BRITISH STANDARD

BS 5131 :
Section 2.1 :
1991

Methods of test for

Footwear and footwear materials

Part 2. Solings

Section 2.1 Ross flexing method for cut growth resistance of soling materials

NOTE. It is recommended that this Section should be read in conjunction with BS 5131 : Part 0, published separately.

Méthodes d'essai des chaussures et des matériaux pour chasussures
Partie 2. Semelles
Section 2.1 Méthode Ross de flexion pour la mesure de l'accroissement des matériaux pour semelles lors de la coupe

Prüfung von Schuhwerk und Schuhwerkstoffen
Teil 2. Sohlen
Abschnitt 2.1 Ross Biegemethode für Zuschneidefestigkeit von Fußbekleidungs-Sohlenwerkstoffen

STANDARDS

Foreword

This Section of BS 5131 has been prepared under the direction of the Textiles and Clothing Standards Policy Committee. It supersedes BS 5131: Section 2.1: 1979, which is withdrawn.

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

Contents

Method

1 Scope

This Section of BS 5131 describes a method for determining the resistance of soling material to cut growth resulting from flexing.

The test is primarily intended for testing the unpatterned soling material, i.e. using a specimen of defined length, width and thickness made from the soling material. In addition however, the method sets out conditions for testing whole soles (which may also be patterned) to assess the cut growth performance of the entire sole when flexed at a critical point of the pattern.

The test gives a good indication of the performance of the soling material in normal use and a reasonable indication of the performance of whole soles in normal use. However, in the case of polyurethane soles (especially those which are patterned) the method does not always predict sole cracking. Furthermore, the method is not suitable for testing specimens of material greater than 15 mm thickness.

When carrying out this test, a decision is made as to which of two temperatures is appropriate, either room temperature or − 5 °C. The appropriate temperature is that at which the material is least resistant to cut growth. Most materials are less resistant to cut growth at lower temperatures. As a consequence, where the soling material consists of either rubber, resin rubber, polyvinyl chloride (PVC), ethylene vinyl acetate (EVA) or nylon, a temperature of − 5 °C has been chosen. However, where the soling material consists of thermoplastic rubber, room temperature has been chosen, because resistance to cut growth is less at room temperature than at − 5 °C for this material.

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

2 Principle

A test specimen is repeatedly flexed through 90 ° over a mandrel after a small cut has been made in the test specimen with a chisel. The rate of growth of this cut is a measure of the tendency of the material to crack. A patterned sole may also be flexed, without making the chisel cut, to establish whether a crack or cracks will be initiated.

NOTE. The method is based on the Ross flexing test as described in the American Society for Testing and Materials Method D1052-55.but differs in some important details.

3 Apparatus[1)]

3.1 *Flexing apparatus*, as shown in figure 2.1/1

(a) *Principle of operation.* Test specimen A is inserted against the end stop M of the flexing arm B and held by clamp C. The other end of the test specimen is not clamped but moves in and out between rollers D, E and F as the test specimen is flexed, at a rate of 60 ± 5 cycles per minute, around mandrel H through 90 ± 2 ° to the position illustrated by the dotted lines.

(b) *Relevant mechanical details*

(1) Length JK is 50 ± 5 mm.

(2) Length JG is 11 ± 1.5 mm.

(3) Mandrel H has a radius of 5.0 ± 0.3 mm.

(4) The tops of rollers E and F and mandrel H are in the same horizontal plane.

(5) Roller D is vertically above roller E.

(6) The dimensions and positions of rollers D, E and F are not critical. A suitable diameter for rollers D and E is 25 mm and for roller F is 10 mm or 15 mm. A suitable distance in plan between the centres of rollers D and E and the centre of mandrel H is 30 mm, and between the centres of rollers D and E and the centre of roller F is 25 mm or 30 mm.

(7) The vertical position of roller D is adjustable so that the gap between this and roller E can accommodate:

either

(i) test specimens of various thicknesses;

or

(ii) several test specimens simultaneously.

A locking mechanism is provided to ensure that the gap cannot change during a test.

(8) Roller F is fitted with a pair of adjustable collars L whose purpose is to help to position the unclamped end of the test specimen during insertion, so that the test specimen is at right angles to mandrel H, and to maintain it in that position during flexing.

The difference between the internal and external diameters of each collar is approximately 10 mm. For the standard test specimen, the distance between the collars is 25.5 mm to 26.0 mm.

NOTE. When testing complete soles, which usually vary in width, the collars cannot normally be used to position the unclamped end of the sole.

