BRITISH STANDARD

BS 5131 :
Section 5.2 :
1990

Methods of test for

Footwear and footwear materials

Part 5. Testing of complete footwear

Section 5.2 Degree of vulcanization of moulded-on rubber soles

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 chaussures
Partie 5. Essai de la chaussure complète
Section 5.2 Degré de vulcanisation des semelles en caoutchouc moulées

Prüfung von Schuhwerk und Schuhwerkstoffen
Teil 5. Prüfung von Schuhwerk
Abschnitt 5.2 Bestimmung des Vulkanisationskoeffizienten von anvulkanisierten Gummisohlen

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 It supersedes BS 5131 : Section 5.2 : 1975, which is withdrawn.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 whether moulded-on rubber soles have been satisfactorily vulcanized. Because of the method of manufacture, the outer side of the sole adjacent to the heated metal mould is fully cured but the inner side, next to the insole, is usually not fully cured. Some undercure next to the insole is acceptable and even desirable to ensure good adhesion; the purpose of this test is to establish that the undercure is not excessive. The test is suitable for routine quality control work and is simple to carry out.

Any direct moulding compound which shows a significant difference in hardness between the cured and uncured state can be tested by this method.

2 Principle

Sections are cut from the sole and measurements of hardness by indentation are made across each section along a line from the outer to the inner side. The results are plotted graphically and from the graph an undercure index and the thickness of undercured rubber are determined.

3 Apparatus[1)]

3.1 *Testing apparatus.* An example of a suitable apparatus is shown in figure 5.2/1. It has the following essential features (upper case letters in brackets refer to the corresponding lettered parts of figure 5.2/1).

(a) *Vertical plunger,* with, at its lower end (A), a hardened conical indentor of apex angle 60 ± 5 ° and at its upper end an aluminium cone (B) to carry the indenting weight centrally.

(b) *Dial gauge* (C), indicating vertical displacement of the plunger to the nearest 0.01 mm. The effective downward force applied by the plunger and gauge system is approximately 500 ± 100 mN (50 ± 10 gf) at a dial gauge reading of 6 mm.

(c) *Horizontal rigid base plate* (D), fixed relative to the dial gauge. The base plate supports the test specimen during test and has, on its underside, a small electrically operated high frequency low amplitude vibrator.

(d) *Detachable indenting weight* (E), of mass 500 ± 10 g, which fits on the conical top of the plunger.

4 Preparation of test specimens

At least 2 h after moulding, strip one sole carefully from its upper. Cut two test specimens in the form of sections, 6.0 ± 0.5 mm thick, as shown in figure 5.2/2, taking one section, test specimen 2, from the position corresponding to the inside joint of the shoe. Take care that the cut surfaces of each section are as smooth and parallel as possible. Do not buff the test specimens.

NOTE 1. Buffing may generate heat which may, as a consequence, affect the test result.

NOTE 2. In order to facilitate removal of the sole, it is preferable to mould without adhesive. This will not affect results.

5 Procedure

5.1 Mark lines on each of the four faces produced in cutting the two test specimens from the sole (as described in clause 4) marking test specimen 1 with four such lines (two lines AA and two lines A′A′) and marking test specimen 2 with two such lines (lines BB). The positions of these lines are illustrated in plan view in figure 5.2/2 and in section view in figure 5.2/3.

5.2 Along one of the two lines marked AA, mark five or more test points at evenly spaced distances from that edge of the test specimen which corresponds to the inner surface of the sole. Ensure that the test points are not less than 1 mm apart from each other or from either edge of the test specimen. Where the thickness of the test specimen is less than 6 mm, stagger the test points alternately on each side of the line in order to achieve such spacing, as shown in figure 5.2/3.

NOTE. Test specimen 1 is taken from the heel, as shown in figure 5.2/2. Since this is normally greater than 6 mm in thickness, the test points are shown in line in figure 5.2/3.

