

Australian Standard®

Geotextiles—Methods of test

Method 5: Determination of puncture resistance—Drop cone method

PREFACE

This Standard was prepared by the Standards Australia committee CE-020, Geosynthetics, to supersede AS 3706.5—2000.

The determination of the puncture resistance with the drop cone makes use of the modified CBR mould. Evaluating the resistance to puncture, this test is particularly relevant in situations where coarse aggregates or riprap is dropped or pushed against the fabric.

The term ‘normative’ has been used in this Standard to define the application of the appendix to which it applies. A ‘normative’ appendix is an integral part of a Standard.

METHOD

1 SCOPE

This Standard sets out the method for determining the puncture resistance of geotextiles by the drop cone method for both atmospheric and wet-conditioned specimens.

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

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

1289 Methods of testing soils for engineering purposes

1289.6.1.1 Method 6.1.1: Soil strength and consolidation tests—Determination of the California Bearing Ratio of a soil—Standard laboratory method for a remoulded specimen

3704 Geosynthetics—Glossary of terms

3706 Geotextiles—Method of test

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

3 PRINCIPLE

A circular specimen is gripped around its entire circumference by clamps. A specified cone is dropped onto the surface of the specimen. The diameter of the punctured hole, in combination with the drop height, gives a measure of the puncture resistance.

4 DEFINITIONS

For the purposes of this Standard, the definitions given in AS 3704 and those below apply.

4.1 Puncture diameter (d_h)

The puncture diameter, in millimetres, corresponding to a test drop height of h .

4.2 Standard puncture diameter (d_{500})

The puncture diameter, in millimetres, corresponding to the standard test drop height of 500 mm.

4.3 Puncture resistance (h_{50})

The drop height, in millimetres, required to obtain a puncture diameter of 50 mm.

5 CALCULATION OF PUNCTURE RESISTANCE

Puncture resistance shall be calculated in accordance with Appendix A.

The puncture resistance may be expressed as either—

- (a) diameter of the hole at a drop height as set out in Clause 6; or
- (b) drop height that will produce a hole of diameter 50 mm.

6 SELECTION OF DROP HEIGHT

The test drop height shall be 250 mm, 500 mm, 750 mm, 1000 mm or 1500 mm, ± 1 mm, measured as the distance from the point of the cone to the surface of the geotextile.

A drop height shall be selected such that a hole diameter greater than or equal to 15 mm and less than 50 mm is achieved.

For weaker materials, a drop height of less than 500 mm shall be used if there is a possibility of the cone totally puncturing the geotextile at the 500 mm test height. For stronger materials, a drop height of up to 1500 mm may be used.

NOTES:

- 1 Greater drop heights are not recommended without due consideration of safety issues.
- 2 Guidance on the selection of a drop height is given in Table 1.

TABLE 1
GUIDE TO SELECTION OF DROP HEIGHTS

Type of geotextile	Mass per unit area, g/m ²	Drop height, mm
Non-woven	<100	250
	$\geq 100 < 350$	500 to 750
	$\geq 350 < 500$	750 to 1000
	>500	1500
Woven	≥ 300	500
	>300	>750

NOTE: Preliminary trial tests may be required, the results of which have to be excluded from the calculation of results.

7 APPARATUS

The following apparatus is required:

NOTE: For typical cone test arrangement, see Figure 7.

- (a) *Marking and cutting equipment*—template (see Figure 1) of plastic or metal, felt-tip pen, and either scalpel and cutting board or scissors.
- (b) *Guide block* (see Figure 2)—to support the specimen while being clamped (if required).
- (c) *Clamping rings*—grooved and toothed concentrically, to prevent slipping of the specimen (similar to Figures 3 and 4), with matching bolt holes to locate ‘teeth’ and grooves accurately. The rings are clamped by tightening the bolts (see Figure 5).
- (d) *Means for holding the clamping rings during the test*—a right cylinder of minimum internal diameter 150 mm and minimum height 150 mm (see Notes 1 and 2).
- (e) *Drop cone*—with a mass of 1 kg $\pm$ 1 g, cone angle of 45°, and maximum diameter of 50 mm, made of stainless steel (see Figures 7 and 8) (see Note 3).
- (f) *Suitable release mechanism for drop cone*—a string cut by scissors or mechanical slide release. The release mechanism shall allow freefall of the drop cone, and shall not impart rotation to it.
- (g) *Measuring cone*—with a mass of 1 kg $\pm$ 10 g, diameter of 50 mm, made of stainless steel, and graduated in millimetres (see Figure 6).

NOTES:

- 1 The lower part of a CBR mould complying with AS 1289.6.1.1 is suitable.
- 2 A protective pad should be placed in the bottom of the cylinder to prevent damage to the cone in case it punches through the specimen.
- 3 Care should be taken to ensure that the point of the drop cone does not come into contact with the CBR base plate or the ground due to either total penetration or rebounding from the material surface, which can damage the cone and bring about misleading results. The cone should be kept clean, with the conical surface free of dents and scratches. A cone with a damaged point or conical surface should be discarded.
- 4 The apparatus should be arranged so that the cone falls on the centre of the specimen, with a tolerance of $\pm$ 5 mm.
- 5 The cone may bounce, depending on the strength of the geotextile. A guide should be used to prevent the formation of secondary punctures, i.e. any bounce should take place in the original impact hole. A guide cylinder (e.g. tube with minimum 3 mm all-round clearance to the cone) may be used. Alternatively, a cone with a lower centre of gravity (see alternative cone type in Figure 8) may give improved results in terms of uniform bounce.

