BRITISH STANDARD

BS 3424 :
Part 21 : 1993

Testing coated fabrics

Part 21. Method 24. Method for determination of elongation and tension set

IMPORTANT NOTE. It is recommended that this Part be read in conjunction with the information in Part 0 'Foreword and general introduction'.

BSI
STANDARDS

Foreword

This revision has been prepared under the direction of the Plastics and Rubber Standards Policy Committee.

The response of many textiles, including coated fabrics, to stresses in the bias direction is particularly important, and this is especially so when one considers that the integrity of a structure depends upon its weakest link. When the tensile properties of textile materials are examined or specified with a particular end-use in mind, their bias direction performance is quite often overlooked.

Tension set, sometimes referred to as permanent set, is defined in various ways depending upon the discipline concerned. The general descriptions of tension set or permanent set, however, invariably agree; it is only the means by which it is derived that differs. In order to avoid any misunderstanding, therefore, a definition of tension set as applied to coated fabrics has been prepared.

The factors affecting the determination of tension set are:

a) the rate at which the specimen is extended;

b) the temperature and relative humidity prior to and during testing;

c) the period or elapse of time between the extension of the specimen and the release of the load or strain;

d) the period allowed for recovery;

e) the previous mechanical history of the specimen.

This last factor can be of particular importance, as specimens can be mechanically conditioned by repeated loadings followed by periods of relative recovery in which some strain is maintained or periods of recovery in which the specimen is under zero strain.

Generally, however, the point of interest in conducting the test is to discover the extent to which the coated fabric will suffer permanent deformation after it has been strained beyond a given point. The extent of the permanent deformation is the value referred to as tension or permanent set.

Because of all these variables and as the designers of coated fabrics for airships, sails and inflated structures will have different interests than designers of coated fabrics for upholstery and clothing applications for example, a method of test has been developed which caters for all these interests and at the same time permits direct comparisons to be made between materials of different types.

For methods related to creep and creep recovery, reference should be made to BS 3424 : Part 0 : 1982.

This edition supersedes BS 3424 : Part 21 : 1987 which is withdrawn.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Contents

Method

1 Scope

This Part of BS 3424 describes a method of test for determining the elongation and tension set of coated fabrics.

2 References

2.1 Normative references

This Part of BS 3424 incorporates, by reference, provisions from specific editions of other publications. These normative references are cited at the appropriate points in the text and the publications are listed on the inside back page. Subsequent amendments to, or revisions of, any of these publications apply to this Part of BS 3424 only when incorporated in it by updating or revision.

2.2 Informative reference

This Part of BS 3424 refers to another publication that provides information. The edition of this publication current at the time of issue of this standard is given on the inside back page but reference should be made to the latest edition.

3 Definitions

For the purposes of this Part of BS 3424 the following definitions apply.

3.1 stress

The force applied to the test specimen.

NOTE. Because of the difficulty of accurately measuring the cross-sectional area of textiles and consequently coated fabrics, cross-sectional area is ignored. Mass per unit area is self cancelling and can be ignored for these purposes.

3.2 strain

The ratio of elongation to original length, i.e the difference between the elongated length of the test specimen and the original length divided by the original length.

3.3 tension set

The extension remaining after a test specimen has been stretched and allowed to retract in a specified manner, expressed as a percentage of the original test length or test strain.

NOTE. This is sometimes referred to as permanent set.

3.4 set

The deformation remaining after complete release of the force producing the deformation.

3.5 yield stress (S_y)

The tensile stress at which occurs the first marked inflection of the stress-strain curve when extended either under the condition described in BS 3424 : Part 4 : 1982 or under the conditions described in this Part of BS 3424.

Where any increase in strain occurs without any increase in stress, this point is taken as the yield stress.

3.6 percentage elongation at yield (E_y)

The percentage elongation produced in the gauge length of the test specimen at the yield stress.

3.7 percentage elongation

The difference between the elongated length of the test specimen and the original gauge length, expressed as a percentage of the original gauge length.