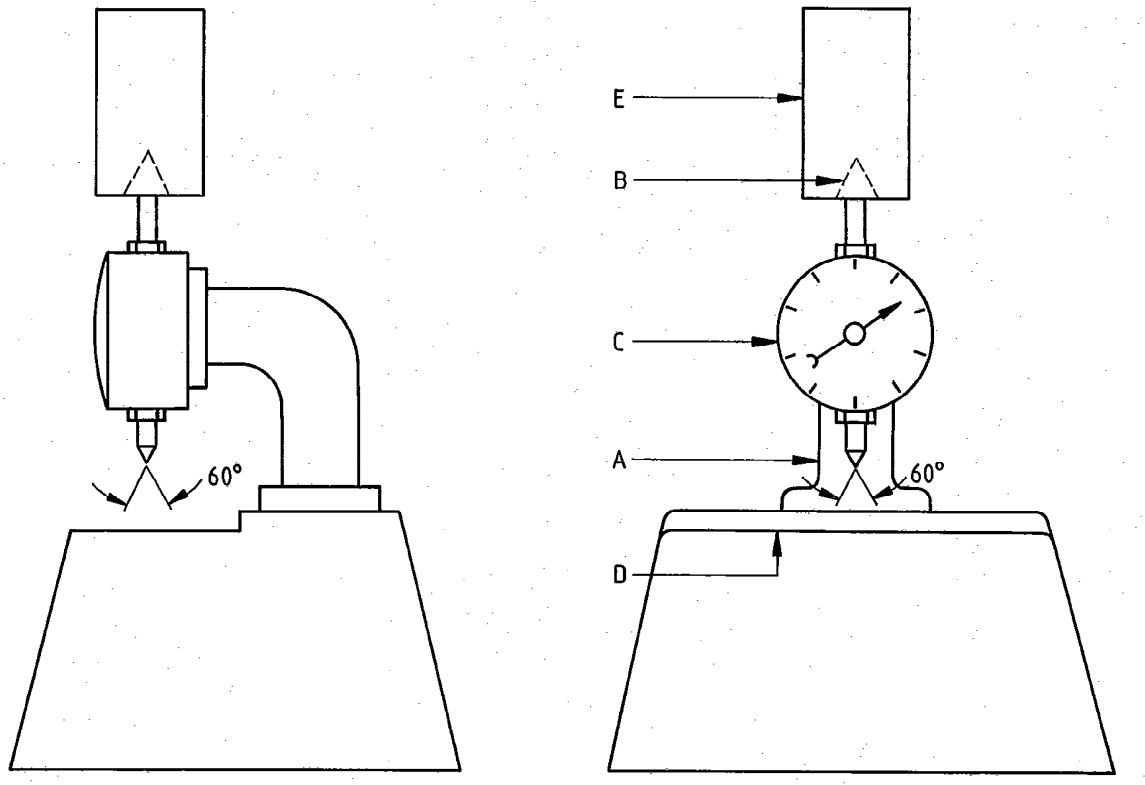
Test specimen 2 is taken from the forepart of the sole, as shown in figure 5.2/2. Since this is normally less than 6 mm in thickness, the test points are shown staggered in figure 5.2/3.

5.3 Along the other line marked AA, mark five or more test points as for the first line at evenly spaced distances from that edge of the test specimen which corresponds to the inner surface of the sole, these distances being the same as in **5.2**. Ensure that the spacing and staggering are as described in **5.2**.

5.4 Along each of the two lines marked A′A′ and each of the two lines marked BB, mark five or more test points as described in **5.2** and **5.3**.

5.5 Switch on the vibrator and raise the vertical plunger. Position one test specimen on the base plate (D) beneath the raised indentor (A) so that the tip of the indentor is above the first selected test point. Lower the vertical plunger so that the

[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.



