भारतीय मानक
Indian Standard

IS 16389 : 2015

भूकृत्रिम — भूवस्त्रादि या मिट्टी/भूवस्त्रादि फिल्टर की जैविक क्लॉगिंग के लिए परीक्षण की विधि

Geosynthetics — Method of Test for Biological Clogging of Geotextile or Soil/Geotextile Filters

ICS 59.080.70

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September 2015 **Price Group 4**

Geosynthetics Sectional Committee, TXD 30

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Geosynthetics Sectional Committee had been approved by the Textile Division Council.

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

GEOSYNTHETICS — METHOD OF TEST FOR BIOLOGICAL CLOGGING OF GEOTEXTILE OR SOIL/ GEOTEXTILE FILTERS

1 SCOPE

1.1 This test method is used to determine the potential for and relative degree of, biological growth which can accumulate on geotextile or geotextile/soil filters.

1.2 The amount of clogging occurred over geotextile is determined by measuring the flow rate over the extended period of time, and the rate of flow can be measured by both the constant head and variable head method.

1.3 This test method can be adopted for unsaturated as well as saturated conditions.

1.4 This test method can also be used to give an indication as to the possibility of backflushing and/or biocide treatment for remediation purposes if biological clogging does occur.

2 REFERENCES

The standards given below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards.

IS No.	*Title*
6359 : 1971	Method for conditioning of textiles
13321 (Part 1) : 1992	Glossary of terms for geosynthetics: Part 1 Terms used in materials and properties.
SP 45 : 1988	Handbook on glossary of textile terms

3 TERMINOLOGY

For the purpose of this standard the following definitions and those given in SP 45 and IS 13321 (Part 1) shall apply.

3.1 Geotextile — A permeable geosynthetic comprised solely of textiles.

3.2 Permeability — The rate of flow of a liquid under a differential pressure through a material.

3.3 Permittivity — The volumetric flow rate of water per unit, in a cross-sectional area head under laminar flow conditions.

3.4 Aerobic — A condition in which a measurable volume of air is present in the incubation chamber or system.

NOTE — In geotextiles, this condition can potentially contribute to the growth of micro-organisms.

3.5 Anaerobic — A condition in which no measurable volume of air is present in the incubation chamber or system.

NOTE — In geotextiles, this condition cannot contribute to the growth of micro-organisms.

3.6 Back Flushing — A process by which liquid is forced in the reverse direction to the flow direction.

NOTE — In other drainage application areas, this process is commonly used to free clogged drainage systems of materials that impede the intended direction of flow.

3.7 Biocide — A chemical used to kill bacteria and other micro-organisms.

4 PRINCIPLE

It is the test in which geotextile filters or soil/geotextiles filters are subjected to the different liquid flow rates, possibility of biological clogging of geotextile is checked by considering the reduction in flow rate. Permittivity is measured using constant head as well as variable head method. The use of the method is primarily oriented toward landfill leachates but can be performed with any liquid coming from a particular site or synthesized from a predetermined mixture of biological micro-organisms.

5 APPARATUS

5.1 The Flow Column and Specimen Mount, consists of a 100 mm inside diameter containment ring for placement of the geotextile specimen along with upper and lower flow tubes to allow for uniform flow trajectories (*see* Fig. 1). The flow tubes are each sealed with end caps which have entry and exit tubing connections. The upper tube can be made sufficiently long so as to provide for a soil column to be placed above the geotextile. When this type of combined soil/ geotextile cross-section is used, however, it is difficult to distinguish which material is clogging, for example, the soil or the geotextile. It does however simulate many existing filtration systems. In such cases, a separate test setup with the geotextile by itself will be

