IS 14324 (1995): Geotextiles - Methods of test for determination of water permeability-permittivity [TXD 30: Geotextiles and Industrial Fabrics]

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भारतीय मानक

भूवस्त्रादि — जलपारगम्यता ज्ञात करने की परीक्षण पद्धतियाँ — अनुमतता

Indian Standard

GEOTEXTILES — METHODS OF TEST FOR DETERMINATION OF WATER PERMEABILITY — PERMITTIVITY

ICS 59·080·70

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Geotextiles Sectional Committee, TX 29

FOREWORD

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

Water permeability is the rate of flow of water under a differential pressure through a material. However, as geotextiles of various thicknesses are used, their evaluation in terms of coefficient of permeability can be misleading. In many instances, it is more significant to evaluate the volumetric flow rate of water per unit cross-section per unit head under laminer flow conditions in the normal directions and is expressed as permittivity.

If the permeability of an individual geotextile is of importance, a nominal coefficient of permeability, as related to geotextile engineering, may be computed by multiplying permittivity with the nominal thickness of the geotextiles.

In the preparation of this standard, assistance has been drawn from ASTM Designation : D 4491-89 'Standard test methods for water permeability of geotextiles by permittivity', issued by American Society for Testing and Materials, USA.

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

GEOTEXTILES — METHODS OF TEST FOR DETERMINATION OF WATER PERMEABILITY — PERMITTIVITY

1 SCOPE

This Indian Standard specifies methods for determining the water permeability of geotextiles in terms of permittivity under standard testing conditions, in the uncompressed state. The standard covers two procedures — the constant head method and the falling head method.

2 REFERENCES

IS 13321 (Part 1) : 1992 'Glossary of terms for geosynthetics: Part 1 Terms used in materials and properties' is a necessary adjunct to this standard.

3 TERMINOLOGY

For the purpose of this standard, definitions given in IS 13321 (Part 1) : 1992 shall apply.

4 PRINCIPLE OF TEST METHODS

4.1 Constant Head Test

A head of 50 mm water is maintained on the geotextile throughout the test. The quantity of flow is measured *versus* time. The constant head test is used when the flow rate of water through the geotextile is so large that it is difficult to obtain readings of head change *versus* time in the falling head test.

4.2 Falling Head Test

A column of water is allowed to flow through the geotextile and reading of head changes *versus* time is taken. The flow rate of water through the geotextile shall be slow enough to obtain accurate readings.

NOTE — Data has shown agreement between the falling and constant head methods of determining permittivity of geotextiles and as such any test method may be used.

5 APPARATUS

5.1 The apparatus shall conform to one of the following arrangements:

a) The apparatus shall be capable of maintaining a constant head of water on the geotextile being tested, or

b) The apparatus shall be capable of being used as falling head apparatus.

5.2 In addition, the apparatus shall not be the controlling agent for flow during the test. Accordingly, it will be necessary to establish a calibration curve of volumetric flow rate *versus* head for the apparatus alone in order to establish compliance with this requirement (*see* **9.1.6**).

5.3 The device consists of an upper and lower unit which fasten together as shown in Fig. 1. The geotextile specimen is positioned in the bottom of the upper unit. There is a standpipe for measuring the constant head value. The rotating discharge pipe allows adjustment of the head of water at the bottom of the specimen.

6 SAMPLING

Take a full width sample of geotextile of sufficient length from each sample roll of the geotextile so that the requirements of **8.1** can be met. The sample shall exclude material from the outer wrap of the roll or the inner wrap around the core unless the sample is taken at the production site, at which point inner and outer wrap material may be used.

7 PREPARATION OF TEST WATER

7.1 To ensure reproducible test results, the test water shall be de-aired under a vacuum of 710 mm of mercury (Hg) for a period of time to bring the dissolved oxygen content down to a maximum of 6 parts per million. The dissolved oxygen content may be determined by either commercially available chemical kits or by a dissolved oxygen meter.

NOTE — The de-airing system may be either a commercially available system or one consisting of a vacuum pump capable of removing a minimum of 150 litres/min of air in connection with a non-collapsible storage tank with a large enough storage capacity for the test series, or at least one specimen at a time.