NOTE. See clause **3** for key to lettering

Figure 5.2/1 Diagram of apparatus

tip of the indentor rests on the first test point and allow 10 s to elapse. Adjust the dial gauge (C) to zero and then place the detachable indenting weight (E) on the conical top of the plunger. Record the dial reading 15 s after the addition of the weight, with the vibrator remaining switched on, as the indentation depth.

NOTE. The low amplitude and high frequency of the vibrator, together with the mass of the system subjected to the vibrations and the elasticity of the material at the test point, are such that the reading on the dial gauge is steady even though the vibrator remains switched on.

5.6 Repeat the procedure described in **5.5** for each selected test point along each line marked on the two test specimens.

6 Calculations and expression of results

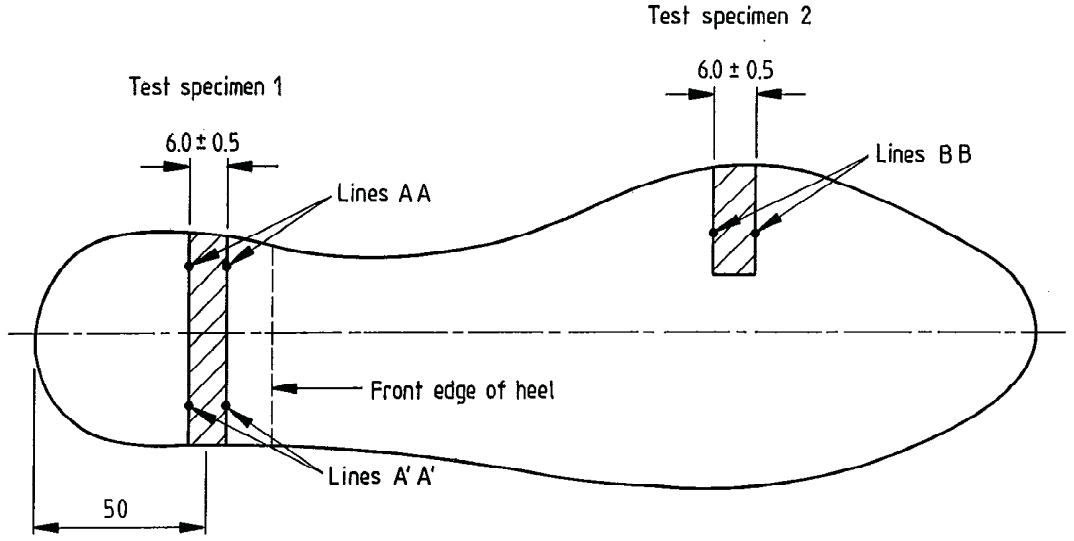
6.1 Undercure index at the inner surface

6.1.1 Add each of the five or more depths of indentation corresponding to the test points on one of the lines marked AA to each of the five or more depths of indentation corresponding to the test points on the other line marked AA. Halve each value, thereby obtaining an average value of depth of indentation corresponding to five or more distances of the indentor from the inner surface at position A.

NOTE. Position A is a hypothetical point whose properties are the average of the properties of the two lines each marked AA.

Plot a graph of average value of depth of indentation against distance of the indentor from the inner surface at position A. Extrapolate the graph (as a smooth curved line which is a continuation of the shape of the existing graph between the points) to cross the vertical line representing the inner surface of the sole at position A. This gives the estimated depth of indentation at the inner surface at position A, i.e. d in **6.1.3**. Obtain from the horizontal part of the graph (near to that end of the graph corresponding to the outer surface) the estimated depth of indentation for the fully vulcanized rubber at position A, i.e. D in **6.1.3**. Typical graphs are shown in figures 5.2/4 and 5.2/5.

6.1.2 Repeat **6.1.1** for the indentation depths corresponding to the test points on the lines marked A′A′ (thereby producing a graph of average value of depths of indentation against distance of indentation from the inner surface at position A′) and similarly BB, thereby obtaining a total of three graphs, each with five or more points on it. These graphs correspond to positions A, A′ and B.



All dimensions are in millimetres.