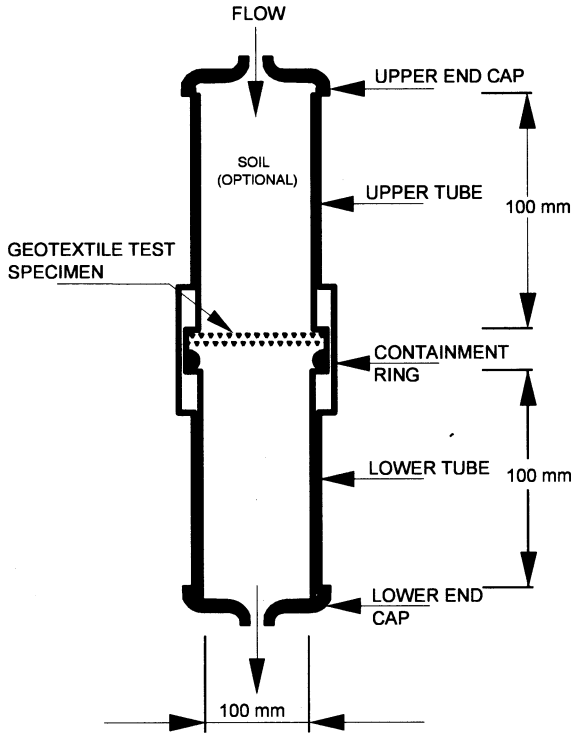

FIG. 1 FLOW COLUMN TO CONTAIN GEOTEXTILE TEST SPECIMEN

required as a control test and the difference in behaviour between the two tests will give an indication as to the contribution of soil clogging to the flow reduction.

5.2 Hydraulic Head Control Devices, are required at both the inlet and outlet ends of the flow column. Figure 2 shows the complete setup based on constant hydraulic head monitoring where concentric plastic cylinders are used with the inner cylinders being at the elevation from which head is measured. The elevation difference between the inner cylinder at the inlet end and the inner cylinder at the outlet end is the total head across the geotextile test specimen (or soil/geotextile test specimen in the case of a combined test column). Note that the elevation of the outlet shall be above the elevation of the geotextile.

5.3 A Hydraulic Head Standpipe, above the flow column is required for falling hydraulic head monitoring. Figure 3 shows this type of test configuration in which a clear plastic standpipe is placed above the flow column. Liquid movement is monitored for the time of flight between two marks on the standpipe. Note that the elevation of the outlet shall be above the elevation of the geotextile.

5.4 The Overall Test System, dimensions are sufficiently small so that either of the above mentioned units can be used at a field site if desirable. They can either be kept stationary in the laboratory or in the field, or they can be transported from the laboratory to the field site when required.

5.5 The Permeating Liquid, is generally site specific and often comprises landfill leachate. Other liquids for which biological clogging is of concern can also be evaluated. The liquid can be synthesized on an as-required basis.

