverfahren zur Simulation von durch Niederschlag hervorgerufener Erosion an geosynthetischen Erosionsschutzprodukten

Géosynthétiques - Essai normalisé de simulation de l'érosion induite par les précipitations de la surface d'une pente protégée par des produits de contrôle de l'érosion géosynthétiques

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59.080.70 Geotekstilije Geotextiles

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Geosynthetics - Standard Test for the Simulation of Rainfall-Induced Erosion on the surface of a slope protected by Geosynthetic Erosion Control Products

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

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

This document (FprCEN/TS 17445:2019) has been prepared by Technical Committee CEN/TC 189 “Geotextiles”, the secretariat of which is held by NBN.

This document is currently submitted to the Vote on TS.

1 Scope

This document specifies an index test method for the simulation of rainfall-induced erosion on the surface of a slope protected by geosynthetic erosion control products.

The test is normally carried out on specimens conditioned under a specified atmosphere.

The test is applicable to most geosynthetics, but is especially suited to geosynthetic erosion control products.

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 13286-2, *Unbound and hydraulically bound mixtures. — Part 2: Test methods for laboratory reference density and water content — Proctor compaction*

EN ISO 9862, *Geosynthetics — Sampling and preparation of test specimens*

EN ISO 10318-1, *Geosynthetics — Part 1: Terms and definitions*

EN ISO 11074, *Soil quality — Vocabulary*

EN ISO 14688-1, *Geotechnical investigation and testing — Identification and classification of soil — Part 1: Identification and description*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 10318-1, EN ISO 14688-1, EN ISO 11074, and the following apply.

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
disdrometer
laser-optical source that produces a parallel light-beam

Note 1 to entry: The instrument determines the size and fall speed of rain drops by measuring the signal reduction caused by the drop falling through the light-beam; the amplitude and duration of the reduced signal is used to estimate the drop size and fall speed, respectively

3.2
test series
test repetitions including at least one test with and without geosynthetic specimens placed in the test box

3.3
N
total number of detected raindrops

3.4
n_i
number of detected raindrops in the size class i

3.5
D_{mean} [mm]
mean drop diameter

3.6
D_i [mm]
drop diameter at the middle of the size class i

3.7
D [mm]
spherical equivalent diameter of the raindrops

3.8
v_{mean} [m/s]
mean fall velocity

3.9
n_j
number of detected raindrops in the fall velocity class j

3.10
v_j [m/s]
fall velocity at the middle of the fall velocity class j

3.11
R [mm/h]
rainfall intensity

3.12
R(Di) [mm/h]
rainfall intensity for a given drop size class i

3.13
A [m^2]
disdrometer detection area

3.14
KE [J/(m^2 mm)]
kinetic energy of the simulated rain

3.15
ρ (10^{-6} kg/mm^3)
water density

3.16

D_{LP} [mm]

expected value of mean drop diameter according to Laws and Parsons (1943)

3.17

KE_e [J/(m^2 mm)]

expected Kinetic Energy according to Renard et al. (1997)

3.18

v_t (m/s)

terminal velocity of rain drops in still air

4 Principle

The specimen is placed on an inclined steel box filled with the specified soil, simulating a slope. Above the slope simulator, a rainfall simulator produces a rainfall of controlled characteristics for the specified duration; the quantity of soil that is eroded by the rainfall is collected, dried, and weighted. The amount of eroded soil is an index value of the ability of the product to protect a slope against rainfall induced erosion.

The apparatus shall be able to produce a rainfall with the required characteristics in terms of:

- the rainfall intensity R;
- the mean drop diameter D_{mean};
- the mean drop velocity v_{mean};
- the kinetic energy KE.

5 Apparatus

5.1 Slope simulator

The slope simulator is made by a rigid box, as shown in Figure 1.

The box shall have minimum dimensions of 1,0 m width x 2,0 m length x 0,10 m depth, with a tolerance of ± 5 mm.

The base of the box shall **not** allow free vertical drainage through the soil profile and out of the box, while containing the soil in the box.

The lower part of the box shall be adapted to separate surface runoff water from water filtrating through the soil (see Figure 2).

The slope of the box is set at a standard inclination of 1V/2H, that is at an angle βequal to 26,6 deg. from the horizontal.

The box shall be capable to vary the inclination from horizontal position up to desired inclination (see Annex A).