4 Principle

A strip of pre-conditioned coated fabric is extended at a specified rate either until a predetermined percentage elongation or until a predetermined load on the test specimen is attained. This deformation or load is maintained for a specified duration, after which the load is released at a specified rate. The test specimen is then allowed to relax under zero load for a specified duration. The amount of unrecovered deformation is measured.

5 Apparatus

5.1 *Measuring device*, suitable for measuring the distance between the gauge marks (see **6.3**) of the test specimen to the nearest 0.1 mm.

5.2 *Constant rate of traverse tensile testing machine*, having a recording system for measuring the variation in applied force and conforming to grade 1 of BS EN 10002-2 : 1992 or conforming to grade B of BS 5214 : Part 1 : 1975.

The central points of the two jaws of the machine shall be in the line of pull, the front edges of the jaws shall be at right angles to the line of pull, and their clamping faces shall be in the same plane. The jaws shall be capable of holding the test specimen without allowing it to slip; designed so that they do not cut or otherwise weaken the test specimen; and their width shall be not less than the width of the test specimen. The faces of the jaws shall be smooth and flat, except that when, even with packing, the test specimen cannot be held satisfactorily with flat faced jaws engraved or corrugated jaws shall be used. One jaw is nominally fixed and one jaw is capable of moving at a nominal rate of 5 mm/min or as specified in the relevant product specification.

NOTE. Suitable packing materials for use with either smooth or corrugated jaws include paper, felt, leather, plastics or rubber sheet.

6 Preparation of test specimens

6.1 Longitudinal and transverse specimens

Avoiding the selvedges, cut three specimens in the longitudinal direction of the roll and three specimens in the transverse direction of the roll. Each test specimen shall be 50 mm wide and of a length sufficient to allow a distance of 200 mm between the edges of the pairs of clamping jaws.

6.2 Bias direction specimens

Unless otherwise stated in the relevant product specification, cut three samples across the transverse direction of the roll, avoiding the selvedge. Each test sample shall be not less than 200 mm in the longitudinal direction and not less than 400 mm in the transverse direction. Bisect each individual 200 mm × 400 mm test sample by a line AB to yield two adjacent 200 mm × 200 mm test specimens (see figure 1). Draw a line from the bottom left hand corner of the 200 mm × 400 mm test sample to the top of the bisecting line and from this point down to the bottom right hand corner of the 200 mm × 400 mm test sample. This yields 'left hand' and 'right hand' bias test specimens (see figure 1).

Mark each bias specimen with individual identification as shown in figure 1 and then cut along the bisecting line AB. Mark each bias specimen in accordance with figure 2.

6.3 Gauge marking of test specimens

Across the centre of each test specimen draw gauge marks 100 mm apart at right angles to the length of the test specimens as shown in figure 2.

7 Conditioning

Condition the test specimens in accordance with BS 3424 : Part 2 : 1992.

8 Procedure

8.1 Standard atmospheres

Conduct the test in the standard atmosphere for conditioning and testing specified in BS 3424 : Part 2 : 1992.

8.2 Clamping and marking

8.2.1 *Clamping*

Set the jaws of the machine 200 mm ± 1 mm apart. Clamp a test specimen centrally in the stationary jaw so that its longitudinal centre line passes through the centre points of the front edges of the jaws.

8.2.2 *Marking*

Make a small mark across the test specimen at each of the jaw/specimen interfaces with a suitably coloured crayon, so that any slippage of the specimen in the jaws can be ascertained.

8.3 Operation

8.3.1 *General*

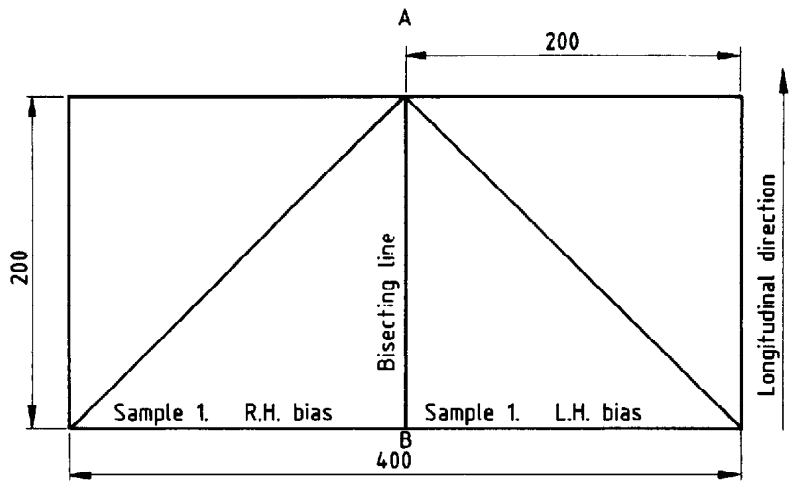
When a bias sample is being evaluated, each single test consists of a left hand and right hand bias test specimen from one original test sample. There are two basic modes of operation, either:

