British Standard

BRITISH STANDARD

BS 6906-5: 1991

Methods of test for

Geotextiles —

Part 5: Determination of creep

Committees responsible for this British Standard

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Association of Consulting Engineers
British Polyolefin Textiles Association
British Textile Technology Group
Chemical Industries Association
Department of Transport
Department of Transport (Transport and Road Research Laboratory)
ERA Technology Ltd.
Federation of Civil Engineering Contractors
Institution of Civil Engineers
Lambeg Industrial Research Association
Ministry of Agriculture, Fisheries and Food
Ministry of Defence
Society of Engineers Incorporated

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Contents

Foreword

This Part of BS 6906 has been prepared under the direction of the Textiles and Clothing Standards Policy Committee, and forms Part 5 of a comprehensive British Standard on methods of test for geotextiles.

Geotextiles are being used increasingly in the reinforcement of soil structures and earthworks. An important characteristic of these materials, as of all plastics, is that their strain under a constant load is a function of time, i.e. they exhibit marked creep characteristics, in that the application of load may lead ultimately to rupture. These characteristics are also affected by environmental factors, in particular, temperature. Information on creep is essential for any consideration of the use of geotextiles as reinforcement.

The method described uses 50 mm wide specimens of woven textiles and corresponding samples of geogrids or sheathed strips. The specimen is narrower than the 200 mm width used for tensile testing (BS 6906-1) and has been chosen in this way in order to reduce the expense of long-term testing. However, the creep of a conventional woven material arises from two sources: the creep of the warp in tension and the relaxation of the crimp in the warp due to creep in the weft. A 50 mm wide specimen will provide data representative of wider material provided that the friction between warp and weft is sufficent to maintain tension in the weft over the greater part of the specimen width. If the weft becomes completely slack the subsequent creep may be an underestimation of the creep of a wider specimen. Materials that exhibit large lateral contractions under tensile load, such as nonwovens, will need to be tested at greater widths. Creep data are not generally required in the cross direction of woven materials.

For woven materials part of the extension on loading arises from a straightening of the weave structure and is relatively variable, while the subsequent time-dependent elongation, which is due to creep of the fibres, is more consistent. This method therefore requires application of a pre-load. Since the loads to be applied are percentages of the tensile strength, before carrying out this test, it is necessary to determine the tensile strength using the method in BS 6906-1.

In soil the creep of the geotextile is likely to be reduced because of transfer of the load to the soil. In-soil testing is, however, difficult to carry out reproducibly. The air environment represents a controlled and more clearly definable test, the results of which are conservative with regard to the behaviour of the material in service and which may also be used as the basis for estimating the performance in stress-relaxation and under other conditions of complex load.

Information on accuracy of the test is given in Appendix A.

Other Parts of BS 6906 are as follows.

— *Part 1: Determination of the tensile properties using a wide width strip;*

— *Part 2: Determination of the apparent pore size distribution by dry sieving;*

— *Part 3: Determination of water flow normal to the plane of the geotextile under a constant head;*

— *Part 4: Determination of the puncture resistance (CBR puncture test);*

— *Part 6: Determination of resistance to perforation (cone drop test);*

— *Part 7: Determination of in-plane waterflow;*

— *Part 8: Determination of sand-geotextile frictional behaviour by direct shear.*

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 6, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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1 Scope

This Part of BS 6906 describes a method for determining the load-strain-time relationship of geotextiles at a given temperature from a series of constant load tests.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this Part of BS 6906, the following definitions apply.

2.1
gauge length

the distance in the direction of the applied load between two fixed lines on the specimen drawn perpendicular to that direction, measured after application of the pre-tension

2.2
strain

the percentage change in gauge length after application of load, including both that which occurs during loading and that which occurs after the load has been applied

2.3
decade of time

the interval between a specified time and its multiple of ten, for example between 100 h and 1 000 h

2.4
isochronous curve

a curve which indicates the strain of a material under load for a specified time, plotted as load against strain

NOTE Curves for a range of times are generally plotted on the same diagram.

2.5
load

the load in newtons per metre width applied to the specimen, including a pre-tension which is applied at commencement of the test

3 Principle

A test specimen is clamped by jaws at either end across its width. A constant load is applied to the specimen. Strain is measured at specified time intervals.

NOTE The time to rupture may also be determined.

4 Number of tests

Creep tests shall be carried out at loads of 20 %, 30 %, 40 % and 60 % of the maximum load per unit width for the material determined in accordance with BS 6906-1. Tests at additional loads may be appropriate for some materials.