Figure 5.2/2 Location of test specimens from the sole and positions of lines AA, A'A' and BB

6.1.3 For each of the three graphs calculate the undercure index (U) at the inner surface from the equation:

$$U = \left(\frac{d-D}{D}\right) \times 100$$

where

d is the estimated depth of indentation (in mm) at the inner surface, as obtained in **6.1.1**;

D is the estimated depth of indentation (in mm) for the fully vulcanized rubber, as obtained in **6.1.1.**

6.2 Thickness of under-vulcanized rubber

6.2.1 Draw a horizontal line corresponding to 1.6 D on the graph plotted in **6.1.1.**

If this line does not intersect the graph already plotted (as is the case shown in figure 5.2/5), record the fact that the sole is satisfactorily vulcanized at position A.

If this line intersects the graph already plotted (as is the case shown in figure 5.2/4) record the fact that the sole is under-vulcanized at position A. Record the horizontal value of the intercept as the thickness of under-vulcanized rubber in the sole at position A (this being under-vulcanized since its undercure index exceeds 60). Calculate and express the thickness of under-vulcanized rubber as a percentage of the total sole thickness at position A.

6.2.2 Repeat **6.2.1** for the graphs obtained in **6.1.2** corresponding to positions A' and B.

NOTE. It is not always advisable to vulcanize the sole completely as this may lead to poor wearing properties and lower adhesion. The curve for a correctly vulcanized sole should lie, therefore, between the two curves in figure 5.2/5. The actual depths of indentation will vary for different rubbers.

7 Test report

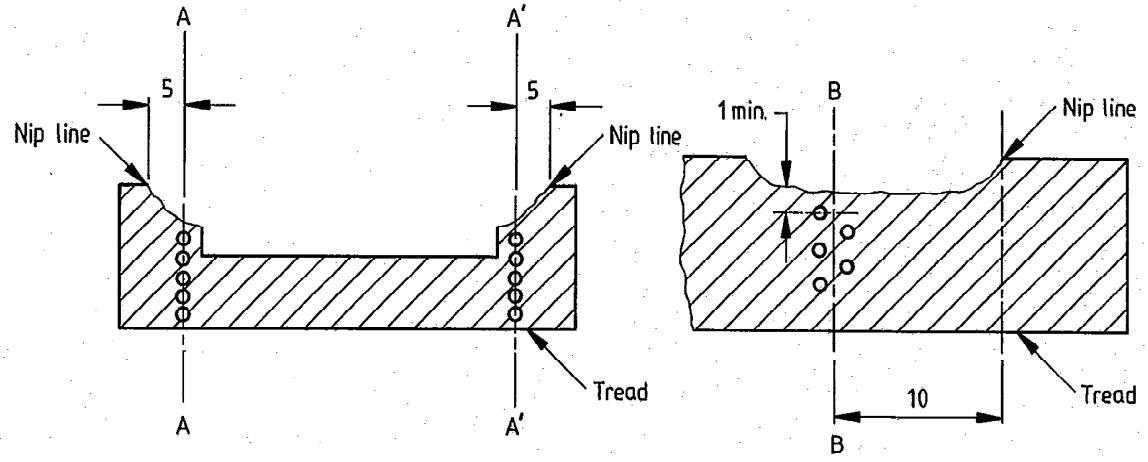
Include the following information in the test report for each of the three positions A, A' and B:

(a) undercure index at the inner surface and the thickness of under-vulcanized rubber, expressed in accordance with clause **6**;

(b) nature and full identification of the sample;

(c) reference to this method of test, i.e. BS 5131 : Section 5.2;

(d) date of testing.



Test specimen 1 (elevation)

Test specimen 2 (part elevation)

All dimensions are in millimetres.

NOTE. O indicates the position of each test point.