a) mode 1, in which the test specimen is strained to a given percentage elongation; or

b) mode 2, in which the test specimen is stressed up to a given load.

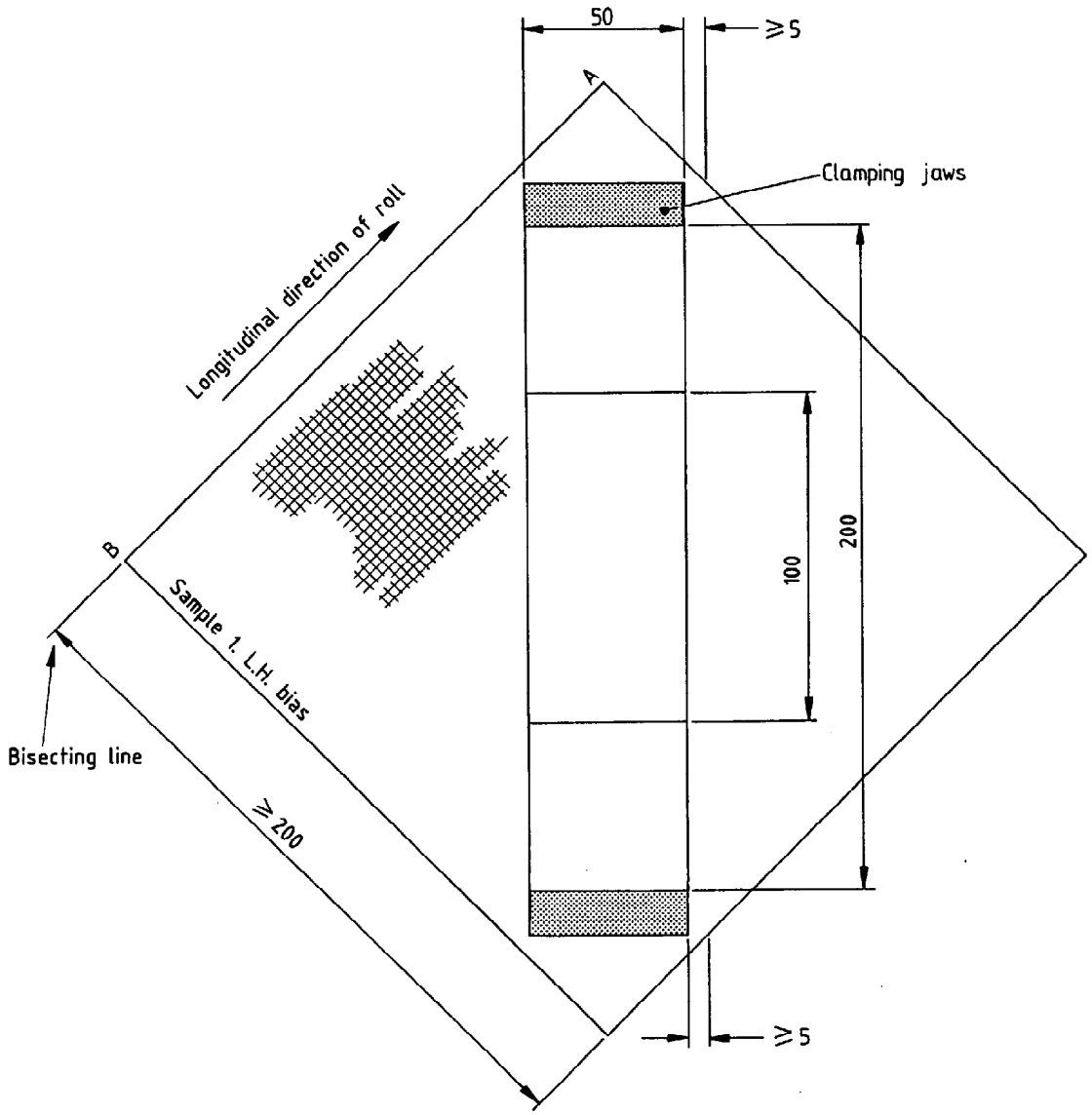
8.3.2 *Mode 1 operation*

Engage the device for recording the stress (load) and extension of the test specimen. Put the moving jaw in motion and extend the test specimen at the nominal rate of 5 mm/min, or some other rate specified in the relevant product specification, until the required percentage elongation is obtained, or, if not specified, until the percentage elongation at the yield point is exceeded (see **3.5** and **3.6** and figure 3).



NOTE. All dimensions are in millimetres.

Figure 1. Preparation of right hand and left hand bias test samples



NOTE. All dimensions are in millimetres.

Figure 2. Dimensions, marking and mounting of a single bias direction specimen

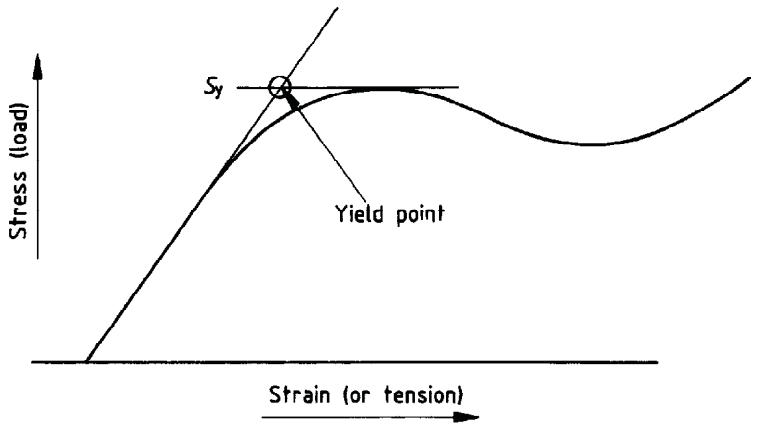


Figure 3. Example of determination of yield stress from an autographic stress-strain curve

8.3.3 *Mode 2 operation*

Engage the device for recording the stress (load) and extension of the test specimen. Put the moving jaw in motion and extend the test specimen at the nominal rate of 5 mm/min, or some other rate specified in the relevant product specification, until the required stress, or, if not specified, until the yield stress is obtained (see **3.5** and **9.5** and figure 3).

8.3.4 *Duration of test*

Unless otherwise stated in the relevant product specification, maintain the desired extension or loading of the test specimen for 1 h, this period commencing immediately the desired extension or loading is obtained.

NOTE. In order to compensate for any stress decay during the period of applied load, it may be necessary to employ a closed-loop correction to the application of the actual load, in order to maintain the stress at a nominally constant value. This would not be necessary for mode 1 operations.

8.3.5 *Measurement of set*

After the appropriate duration of deformation, release the strain at a speed of 5 mm/min, remove the test specimen from the jaws of the machine and lay it free of stress on a flat horizontal surface. Immediately measure and record the distance (L_2) to the nearest millimetre between the central gauge marks on the test specimen (see **6.3**).

8.3.6 *Measurement of tension set*

After a period corresponding to the duration of strain (see **8.3.4**), measure and record the distance (L_R) to the nearest millimetre between the central gauge marks on the test specimen (see **6.3**).

9 Calculation and expression of results

9.1 Bias tests

In calculating the result for a bias sample, the mean result from the test on adjacent left hand and right hand test specimens shall be recorded.