5 Apparatus

5.1 *Loading apparatus,* consisting of a loading frame sufficiently strong so as not to deform or vibrate when in use. It shall provide access for the specimen to be mounted, the load to be correctly applied, and strain monitored. The connections between jaws and loading apparatus shall have sufficient freedom (e.g. universal joints) to ensure that the load is applied uniformly across the width of the specimen. The jaws shall grip the specimen with sufficient firmness to allow minimum slippage. They shall not cause damage nor produce areas of weakness outside the gauge length (see BS 6906-1).

Throughout the test, the load shall be known and maintained constant to within ± 1 %. Where the load is applied by means of weights, with or without a lever, no load cell is necessary provided that the weights and lever ratio have been calibrated previously and that the lever has been balanced with the associated jaw in place.

The pre-tension shall be 1.0 ± 0.2 % of the maximum load per unit width determined in accordance with BS 6906-1.

NOTE 1 In designing lever type apparatus particular attention should be paid to the limits on lever movement necessary to maintain this tolerance.

NOTE 2 This apparatus has been selected as a simple means of establishing zero strain although it is recognized as not ideal.

5.2 *Extensometer(s),* to give strain measurements. Strain of the geotextile under load shall be measured between two lines drawn across the width of the specimen, parallel to each other and to the jaws and at a minimum spacing of 100 mm. If the mass of the extensometer equipment exceeds 1 % of the applied load an appropriate correction shall be made to the load. In general, two extensometers are necessary on opposite sides and ends of the specimen, from which the average reading will compensate for alignment errors. The extensometer shall allow for a resolution of 0.0002 (0.02 %) strain, and its range shall be selected such that it will accommodate material extension during at least the first hour of testing without exceeding its limits of calibration and without adjustment.

6 Conditioning and testing atmosphere

Unless otherwise specified, the test specimens shall be conditioned, and the test conducted in the standard temperate atmosphere for testing textiles defined in BS 1051, i.e. at a relative humidity of 65 ± 2 % and a temperature of 20 ± 2 °C.

Any departure from these conditions, for example due to power failure, shall be noted in the final report.

NOTE 1 The requirement for a specified relative humidity may be relaxed or omitted, if it can be shown that the material is not sensitive to humidity.

NOTE 2 Testing at other temperatures will often be required. Recommended additional temperatures are 10 ± 2 °C, 40 ± 2 °C and 60 ± 2 °C.

7 Test specimens

For geotextile fabrics, take specimens at random from different positions across the width of the laboratory sample. Unless otherwise specified, take no specimens nearer than 100 mm from the selvedge or edge of the geotextile. Cut specimens parallel to the warp (or machine direction) of the geotextile.

Test specimens shall be 50 mm wide, and sufficiently long to allow a separation of 200 mm between the jaws.

NOTE For woven geotextiles that fray, cut each specimen 10 mm wider than the final width and then remove an equal number of threads from each side to obtain the finished dimension. This helps maintain the specimen integrity during the test.

For geomeshes or geogrids choose a specimen width that contains a whole number of ribs and at least one row of nodes or cross-members within the gauge length.

Where appropriate, draw four parallel lines running the full width of the specimen, perpendicular to the length dimension, the inner two separated by 100 mm and the outer two by 200 mm.

Examine specimens for any signs of damage or inperfections. If any specimens are rejected, this shall be noted.

Condition each test specimen for at least 48 h in the test environment (see clause **6**). Do not subject the specimen to any stress or strain which could affect its subsequent performance.

8 Procedure

8.1 Setting up

The apparatus, including the mass of the jaws, shall be balanced before the specimen is mounted.

Mount the test specimen centrally in the jaws with the jaws parallel. Where appropriate, do this by having the outer two lines, which were previously drawn 200 mm apart across the width of the specimen, positioned as close as possible adjacent to the inside edges of the upper and lower jaw. Take care that the specimen length in the machine direction is parallel to the direction of application of force. Attach the apparatus for measuring strain.

8.2 Application of pre-tension

Apply the pre-tension which includes any load due to the mass of the jaws. If possible, record the strain up to application of the pre-tension but do not include it in the overall value of strain.

8.3 Measurement of dimensions

Carry out measurements after application of the pre-tension. Determine the specimen width from the average of three measurements, each made at different positions in the gauge length of the mounted specimen with a resolution of 0.5 mm.

Determine the specimen width of a geogrid from the number of ribs under load multiplied by the average rib spacing as determined from three measurements at separate positions on the roll.

Determine the gauge length from the average of two measurements between the inner two lines drawn on the specimen, to which is attached the extensometer clamps. Make measurements at opposite ends and sides of the specimen, to the nearest 0.5 mm.