8 PREPARATION OF TEST SPECIMENS

8.1 Sampling

A minimum of 10 specimens shall be sampled in accordance with AS 3706.1. Each specimen shall be of a minimum dimension of 195 mm.

8.2 Conditioning

The specimens shall be conditioned either atmospheric or wet, as required, in accordance with AS 3706.1.

9 TEST CONDITIONS

The test atmosphere shall be in accordance with AS 3706.1.

Wet-conditioned specimens shall be tested in the apparatus within 20 min of their removal from the water.

10 PROCEDURE

The procedure shall be as follows:

- (a) Place the lower clamping rings on the guide block so that their upper surfaces are on the same level. Lay the specimen centrally on this level surface, with the face to be tested facing upwards. The same face shall be tested for all specimens (essentially homogeneous geotextiles have recognizable face differences). Place the upper clamping ring over the specimen, at the same time ensuring that the specimen is lying flat and is free of wrinkles. Tighten the clamp uniformly to ensure no slippage during testing. Remove the assembled rings and specimen from the guide block, and place them on the CBR mould or hollow cylinder. Mark the sample around the internal edge of the clamping ring, using a suitable marker.
- (b) Place the drop cone in the release mechanism or suspend it on the end of a length of string. Adjust the height of the point of the cone above the specimen to the required height ± 1 mm (see Clause 6). Locate the specimen so that the cone will strike it at its centre ± 5 mm.
- (c) Operate the cone release mechanism (e.g. cut the string).
- (d) Once the cone has punctured the specimen, immediately remove the cone from the impact hole.
- (e) Insert the measuring cone and allow it to come to rest under its own weight with its axis vertical. Do not push, twist or allow it to fall over.
NOTE: For highly extensible geotextiles it may be necessary to tilt the cone to enable a reading to be made.
- (f) Immediately mark or hold a marker on the lowest point of contact between the measuring cone and the geotextile, to enable a reading to be made.
- (g) Read the measuring cone and record the diameter of the impact hole to the nearest millimetre.
- (h) Reject results if the initial fall of the cone is in any way hindered (e.g. by fouling with guides or falling outside the target centre ± 5 mm) and test other specimens from the same roll.
- (i) Repeat Steps (a) to (g) until a minimum of 10 specimens have been tested.
- (j) Reject any abnormal results in accordance with AS 3706.1 and test other specimens from the same roll.

11 VALUES

11.1 Representative values

Representative values shall be calculated from the puncture diameter (d_h) in accordance with AS 3706.1 as follows:

- (a) Mean (d_h to the nearest 1 mm).
- (b) Standard deviation (d_h to the nearest 0.1 mm).
- (c) Coefficient of variation (to the nearest 0.1%).
- (d) Ninety-fifth percentile value (d_h to the nearest 1 mm).

Test results that were rejected in accordance with the provisions of Steps (h) and (j) of Clause 10 shall not be included in the calculations; however, the rejected results shall be recorded and reported separately.

11.2 Requirements for further testing

11.2.1 *Repeatability of results*

Where the coefficient of variation calculated in Clause 11.1(c) exceeds 20%, additional tests shall be conducted to produce results within the limits of error specified in AS 3706.1. The number of test specimens required to be tested shall be calculated in accordance with AS 3706.1.

11.2.2 *Limits of error*

The results obtained in Clause 11.2 shall be checked to ensure that the acceptable limits of error, as specified by the parties to the test, have not been exceeded. The error in the obtained results shall be deemed satisfactory if the number of tests required, when calculated in accordance with AS 3706.1, does not exceed the number of tests actually conducted.

NOTE: The results of the test may be reported when sufficient tests have been conducted to comply with the requirements of Clauses 11.2.1 and 11.2.2.

12 REPORT

The following information shall be reported:

- (a) The number of this Australian Standard, i.e. AS 3706.5.
- (b) Sampling and testing information as follows:
 - (i) Name of testing authority and client.
 - (ii) Identification of batch or order represented by the sample.
 - (iii) Date or dates of sampling and testing.
 - (iv) Number of specimens tested.
 - (v) Type of conditioning of specimens.
 - (vi) The nominal mass per unit area of the sample if requested.
 - (vii) Face of the specimen tested, where this is relevant.
 - (viii) Test environment (standard or non-standard).
 - (ix) Temperature and relative humidity of the testing atmosphere.
 - (x) Height of drop.
- (c) Representative values for d_h .
- (d) Individual values as follows:
 - (i) Individual test results.
 - (ii) Detailed information about any result that is considered to be abnormal.
- (e) Any modifications of procedure.
- (f) Details of rejected results, including the reasons for the non-inclusion of rejected results in the assessment of the representative values.