7.2 The de-aired water be allowed to stand in a closed storage tank under a slight vacuum until room temperature is attained.

8 SPECIMEN PREPARATION

8.1 In order to obtain a representative value of permittivity, take specimens from each 1 m^2 sample.

8.2 Select four specimens, *A*, *B*, *C*, and *D*, as follows:

- Take specimen *A* at the centre of the sample *B* at one corner (centre located 200 mm from the corner), *C* midway between *A* and *B*, and *D* the same distance from *A* as *C*, located on a line with *A*, *B* and *C*, as shown in Fig. 2.
- Cut specimens shall fit the testing apparatus, for example, 73 mm in diameter for the device illustrated in Fig. 1.

8.3 Condition the specimen by soaking in a closed container of de-aired water, at room conditions, for a period of 2 hours. The minimum specimen diameter shall be 25 mm.

NOTE — If the illustrated device is used, the specimens are attached to the specimen ring by contact cement.

9 PROCEDURE AND CALCULATION

9.1 Constant Head Method

9.1.1 Assemble the apparatus with the specimen in place. Open the bleed valve and backfill the system through the standpipe or discharge pipe, with de-aired water. Backfilling in this manner forces any trapped air out of the system and the geotextile.

NOTE — The water should be at the bottom level of the specimen at the time of specimen installation.

9.1.2 Close the bleed valve once water flows from it. Continue to fill the apparatus with de-aired water until the water level reaches the overflow.

9.1.3 With water flowing into the system through the water inlet, adjust the discharge pipe along with the rate of water flowing into the apparatus to obtain a 50 mm head of water on the geotextile under which the test will be performed initially.

9.1.4 Submerge a tube attached to a source of vacuum to the surface of the geotextile and move the tube gently over the surface while applying a slight vacuum to remove any trapped air which may be in or on the specimen. If necessary, readjust the head to 50 mm after removing the vacuum.

9.1.5 Record the values of time (t), quantity of flow (Q) as collected from the discharge pipe, and water temperature (T), holding the head at 50 mm. Make at least five readings per specimen and determine an average value of permittivity for the specimen.

NOTE — The quantity of flow may be measured in millilitres and then converted to cubic millimetres for the computation of permittivity (1 ml = 1 000 mm³).

9.1.6 After the first specimen has been tested under a 50 mm head, using the same specimen, start with a 10 mm head and repeat the procedure. Increase the head by 5 mm after every five readings. Increase the head until a 75 mm head is reached. Use this data to determine the region of laminar flow. Plot volumetric flow rate, v (where v equals Q/At, values defined in **9.1.8.1**) *versus* head. The quantity of flow (Q) should be corrected to 27°C. The initial straight line portion of the plot defines the region of laminar flow. If the 50 mm head is outside the region of laminar flow, repeat the test procedure using the head of water in the mid region of laminar flow.

9.1.6.1 Compare the data from **9.1.6** with the apparatus calibration curve referred to in **5.2**. If the specimen curve intersects the calibration curve, the apparatus is controlling the flow through the geotextile rather than the structure of the geotextile itself. In such an instance, modify the apparatus by enlarging the discharge pipe so that the device does not control the flow.

9.1.7 Repeat **9.1.1** through **9.1.6** on the three remaining previously conditioned specimens.

9.1.8 *Calculation*

9.1.8.1 Calculate the permittivity, ψ, as follows:

$$\psi = QR_t/hA_t$$

where

ψ = permittivity, s^{-1};
Q = quantity of flow, mm^3;
h = head of water on the specimen, mm;
A = cross-sectional area of test area of specimen, mm^2;
t = time for flow (Q), s; and
R_t = temperature correction factor determined using the following equation:

$$R_t = u_t/u27c \qquad \text{......... (1)}$$

where

u_t = water viscosity at test temperature in millipoises, as determined from Table 1; and
$u27c$ = water viscosity at 27°C, millipoises.