8.4 Application of load

Apply the load smoothly but rapidly to the specimen at a rate which will not cause any rebound. This may be checked either by monitoring strain or by a load cell mounted in series with the end of the specimen. The loading time excluding any pre-tension shall be between 2 s and 60 s and shall be recorded.

NOTE 1 Particular attention should be paid to adjusting the mechanism to maintain levers within their calibrated limits (see **5.1**) and to avoiding any undue load on or distortion of the specimen when making such adjustments.

NOTE 2 Starting time is the moment at which the full load is first applied to the specimen.

With certain jaws such as roller grips the specimen will slip during loading. If this slippage is seen to be uneven across the width of the specimen, for example by curvature of one of the outer two lines, abandon the test.

8.5 Measurement of strain

Measure strain and time continuously, or at intervals as given below, after the load is applied.

Record the time of loading. After an elapse of 10 × the period of loading, take not less than the following number of measurements:

four within the first 0.1 h;

four more within the first 1 h;

four more within the next 10 h;

four more within the next 100 h;

four more within the next 1 000 h;

four more within the next 10 000 h.

Take additional readings if there is any possibility of a change in conditions, such as temperature or humidity variations or adjustments to the apparatus.

Unless otherwise specified, the duration of testing shall be not less than 10 000 h, or to failure if this occurs in a shorter time.

NOTE 1 A test duration of 100 h is useful for monitoring of products, but for a full analysis of creep properties, durations of up to 10 000 h will be necessary.

Readjust any extensometer that reaches its limit of measurement or limit of accuracy as rapidly as possible and make a corresponding correction to further readings.

Evaluate the results at regular intervals and inspect the specimen for signs of damage or failure.

NOTE 2 It may be necessary to establish a failure criterion which is indicative of unserviceability other than total separation of the specimen.

Terminate a test either when the specimen has failed, or at the end of the specified period. If the specimen has failed, note the nature of the failure. If it has not failed, note its width, and any signs of local strain or damage before removing it.

9 Results

9.1 Evaluation

Evaluate the results in the following manner:

a) load: express in kilonewtons per metre (or for strip elements in kilonewtons);

b) strain: express in percent or in absolute terms taking the specimen with the pre-tension applied as corresponding to zero strain;

c) time: express in hours.

9.2 Graphical presentation

Plot the results as strain against the logarithm of time. Given sufficient clarity, plot the results from tests at a range of loads on the same diagram (see Figure 1).

10 Test report

The test report shall include the following particulars:

a) number and date of this British Standard, i.e. BS 6906-5:1991;

b) identification of the sample tested;

c) load used;

d) test environment;

e) temporary departures from environmental or load specifications;

f) details of the clamping arrangement;

g) pre-tension and corresponding strain, if measured;

h) loading time;

i) readings of strain against time to the precision given in **5.2**;

NOTE 1 These may be tabulated or plotted.

NOTE 2 Presentation of isochronous curves for 1 h, 10 h, 100 h and further decades, if available, is also recommended.

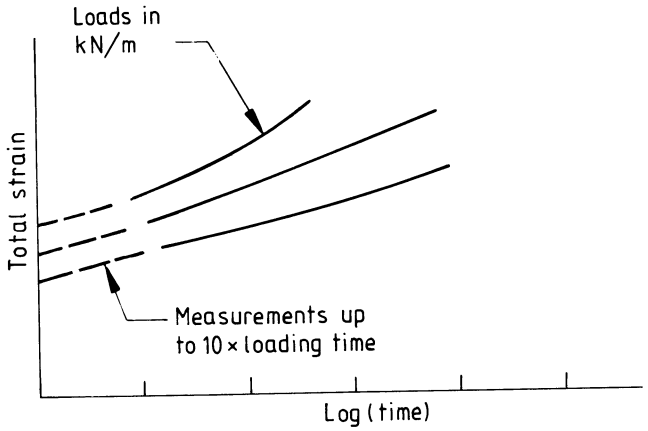

Figure 1 — Strain/time relationship

j) details of tensile or short-term creep tests carried out on adjacent specimens;

k) time to any failure and the nature of failure;

l) gauge length and width tested.

Appendix A Guidance on accuracy of test

Preliminary results from interlaboratory trials suggest that results from different laboratories under otherwise identical conditions are subject to coefficients of variation of between 5 % and 14 %. Examination of the results suggests that the primary source of error may occur during the initial loading of the specimen.

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Publication(s) referred to

BS 1051, *Glossary of terms relating to the conditioning, testing and mass determination of textiles.*
BS 6906, *Methods of test for geotextiles.*
BS 6906-1, *Determination of the tensile properties using a wide width strip.*

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