6 PREPARATION OF TEST SPECIMEN

6.1 Take the sample from a swatch extending in width of the fabric and approximately 1 m along the selvage

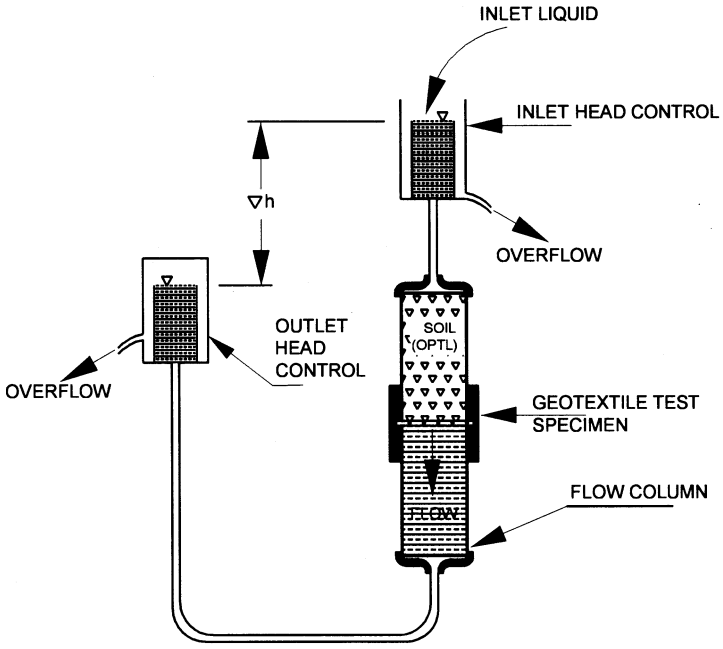

FIG. 2 FLOW COLUMN WITH INLET AND OUTLET HYDRAULIC HEAD CONTROL DEVICES FOR CONSTANT HEAD TEST

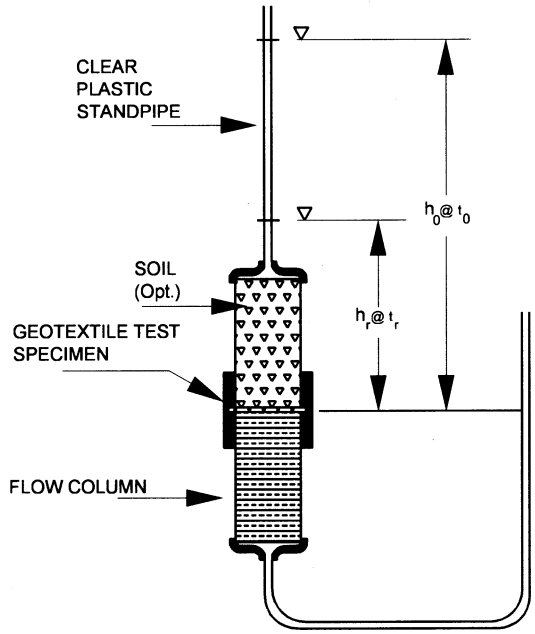

FIG. 3 FLOW COLUMN WITH STANDPIPE FOR VARIABLE (FALLING) HEAD TEST

from each roll in the lot sample. Take a swatch such a way that fabric from the outer wrap of the roll or the inner wrap around the core is avoided.

6.2 Take no specimens nearer the selvage or edge of the laboratory sample than 10 percent of the width of the laboratory sample. The minimum specimen diameter shall be 100 mm so that full fixity can be achieved around the inside of the flow column.

7 CONDITIONING

7.1 There is no conditioning of the geotextile test specimen, *per se*, since this test method is a hydraulic one and the conditions of the permeating fluid shall be the controlling factor.

7.2 The relative humidity shall be 100 percent except during times of air drying between non saturated test readings. For saturated conditions the relative humidity shall always be 100 percent.

7.3 The temperature of the test over its entire duration is important. It is desirable to track temperature continuously. If not possible, frequent readings at regular intervals are required.

8 PROCEDURE

8.1 Procedure A — Constant Head Test

8.1.1 Select and properly prepare the geotextile test specimen. Trim the specimen to the exact and full diameter of the inside of the flow column.

8.1.2 Fix the geotextile test specimen to the inside of the containment ring. If water insoluble glue is used be sure that any excess does not extend into the flow area of the geotextile.

8.1.3 Caulk the upper surface of the geotextile to the inside of the containment ring using a silicon based caulk and allow it to completely cure. The caulk shall be carefully placed so as not to restrict flow through the geotextile.

8.1.4 Insert the upper and lower tubes into the containment ring and create a seal. If polyvinyl chloride (PVC) tubing and fittings are being used, first a cleaner and then a solvent wipe is used to make the bond.

8.1.5 If a screen or gravel of approximately 50 mm size is necessary to support the geotextile, it shall be placed with the device in an inverted position.

8.1.6 Place the lower end cap on the device and make its seal.

8.1.7 If soil is to be placed over the geotextile, place it at this time. Place the soil at its targeted moisture content and density taking care not to dislodge or damage the geotextile beneath.

8.1.8 Place the upper end cap on the device and make a permanent seal.

8.1.9 Connect flexible plastic tubing from the flow column's top and bottom to the head control devices. At this point the system shall appear as shown in Fig. 2.

8.1.10 Adjust the total head lost to 50 mm and initiate flow via the introduction of the permeating fluid to the system. When using leachate, proper safety and health precautions shall be maintained depending upon the nature of the leachate itself.

8.1.11 Convert the liquid collected from the discharge tube to flow rate (litres/min) and repeat the measurement three times. Report the average of this value.

8.1.12 Increase the total head lost if desired. Heads of 100 mm, 200 mm, and 300 mm may be considered. These relatively high values of total head may be required if the geotextile begins to clog.

8.1.13 After readings are completed, disconnect the head control devices. If non-saturated (aerobic) conditions are desired, the bottom end cap outlet is allowed to vent to the atmosphere. If saturated conditions are desired, the flexible plastic tubing from the bottom end cap shall remain in position and be brought higher than the elevation of the geotextile or soil within the test column. This will maintain saturated conditions between readings.

8.1.14 Use fresh liquid for each set of measurements since changes, either biological or particulate in nature, may influence the test results.

8.2 Procedure B — Falling Head Test

8.2.1 Select and properly prepare the geotextile test specimen. Trim the specimen to the exact and full diameter of the inside of the flow column.

8.2.2 Fix the geotextile test specimen to the inside of the containment ring. If water insoluble glue is used be sure that an excess amount does not extend into the flow area of the geotextile.