[1)] For information on the availability of suitable apparatus to perform this test apply to Enquiry Section, BSI, Linford Wood, Milton Keynes MK14 6LE, quoting the number of this standard and the clause number referring to the items concerned. Enclose a stamped addressed envelope for reply.

3.2 *Suitable driving mechanism,* to operate the flexing apparatus (**3.1**) at a rate of 60 ± 5 cycles per minute.

3.3 *Chisel,* details of which are shown in figure 2.1/2. A collar may be fitted to the chisel to ensure that it cannot be inserted more than the maximum distance of 7.5 mm into the test specimen.

3.4 *Mandrel,* approximately 15 mm in diameter, for flexing the specimen to permit measurement of the cut length.

3.5 *Suitable measuring device,* accurate to 0.1 mm, for measuring crack/cut length.

4 Preparation of test specimens

NOTE 1. Where a material is to be tested, the test specimens prepared from this material are referred to as normal test specimens.

NOTE 2. Where a fabricated item (that is, an item consisting of a material already fabricated into a particular shape) is to be tested (for example, a patterned sole), the test specimens consisting of or prepared from the fabricated item are referred to as special test specimens.

4.1 Test material of sufficient size

4.1.1 *Normal test specimens*

Prepare the test material using the appropriate method given in BS 5131 : Section 2.7 so that its thickness is uniform and is as follows according to the nature of the material :

(a) 3.0 ± 0.2 mm for natural and synthetic rubber, resin rubber and nylon;

(b) 5.0 ± 0.2 mm for microcellular rubber, cellular EVA and cellular polyurethane;

(c) 7.0 ± 0.2 mm for thermoplastic rubber and PVC.

Cut six normal test specimens 25 ± 2 mm wide and 150 ± 5 mm long. Cut three of these so that the length of the normal test specimen is parallel to the length direction of the material and cut the other three so that the length of the normal test specimen is at right angles to the length direction of the material.

4.1.2 *Special test specimens*

If it appears that the surface pattern might prevent the special test specimen from moving freely between rollers D and E of the flexing apparatus (**3.1**) during flexing, remove a sufficiently thick layer of the pattern to stop this happening. Record the approximate thickness of the layer which has been removed. Ensure that the resulting surface is level.

Measure and describe this surface and the thickness of the special test specimen as accurately as possible, taking into account the nature and depth of the surface pattern (if any) as given in appendix A.4 of BS 5833 : 1988.

Where the fabricated item will suffer flexure in two or more directions when in normal use, cut six special test specimens 25 ± 2 mm wide and 150 ± 5 mm long. Cut three of these so that the length of the special test specimen is parallel to the length direction of the material and cut the other three so that the length of the special test specimen is at right angles to the length direction of the material.

Where the fabricated item will suffer flexure in one direction only when in normal use (as is normally the case for soles) cut three special test specimens 25 ± 2 mm wide and 150 ± 5 mm long. Cut these so that they will be flexed in the same direction as the fabricated item.

4.2 Test material of insufficient size

4.2.1 *Necessity for extension pieces*

If there is insufficient material available to produce normal test specimens 150 mm long, but pieces of material 25 ± 2 mm wide and 100 mm long or more can be cut, cut these and extend their length to 150 mm by attaching suitable extension pieces to one or both ends as described in **4.2.2** to produce normal test specimens. Similarly, if the fabricated items are of insufficient size to produce special test specimens 150 mm long, but pieces of material 25 ± 2 mm wide and 100 mm or more long can be cut, cut these and extend their length to 150 mm by attaching suitable extension pieces to one or both ends as described in **4.2.2** to produce special test specimens.

4.2.2 *Attachment of extension piece(s)*

Choose material for the extension pieces that is of the same type and thickness as the soling material to be tested and of approximately the same hardness. Cut the extension pieces 25 ± 2 mm wide. Hold the ends of the specimen and extension piece in contact and fix them together using an office stapler, inserting six or more staples evenly across the joint. Turn the test specimen over and insert six or more staples from the other side. If the staples are proud, place the joint on a hard level surface and gently hammer the staples to make sure that they are fully clenched and not standing proud. Attach another extension piece to the other end of the test specimen if the combined length has not been increased to 150 mm.

4.3 Location and insertion of chisel cut

4.3.1 *Normal test specimen*

Use the chisel (**3.3**) to cut right through the normal test specimen or to a depth of 7.5 ± 0.5 mm, whichever is the smaller. Make the cut in the wearing (outer) surface so that it lies symmetrically across the centreline of the test specimen and is at such a position that the cut can be clamped at position G to within 0.5 mm as shown in figure 2.1/1 (i.e. with the average dimensions given in **3.1** for the flexing apparatus, make the cut 61 mm from the end of the test specimen).