9.1.8.2 Calculate the permittivity for the five sets of readings per specimen at the 50 mm head.

9.1.8.3 Determine the average permittivity for the individual specimen tests.

9.1.8.4 Determine the average permittivity for the four specimens tested.

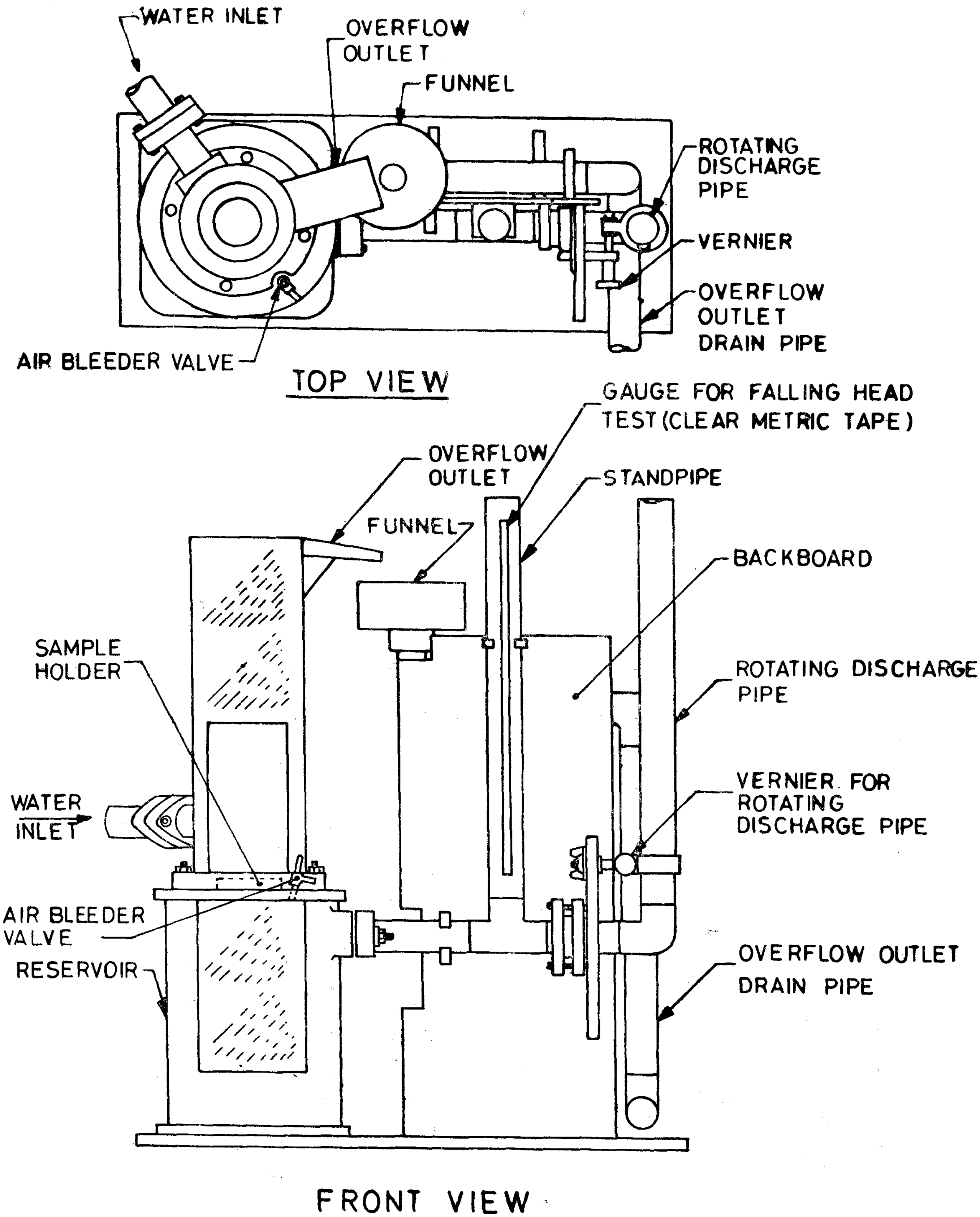

Fig. 1 Constant and Falling Head Permeability Apparatus

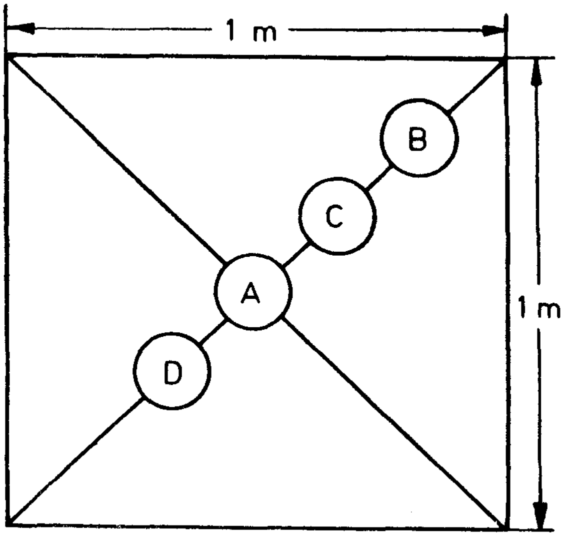

FIG. 2 SAMPLING PATTERN

9.1.8.5 Determine the standard deviation and coefficient of variation for the four specimens tested.

9.2 Falling Head Test

9.2.1 Proceed as in **9.1.1** through **9.1.4**.

9.2.2 Adjust the discharge pipe so that its outlet is below the level of the specimen.

9.2.3 Adjust the water level to 150 mm. Once the water is at this level, shut off the water supply and allow the water level to fall to 80 mm. At this point, start the stop watch and determine the time for the water level to fall to the 20 mm level. Record the inside diameter (d) of the upper unit, the diameter (D) of the exposed portion of the specimen, and the water temperature (T). Make at least five readings per specimen.

9.2.4 Repeat the procedure on the three remaining previously conditioned specimens.

9.2.5 *Calculation*

9.2.5.1 Calculate the permittivity, ψ as follows:

$$\psi = [\,(a/At)\ \ln\,(h_0/h_1)\,]R_t$$

where

a = $\pi d^2/4$ — cross-sectional area of standpipe above specimen;

A = $\pi D^2/4$ — cross-sectional test area of specimen, mm^2;

t = time for head to drop from h_0 to h_1, s;

h_0 = initial head (80 mm);

h_1 = final head (20 mm); and

R_t = temperature correction factor determined from Eq 1.

Table 1 Viscosity of Water *Versus* Temperature

(*Clause* 9.1.8.1)

Temperature, °C	Viscosity (millipoise)[1]
0	17·94
1	17·32
