

Australian Standard[®]

AS 3706.9—2012

Geotextiles—Methods of test

Method 9: Determination of permittivity, permeability and flow rate

1 SCOPE

This Standard sets out the method for determining the permittivity of geotextiles by measuring the flow of water through the fabric normal to its surface under a constant head.*

2 APPLICATION

This method is applicable to both woven and non-woven geotextiles.

NOTE: The test is intended to simulate laminar flow conditions. The permittivity will vary significantly with the flow rate in turbulent flow conditions. It should also be remembered that the permittivity may decrease under in-service conditions if the geotextile is placed in the soil (e.g. owing to compressive stresses and contamination).

3 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

1289 Methods of testing soils for engineering purposes

1289.6.7.1 Method 6.7.1: Soil strength and consolidation tests—Determination of permeability of a soil—Constant head method for a remoulded specimen

3704 Geotextiles—Glossary of terms

3706 Geotextiles—Methods of test

3706.1 Method 1: General requirements, sampling, conditioning, basic physical properties and statistical analysis

4 PRINCIPLE

Water is made to flow at a constant rate under laminar flow conditions through a specimen comprising one or more layers of fabric with a known cross-sectional area. The head loss is measured using piezometric tubes. Measurements are made using at least five different flow rates, and the permittivity is determined by graphical methods.

NOTES:

- 1 The determination of the permittivity (ψ) is based on Darcy's law. This means that ψ is only constant for a particular material if laminar flow conditions exist, which is likely in a typical soil environment where geotextiles are used.
- 2 It appears that for most fabrics, Darcy's law holds if the approach velocity (the velocity of the water approaching the fabric) is kept at or below 0.035 m/s.

5 DEFINITIONS

For the purpose of this Standard, the definitions given in AS 3704 apply.

* This method is based on RILEM SM-9, *Synthetic membranes—Geotextiles. Hydraulic permittivity.*

6 APPARATUS

6.1 Supply of de-aired water

If the dissolved oxygen content in de-aired water is more than 6 mg/L, water that is used for this test shall be de-aired under a vacuum.

Where de-aired water is not available, the dissolved oxygen content of the water that is used shall be measured and recorded.

If air bubbles or sediments are trapped in the fabric, its permittivity could be reduced significantly. The formation and trapping of these bubbles and sediments on the fabric shall be observed visually and reported.

If de-aired water is not available, improved results may be obtained if the water is filtered upstream of the test specimen by a fabric similar to or finer than that being tested.

6.2 Permeameter

A permeameter shall be supplied, which shall be transparent and have the following features:

- (a) Means of supplying and controlling a flow of water with a steady approach velocity between 0 m/s and 0.035 m/s, which may be either a valve to control the flow rate or a means to vary the head.
- (b) Piezometric tubes for measuring head loss in the range between 0 mm and 500 mm across the specimen. For small head losses, an inclined alcohol manometer may be used.
- (c) A clamping system to hold the test specimen firmly without distortion and leakage both before and during the test (see Notes 1 and 2)
NOTE: The area (A) of the specimen when fixed in the tube (see Figure 1) should be not less than 2000 mm².
- (d) A flow rate meter connected to the system, but not situated between the piezometric tubes. Where the permeameter has no flow meter, it shall have a container, timer, and weighing apparatus for water.
- (e) Thermometer.

NOTES:

- 1 Distortion (bulging under pressure) of woven fabrics may decrease their permittivity. A supporting grid may be used to prevent excessive distortion under high flow rates.
- 2 A typical test arrangement is shown in Figure 1.