In the case of normal test specimens with extension pieces, ensure that the cut is not in either of the extension pieces or in the stapled region.

NOTE. The vertical aspect of the chisel cut and its correct location is made easier by the use of a jig.

4.3.2 ***Special test specimens***

If a chisel cut is to be made, make it in the area of the sole pattern where the maximum degree of strain occurs when the special test specimen is flexed and also at such a position that the cut can be clamped at position G shown in figure 2.1/1.

In the case of special test specimens with extension pieces, ensure that the cut is not in either of the extension pieces or in the stapled region.

NOTE. A chisel cut is made to obtain information about cut growth resistance and spontaneous cracking. If information is required about cut growth resistance of an item, a chisel cut is essential. If information is required about the spontaneous cracking properties of an item, a chisel cut is superfluous.

5 Conditioning and testing temperature

5.1 Conditioning

No conditioning of the test specimens is necessary.

5.2 Testing temperature

The standard testing temperature is − 5 °C for all materials except thermoplastic rubber for which the standard test temperature is 20 °C.

6 Procedure

6.1 Measure and record the initial length of the cut in each test specimen to an accuracy of 0.1 mm with the test specimen bent through 45 ° around the 15 mm diameter mandrel (**3.4**).

NOTE. The cutting edge of the chisel is 2 mm long but the length of cut produced in the material tends to differ a little from this.

6.2 When the test apparatus is to be used in a refrigerated cabinet adopt the following procedure to ensure that all test specimens receive the same treatment:

(a) lay out all the test specimens in the cabinet and note the time;

(b) load the test specimen into the flexing apparatus in the manner described in **6.3**;

(c) commence flexing 10 min after placing the test specimens in the cabinet.

6.3 Turn the driving mechanism of the flexing apparatus (**3.1**) manually until the flexing arm B is horizontal. Raise the top roller D and slacken the clamping plate C. Insert the test specimen(s), wearing (outer) surface uppermost, between collars L on roller F, between rollers D and E, and then between clamp C and flexing arm B. Position the test specimen at right angles to mandrel H and so that the cut is in position G (vertically above the edge of the mandrel) shown in figure 2.1/1. If the test specimen incorporates extension pieces (see **4.2**), ensure that the extension piece attached to the clamped end of the test specimen is not so long that the staples come within 10 mm of edge J of clamp C and that the staples of an extension piece attached to the unclamped end do not pass between rollers D and E when the extended test specimen is fully flexed (see figure 2.1/1). Tighten clamp C. Screw down and lock roller D so that it just touches the test specimen. Ensure that the test specimen moves freely between rollers D and E throughout the test.

If special test specimens are being tested which have a surface pattern of significant depth but do not have a chisel cut, clamp them so that a point of the pattern that is judged to be a point of potential crack initiation is at position G (normally the base of a protruding section of the pattern).

6.4 Start the driving mechanism (**3.2**). After it has driven the flexing apparatus (**3.1**) for 5000 cycles stop the driving mechanism. Inspect the test specimen for the spontaneous initiation of any cracks. Whilst the test specimen is in a 45 ° flexed position and without removing it from the apparatus, measure and record the lengths of the chisel cut and any spontaneous cracks to an accuracy of 0.5 mm. Resume the flexing and make further examinations and measurements at intervals of time that are judged to be necessary to give cut growth information and any spontaneous crack growth information. If sufficient information has been gained after 150 000 cycles stop the test.

NOTE. Sometimes information is required about the number of cycles which cause a cut growth of 6 mm, in which case if this cut growth has been achieved before 150 kilocycles of flexing have taken place the test can be stopped. Occasionally information is required about the number of cycles which cause the cut to extend across the full width of the test specimen, in which case more than 150 kilocycles of flexing may be necessary.

Should the flexing be interrupted before completion of the test, e.g. because overnight running is not possible, remove the test specimen from the apparatus and refrigerated cabinet. Before flexing is resumed, replace the test specimen in the same position in accordance with the procedure given in **6.2** and **6.3**. However, if the test is not being carried out under cold conditions, the test specimen may be left in the stationary apparatus with the flexing arm horizontal.

6.5 At the end of the test remove the test specimen from the machine and with the test specimen bent through 45 ° around the 15 mm diameter mandrel, measure and record the length of the cut to an accuracy of 0.1 mm. If the cut is jagged, measure the linear distance between the two extreme points. Note the occurrence of any cracks that have developed spontaneously close to the chisel cut and which may have affected the increase in its length. Record the severity of any other spontaneous cracks. Examine the reverse side of the test specimen and record any cut growth or spontaneous cracks occurring on the reverse side.