NOTE The box can be vertically positioned such that the centre point of the surface is at approximately 1,00 m over the ground surface.

5.2 Runoff and Sediment Collection System

The runoff and eroded soil collection system includes a collection apparatus and holding tanks.

The collection apparatus shall be fabricated to collect direct runoff flow and infiltration flow separately into the holding tanks, as shown in Figure 2, using either a geomembrane deflector fixed continuously across the entire bottom edge of the plot or any other suitable method. The infiltration flow may fall freely into its holding tank, or a specific collection and diversion system can be arranged.

The collecting tanks shall be shielded from the rainfall, that is no rainfall shall fall directly into the tanks.

A nonwoven geotextile with characteristic opening size less than or equal to 75 µm shall be placed above the tanks for collecting the eroded soil while allowing water to flow into the tanks, as shown in Figure 2. The geotextile pieces shall be dried and weighted before testing.

5.3 Rainfall simulator

5.3.1 General

The rainfall simulator shall be designed in order to achieve the required characteristics of the rainfall, i.e. - rainfall intensity R; mean drop diameter D_{mean}; mean drop velocity v_{mean}; kinetic energy KE.

Figure 3 shows a typical rainfall simulator layout.

NOTE 1 Rainfall simulator typically includes a suspension system, pipes, sprinkler nozzles and pressurized systems giving a range of raindrop sizes, replicating as closely as possible natural rainfall with valves and pressure gauges for control.

The sprinkler nozzles can be single full-cone nozzles, with spray angle of 120°, in order to model natural raindrop size and distribution. At least one nozzle is necessary to cover the plot of 1 m x 2 m.

NOTE 2 Additional nozzles can be required to ensure uniform rainfall on the whole test plot.

NOTE 3 A flow control valve and a pressure gauge, capable of maintaining a uniform operating pressure and the set rainfall intensity can be located on the inlet pipe.

A first estimation of rainfall uniformity and full plot coverage shall be carried out, and tests shall be performed to adjust the distance between the rainfall generating system and the centre of the slope.

NOTE 4 The use of one mesh (or more meshes, if required) can provide a better distribution of the drops, and can also increase their size and kinetic energy (PeixeiraCarvalho, 2004). The meshes can be made of plastic, stainless steel, aluminium or any other suitable material. When meshes are used, the vertical distance between the mesh and the nozzles is 200 mm. Anyway this distance can be adapted to get the required mean drop size and kinetic energy.

NOTE 5 In order to reduce the height of the installation, experience has shown that with suitable adjustment the distance between the nozzles or the lowest mesh and the centre point of the specimen placed on the soil in the slope simulator can be reduced to a typical minimum of 2,50 m, provided that the required characteristics of the rainfall are met.

5.3.2 Water Source

Any water source is suitable provided that it does not contain deleterious materials which could impair the operation of the rainfall simulators.

5.4 Disdrometer

The simulated rainfall intensity and the speed and size of the drops shall be measured with a Laser Precipitation Monitor (LPM) or disdrometer.

NOTE Other methods or instruments can be used, provided that their performance match that of the disdrometer.

The instrument itself, or a computer connected to it and featured with a specific software, shall be able to provide statistics (distribution, mean value, variance, etc.) of the raindrops size and velocity, and calculation of the rainfall intensity and the kinetic energy achieved on the horizontal measuring plane of the disdrometer.

Other methods are acceptable as long as they give at least the required parameters of rainfall intensity, mean drop diameter, mean drop velocity, kinetic energy KE with the prescribed accuracy.

6 Soil

The test soil shall be defined as a very erodible soil.

The soil mix for the standard test shall be:

- clay (particle size less than or equal to 0,002 mm): 10 to 14%,
- silt (particle size in the range 0,002mm to 0,050 mm): 24 to 28%,
- sand (particle size in the range 0,050 to 2,0 mm): 58 to 62%.

The target gradation curve for this soil type is shown in Figure 4.

The target plastic index (PI) for the soil shall be approximately 4.5.

The test soil shall be placed in the box in two lifts of 50 mm each and compacted to 90 % of Standard Proctor density in accordance with test method EN 13286-2.

NOTE Other soil types can be used for non-standard tests, as stated in Annex B.

7 Specimens

A minimum of three specimens shall be tested for each rainfall intensity.