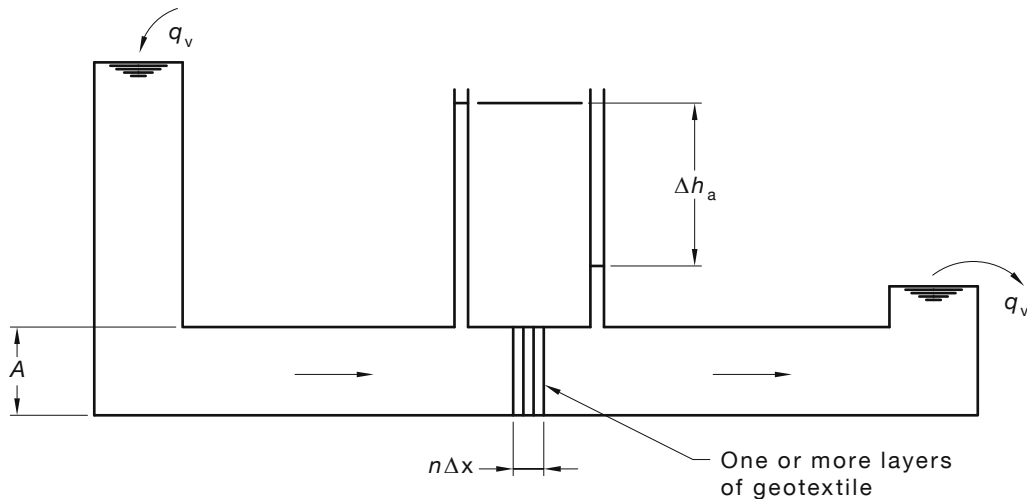


FIGURE 1 SCHEMATIC DIAGRAM OF CONSTANT-HEAD PERMEAMETER

7 PREPARATION OF TEST SPECIMENS

7.1 Sampling

A minimum of five specimens shall be sampled in accordance with AS 3706.1. Each specimen shall have a minimum area of 2000 mm² plus a border for clamping, and shall fit neatly in the opening of the permeameter tube.

7.2 Conditioning

The specimens shall be wet-conditioned in accordance with AS 3706.1.

8 PROCEDURE

The procedure shall be as follows:

- If the coefficient of permeability is to be reported, determine the thickness of each specimen in accordance with AS 3706.1 to 0.01 mm.
- Measure and record the temperature of the water.
NOTE: If temperature corrections are to be made, see AS 1289.6.7.1
- Operate the water supply. Determine the head loss of the apparatus between the standpipes for several approach velocities up to 0.035 m/s. Prepare a graph of head loss versus flow.
NOTE: Depending on the apparatus, particularly the use of a supporting grid to prevent excessive deformation of the specimen, measurable head losses may occur in the apparatus between the standpipes, shown in Figure 1. This needs to be determined without the specimen in place.
- Turn off the water supply. Remove a specimen from wet-conditioning and immediately place in the permeameter, clamping it firmly in position.
- Slowly saturate it by raising the water level.
- Operate the water supply. Establish a steady state flow condition and remove any air from the system.
NOTE: If air bubbles form on the test specimen the permeameter may be lightly tapped to aid in their removal.
- Measure the flow rate through the single-layer specimen and calculate the approach velocity.

- (h) If the approach velocity is more than 0.01 m/s, bring it below 0.01 m/s by one of the following:
- (i) Adding one or more additional layers of fabric, placed at varying orientations by the relative rotation of adjacent layers, the resulting test piece or combination of pieces comprising one specimen.
NOTE: Multi-layer testing of non-woven fabrics gives fairly consistent results, but significant discrepancies may be observed in some types of woven fabrics.
 - (ii) Adjusting the flow rate by reducing the head or closing the valve.
 - (iii) For each specimen, taking not less than five measurements of head loss corresponding to five different approach velocities. As a minimum, two of these approach velocities shall be chosen below 0.01 m/s and another one shall be between 0.01 m/s and 0.035 m/s, unless the head loss exceeds limitations of the equipment.
- (i) Repeat Steps (d) to (h) until a minimum of five specimens have been tested.
NOTE: Further testing may be required in accordance with Step (j) and Clause 9.3.
- (j) Reject abnormal results in accordance with AS 3706.1, and test other specimens from the same roll.

9 CALCULATIONS

9.1 For each specimen

9.1.1 Calculation of permittivity

The permittivity for each specimen shall be calculated as follows:

- (a) Take the measured head loss (Δh_a) at the flow rate, and correct it by deducting any head loss inherent in the apparatus alone, including any supporting grid, to give the true head loss across the specimen (Δh).
- (b) The permittivity may be determined for particular flow readings, if required, from the following equation:

$$\psi = \frac{q_v n}{A \Delta h} \quad \dots 9.1.1(1)$$

where

- ψ = permittivity, in reciprocal seconds
- q_v = flow through specimen, in cubic metres per second
- n = number of layers of fabric
- A = cross-sectional area of specimen exposed to the water flow, in square metres
- Δh = true head loss, in metres

- (c) Plot on a graph the measured flow rates (q_v) versus the head loss per layer ($\Delta h/n$). Add a scale for corresponding approach (flow) velocities.
- (d) Draw the straight line of best fit from the origin of the graph through the plotted points.

NOTE: For some types of fabrics, the graph may appear to be a curve. In this case, draw a line from the origin to the point corresponding to 10 mm or 50 mm head loss and report accordingly (see Figure 2).