8.2.3 Caulk the upper surface of the geotextile to the inside of the containment ring using a silicon based caulk and allow it to completely cure. The caulk shall be carefully placed so as not to restrict flow through the geotextile.

8.2.4 Insert the upper and lower tubes into the containment ring and create a permanent seal. If polyvinyl chloride (PVC) tubing and fittings are being used, first a cleaner and then a solvent wipe is used to make the bond.

8.2.5 If a screen or a gravel of approximately 50 cm size is necessary to support the geotextile, it shall be placed with the device in an inverted position.

8.2.6 Place the lower end cap on the device and make it seal.

8.2.7 If soil is to be placed over the geotextile, place it at this time. The soil shall be placed at its targeted moisture content and density taking care not to dislodge or damage the geotextile beneath.

8.2.8 Place the upper end cap on the device and make a seal.

8.2.9 Attach a clear, rigid plastic standpipe to the upper end cap. The standpipe shall have clearly visible markings at regular intervals to monitor the movement of liquid. At this point the system shall appear as shown in Fig. 3.

8.2.10 Fill the standpipe to a level above its upper mark.

8.2.11 Allow for flow through the system until the liquid level reaches the upper mark and then start a stopwatch.

8.2.12 Allow flow to continue unimpeded until the liquid level reaches the lower standpipe mark and immediately stop the stopwatch so as to record the elapsed time.

8.2.13 Repeat this measurement procedure three times. The average of this value is to be reported.

8.2.14 After readings are completed, disconnect the head control devices. If non-saturated conditions are desired, the bottom end cap outlet is allowed to vent to the atmosphere. If saturated conditions are desired, the flexible plastic tubing from the bottom end cap shall remain in position and be brought higher than the elevation of the geotextile or soil within the test column. This will maintain saturated conditions between readings.

8.2.15 Use fresh liquid for each set of measurements since changes, either biological or particulate in nature, may influence the test results.

9 CALULATION

9.1 Procedure A — Constant Head Test

9.1.1 Flow rate per unit area, is calculated on the basis of the average flow rate measured during conducting of the test. This value is then divided by the cross sectional area of the geotextile for the flow rate per unit area or 'Flux'. The units are litres/min-cm^2.

9.1.2 Permittivity can be calculated by using Darcy's formula for constant head flow test as follows:

$$q = kiA$$

$$\frac{q}{A} = ki$$

$$\frac{q}{A} = k\frac{\Delta h}{t}$$

$$\frac{q}{t\Delta h} = \frac{k}{t} = \psi$$

where

q = flow rate (L^3/T);
A = cross-sectional area (L^2);
k = coefficient of permeability (L/T);
t = geotextile thickness (L);
i = hydraulic gradient (L/L);
Δh = change in total head (L), and
ψ = permittivity (T^{-1}).

9.1.3 Plotting of the results is very descriptive of the process as it is on-going. Figure 4 presents a number of possible trends in the resulting behaviour.

9.2 Procedure B — Falling Head Test

9.2.1 Permittivity is calculated when using the geotextile by itself with no soil. It is based on Darcy's formula which is integrated over the head lost during the arbitrary time interval Δt and results in the following equation:

$$\frac{k}{t} = \psi = 2.3\frac{a}{A\Delta T}\log_{10}\frac{h_o}{h_f}$$

where

k = coefficient of permeability (L/T),
t = thickness (L),
ψ = permittivity (T^{-1}),
a = area of liquid supply standpipe (L^2),
A = area of test specimen (L^2),
ΔT = time change between h_o and h_f (T),
h_o = head at beginning of test (L), and
h_f = head at end of test (L).

9.2.2 The permeability coefficient is calculated when using soil and geotextile together. It uses the exact formulation as above in the following form.

$$k = 2.3\frac{at}{A\Delta T}\log_{10}\frac{h_o}{h_f}$$

9.2.3 Plotting of the results is very descriptive of the process as it is on-going. Figure 4 presents a number of possible trends in the resulting behaviour.

10 REPORT

10.1 State that the specimens were treated as directed in this test method or state what modifications were made.

10.2 Report on the following information:

a) The method of holding the test specimen in the containment ring.
b) The use or non use of soil above the geotextile.
c) The type, style and description of the geotextile test specimen.
d) The type of permeating liquid.
e) Whether non-saturated or saturated test conditions.

10.3 Report on trends in the results:

a) The behaviour of the curves (*see* Fig. 4 for possible trends).
b) The reasons for terminating the tests.
c) The temperature of the liquid used in the tests.
d) Possible remediation schemes if clogging occurred.