If the erosion protection characteristics of the geosynthetic have previously been established, then for control purposes it can be sufficient to determine the soil loss on one specimen only.

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

Specimens shall be cut in 1,0 m x 2,0 m dimensions, or according to the length and width of the rigid box, with the machine direction placed down the slope or across the slope in accordance with the manufacturer recommendation.

If the material to be tested is known to have different characteristics on each faces (example a flat face and a waving face), specimens shall be placed in the slope simulator in accordance with the manufacturer recommendation.

Specimens shall be placed above the soil that fills the slope simulator.

NOTE Specimens can be either placed without filling or filled with the same soil used in the box and in accordance with the manufacturer recommendation. The filling conditions are reported in the Report.

8 Conditioning

The test specimens shall be conditioned at standard atmosphere for testing (20 ± 2) °C and (65 ± 5) % relative humidity as defined in ISO 554.

The specimens can be considered to be conditioned when the change in mass in successive weightings made at intervals of not less than 2 h does not exceed 0,25 % of the mass of the test specimen.

Conditioning and/ or testing at the standard atmosphere may only be omitted when it can be shown that results obtained for the same specific type of product (both structure and material type) are not affected by changes in temperature and humidity exceeding the limits. This information shall be included in the test report.

Specimens shall be conditioned after cutting, and shall be placed on a horizontal surface in order to minimize bowing and curling.

9 Calibration

9.1 Setting the rainfall intensity gauges

9.1.1 General

The apparatus is set for calibration of the rainfall intensity as shown in Figure 5.

9.1.2 Place the rainfall simulator (the nozzles, and optionally the meshes) at the prescribed height above the slope simulator.

9.1.3 Place the box of the slope simulator horizontally, empty, with the top surface approximately. 1,0 m above the floor.

NOTE A horizontal plane of 1 m x 2 m minimum, like a table, with the top surface approximately. 1,0 m above the ground level, can be used as well.

9.1.4 Place minimum 18 rainfall intensity gauges (e.g. calibrated glasses or an equivalent system) uniformly in the box, as shown in Figure 5.b.

9.2 Rainfall intensity calibration

9.2.1 Start the rainfall, with the expected intensity, and apply for 30 minutes. Recorded to the nearest second.

9.2.2 For each rainfall intensity measure the distribution of rainfall intensity in the rain gauges.

9.2.3 If such spatial distribution is not correct according to the criteria set in 9.8, fine tune the water pressure, flow rate, position of nozzles, and mesh type and position. Repeat until the measured rainfall intensity is satisfactory.

9.3 Disdrometer preparation

9.3.1 Check that the disdrometer is correctly working, according to its operating instructions

9.3.2 Place the disdrometer in position, with the laser beam at approx. 1 m above the floor.

9.3.3 Three measurements with the disdrometer positioned vertically below the nozzle and laterally to it shall be taken, as shown in Figure 6.

9.4 Rainfall calibration

9.4.1 Start the rainfall, with the expected intensity as calibrated at 9.2.

9.4.2 Measure rain drop diameters, drop velocity and kinetic energy with the disdrometer in the three positions, for one minute each, or according to the sampling time of the disdrometer.

9.4.3 If the values of mean drop diameter, mean fall velocity, and mean kinetic energy are not correct according to the criteria set in 9.8, fine tune the water pressure, flow rate, position of nozzles, and mesh type and position. Repeat until the measured values are satisfactory.

9.5 Recording of data

Record the following for each calibration test:

— Rainfall height in each rain gauge,

— Number of rain drops in each class of drop diameter set in the disdrometer regulations,

— drop speed in each class of drop diameter set in the disdrometer regulations,

— kinetic energy in each class of drop diameter set in the disdrometer regulations.

9.6 Calculation and expression of results

9.6.1 For the three disdrometer measurements plot the raindrop diameter distribution versus the raindrop velocity distribution and the kinetic energy distribution. Figure 9 shows examples of such plots.

9.6.2 From data measured and recorded by the rain gauges and the disdrometer, make the following calculations:

— The mean drop diameter, D_{mean} [mm];

— The mean fall velocity, v_{mean} [m/ s];

— The mean rainfall intensity, R [mm/h];

— The kinetic energy KE [J/(m2 mm)].

Formulas for calculating D_{mean}, v_{mean}, R, KE are reported in Annex C.

NOTE Disdrometer software usually performs such calculations automatically.