7 Expression of results

Express the results in one of the three following ways.

(a) *Rate of cut growth.* Calculate the average rate of cut growth for the whole of the flexing period in millimetres per kilocycle, by dividing the growth in millimetres at the end of the test by the number of flexes in kilocycles.

NOTE. Where a more detailed investigation is to be carried out, plot the results obtained in **6.4** as points on a graph, with the length of the cut along the Y axis and the number of cycles along the X axis thereby providing values of the rate of cut growth for successive flexing intervals.

(b) *Specified increase in the length of the cut.* Express the result as either:

(1) the number of cycles required to increase the length of the cut by a specified amount;

or

(2) the increase in length of the cut after a specified number of cycles.

(c) *Crack initiation.* For test specimens that had no chisel cut express the result as the number of cycles for a crack to initiate. Describe the crack growth characteristics at initiation and throughout the test period.

8 Test report

The test report shall include the following items :

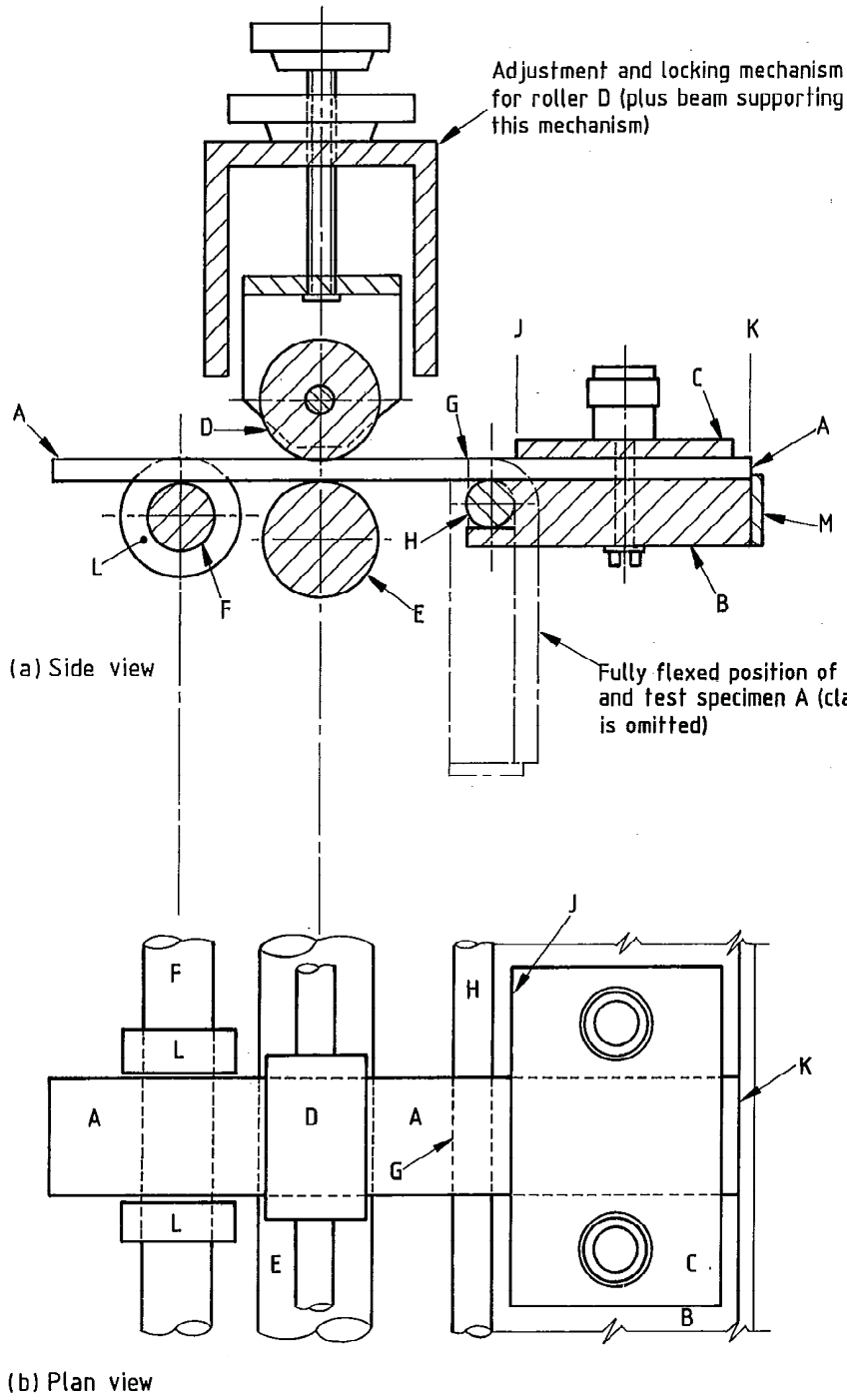
(a) results expressed individually in accordance with clause **7** including a report of any irregular behaviour as described in **6.5**;