9.2 Percentage elongation

Calculate the percentage elongation, E, where necessary, from the equation:

$$E = \frac{(L_1 - L_0) \times 100}{L_0}$$

where

L_0 is the original gauge length (in mm);

L_1 is the elongated gauge length (in mm) = L_0 + actual extension (in mm) (see **8.3.2**);

9.3 Set

Calculate the percentage set, S, from the equation:

$$S = \frac{(L_2 - L_0) \times 100}{(L_1 - L_0)}$$

where

L_0 is the original gauge length (in mm);

L_1 is the elongated gauge length (in mm) = L_0 + actual extension (in mm) (see **8.3.2**);

L_2 is the elongated gauge length after immediate recovery (in mm) (see **8.3.5**).

9.4 Tension set

Calculate the percentage tension set, T, from the equation:

$$T = \frac{(L_R - L_0) \times 100}{(L_1 - L_0)}$$

where

L_R is the elongated gauge length after a period of recovery (in mm) (see **8.3.6**);

L_0 is the original gauge length (in mm);

L_1 is the elongated gauge length (in mm) = L_0 + actual extension (in mm) (see **8.3.2**).

9.5 Yield stress

Where necessary, determine the yield stress of the test specimen by drawing a tangent to the line from the origin and a tangent to the line of least slope occurring from the first marked inflection of the stress-strain curve, obtained in accordance with BS 3424 : Part 4 : 1982, as shown in figure 3.

9.6 Percentage elongation at yield

Where necessary, determine the percentage elongation at yield, E_y, from the equation:

$$E_y = \frac{(L_y - L_0) \times 100}{L_0}$$

where

L_0 is the original gauge length (in mm);

L_y is the elongated gauge length at the yield stress (in mm).

10 Test report

The test report shall include the following information:

a) a full description of the coated fabric;

b) whether the test was conducted in the longitudinal, transverse or bias directions and whether mode 1 or mode 2 operation was used;

c) the duration of the test (see **8.3.4**);

d) the applied percentage elongation and, where relevant, the applied stress;

e) the mean value of percentage set in each direction;

f) the mean value of tension set in each direction;

g) where relevant, the yield stress and the percentage elongation at yield;

h) reference to this method of test, i.e. Method 24 of BS 3424 : Part 21 : 1993;

i) details of any deviations from the standard test procedure.

List of references (see clause 2)

Normative references

BSI standards publications

BRITISH STANDARDS INSTITUTION, London

BS 3424 :	*Testing coated fabrics*
BS 3424 : Part 2 : 1992	*Method 4. Pre-conditioning of coated fabrics for testing purposes*
BS 3424 : Part 4 : 1982	*Method 6. Method for determination of breaking strength and elongation at break*

Informative references

BSI standards publications

BRITISH STANDARDS INSTITUTION, London

BS 3424 :	*Testing coated fabrics*
BS 3424 : Part 0 : 1982	*Foreword and general introduction*

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Plastics and Rubber Standards Policy Committee (PRM/-) to Technical Committee PRM/78, upon which the following bodies were represented:

British Nonwovens Manufacturers' Association
British Plastics Federation
British Railways Board
British Resin Manufacturers' Association
British Rubber Manufacturers' Association Ltd.
British Textile Confederation
British Textile Technology Group
Department of Health
Department of the Environment (Building Research Establishment)
Electricity Industry in United Kingdom
Furniture Industry Research Association
Home Office
Industrial Safety (Protective Equipment) Manufacturers' Association
London Regional Transport
Made-Up Textiles Association
Ministry of Defence
National Union of Dyers, Bleachers and Textile Workers (NUDBTW)
RAPRA Technology Ltd.
SATRA Footwear Technology Centre
Society of Motor Manufacturers and Traders Ltd.

The following body was also represented in the draft of the standard, through subcommittees and panels:

Ministry of Defence

This British Standard, having been prepared under the direction of the Plastics and Rubber Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on
15 June 1993

First published October 1973
Second edition March 1987
Third edition June 1993

The following BSI references relate to the work on this standard:
Committee reference PRM/78
Draft for comment 91/43290 DC

ISBN 0 580 21729 9

9306– 4– 0.5k– B

Amendments issued since publication

Amd. No.	Date	Text affected

BSI, 2 Park Street, London W1A 2BS BSI, Linford Wood, Milton Keynes MK14 6LE