10.4 Identify the micro-organisms which caused the clogging if it occurred (optional).

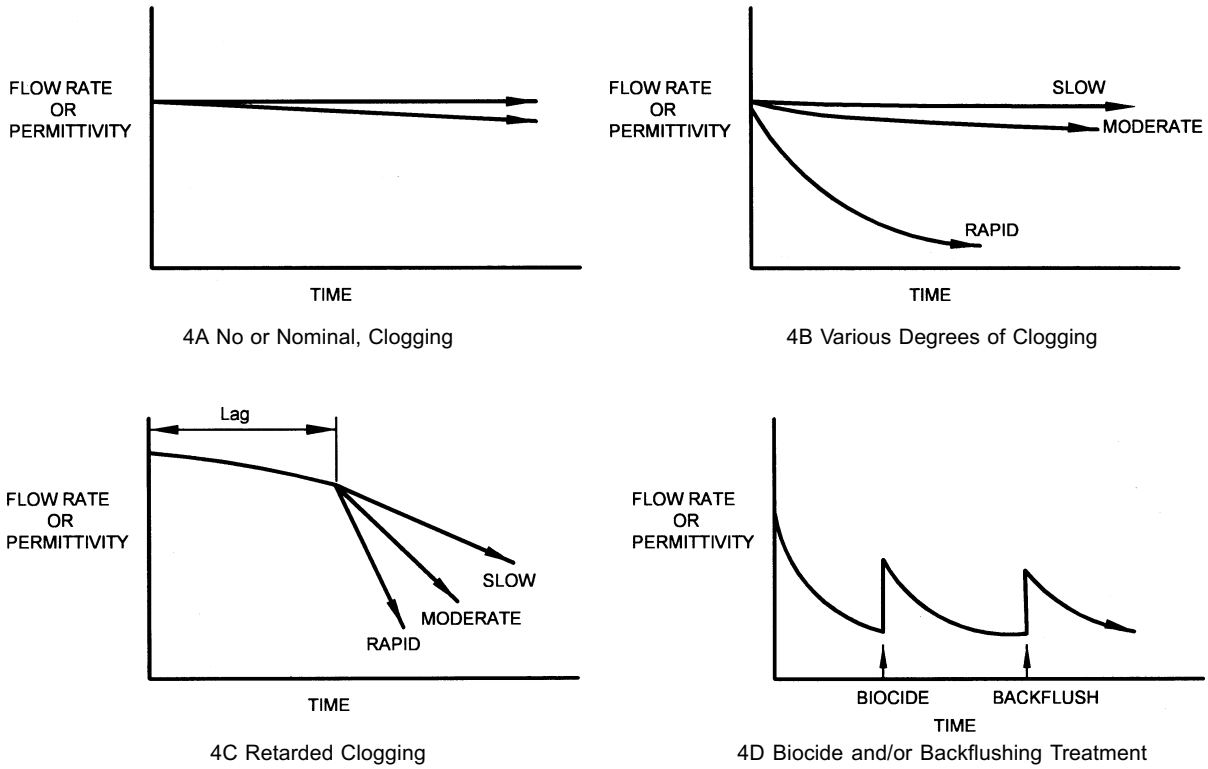

FIG. 4 POSSIBLE LONG-TERM FLOW BEHAVIOUR OF GEOTEXTILE FILTER SUBJECTED TO LIQUIDS CONTAINING BIOLOGICAL MICRO-ORGANISMS

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Geosynthetics Sectional Committee, TX 30

Organization	*Representative(s)*
The Bombay Textile Research Association, Mumbai	Dr A. N. Desai (***Chairman***) Shri V. K. Patil (*Alternate*)
Business Coordination House, New Delhi	Shri Samir Gupta Shrimati Ritika Gupta (*Alternate*)
Central Road Research Institute, New Delhi	Shri Sudhir Mathur Shri Jai Bahagwan (*Alternate*)
Central Soil and Materials Research Station, New Delhi	Shri Nripendra Kumar Shri Manish Gupta (*Alternate*)
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Supreme Nonwovens Pvt Ltd, Hyderabad	Shri C. K. Chaudhuri Shri C. K. Jain (*Alternate*)
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Member Secretary
Shri J. K. Gupta
Scientist 'C' (TXD), BIS

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards : Monthly Additions'.

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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