(b) description of the test specimen, including the material, the method of preparation, whether or not a chisel cut was made, the thickness of the test specimen, and in the case of special test specimens a description of the surface pattern and the method of thickness determination (where applicable) together with the description of length and width as described in **4.1.2**;

(c) temperature of the test;

(d) reference to this method of test, i.e. BS 5131 : Section 2.1;

(e) date of testing.

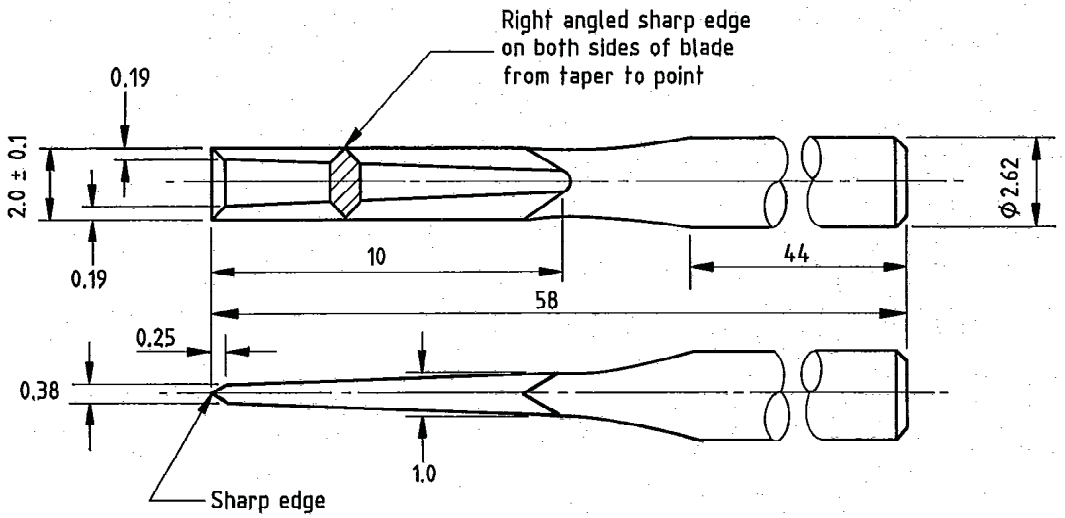


Key

A Test specimen
B Flexing arm
C Clamp
D Adjustable upper guide roller
E Lower guide roller
F Rear guide roller
G Chisel cut inserted in test specimen
H Mandrel, around which test specimen is flexed
J Edge of clamp C adjacent to cut G and mandrel H (JG = 11 ± 1.5 mm)
K Position of end of test specimen (JK = 50 ± 5 mm)
L Positioning collar for test specimen on roller F
M End stop

NOTE. For clarity, the adjustment and locking mechanism for roller D has been omitted from the plan view, and roller D has been drawn a little smaller than roller E.

Figure 2.1/1. Flexing apparatus



All dimensions are in millimetres.

Figure 2.1/2. Details of chisel

Publication(s) referred to

BS 5131	Methods of test for footwear and footwear materials Part 2 Solings Section 2.7 The preparation of test pieces from soling materials for physical testing
BS 5833	Scheme for labelling of footwear

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Textiles and Clothing Standards Policy Committee (TCM/-) to Technical Committee TCM/39, upon which the following bodies were represented:

British Footwear Manufacturers' Federation
British Leather Confederation
British Rubber Manufacturers' Association
British Steel plc
Consumer Standards Advisory Committee of BSI
Cork Industry Federation
Footwear Components Federation
Footwear Distributors' Federation
Institute of Trading Standards Administration
Iron and Steel Trades Confederation
Lancashire Footwear Manufacturers' Association
Mail Order Traders' Association of Great Britain
Ministry of Defence
National Union of Footwear, Leather and Allied Trades
Office of Fair Trading
SATRA Footwear Technology Centre

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

British Adhesives and Sealants Association
British Paper and Board Industry Federation
British Plastics Federation
Multiple Shoe Retailers' Association
RAPRA Technology Ltd.

This British Standard, having been prepared under the direction of the Textiles and Clothing Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 31 January 1991

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Amendments issued since publication

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