2	16·74
3	16·19
4	15·68
5	15·19
6	14·73
7	14·29
8	13·87
9	13·48
10	13·10
11	12·74
12	12·39
13	12·06
14	11·75
15	11·45
16	11·16
17	10·88
18	10·60
19	10·34
20	10·09
21	09·84
22	09·61
23	09·38
24	09·16
25	08·95
26	08·75
27	08·55
28	08·36
29	08·18
30	08·00
31	07·83
32	07·67
33	07·51
34	07·36
35	07·21

[1]Poise = $kg\ s^{-1}\ m^{-1}$ = Nsm

9.2.5.2 Repeat calculations for the five sets of data per specimen. Determine the average permittivity for the individual specimens tested.

10 REPORT

The report shall include the following:

a) Procedure used;

b) Any deviations from the standard test method, such as a head other than 50 mm for the constant head procedure;

c) Average permittivity;

NOTE — To express permittivity in litres per unit area per unit head per time ($1/m^3/min$) multiply the results obtained in 9.1.8.4 or 9.2.5.2 by 6×10^7.

d) Standard deviation for the individual observations;

e) Coefficient of variation for the four observations; and

f) A plot of flow rate *versus* head for the laminar flow test in the constant head procedure.

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BUREAU OF INDIAN STANDARDS

Headquarters:
Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002

Telephones : 331 01 31, 331 13 75

Telegrams : Manaksanstha
(Common to all Offices)

Regional Offices :	Telephone
Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	331 01 31 331 13 75
Eastern : 1/14 C. I. T. Scheme VIII M, V. I. P. Road, Maniktola CALCUTTA 700054	37 84 99, 37 85 61 37 86 26, 37 86 62
Northern : SCO 335-336, Sector 34-A, CHANDIGARH 160022	60 38 43, 60 20 25,
Southern : C. I. T. Campus, IV Cross Road, MADRAS 600113	235 02 16, 235 04 42 235 15 19, 235 23 15
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