Figure 5.2/3 Marking of lines on test specimens and arrangement and marking of test points

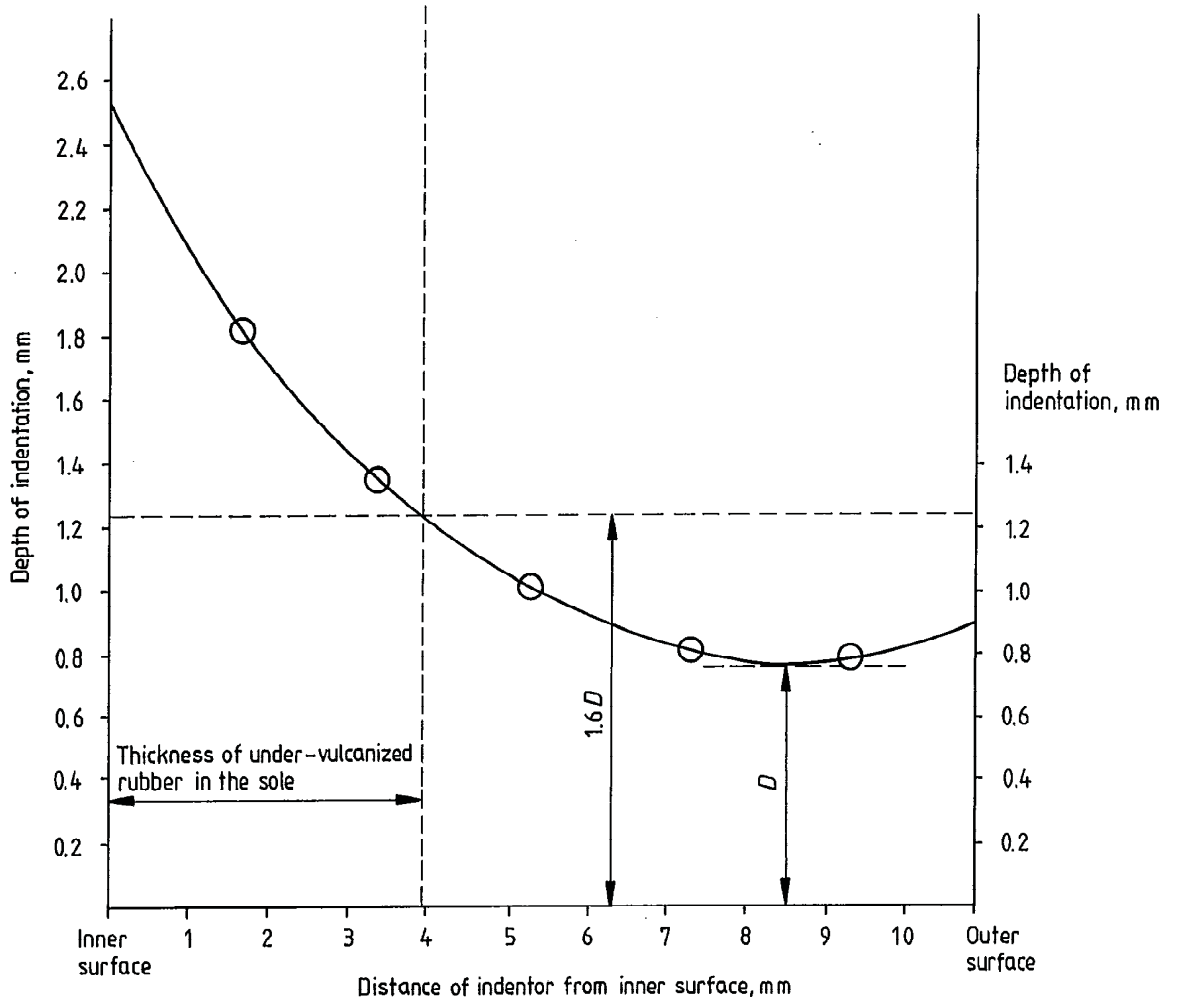


Figure 5.2/4 Typical indentation graph for an under-vulcanized position on a sole

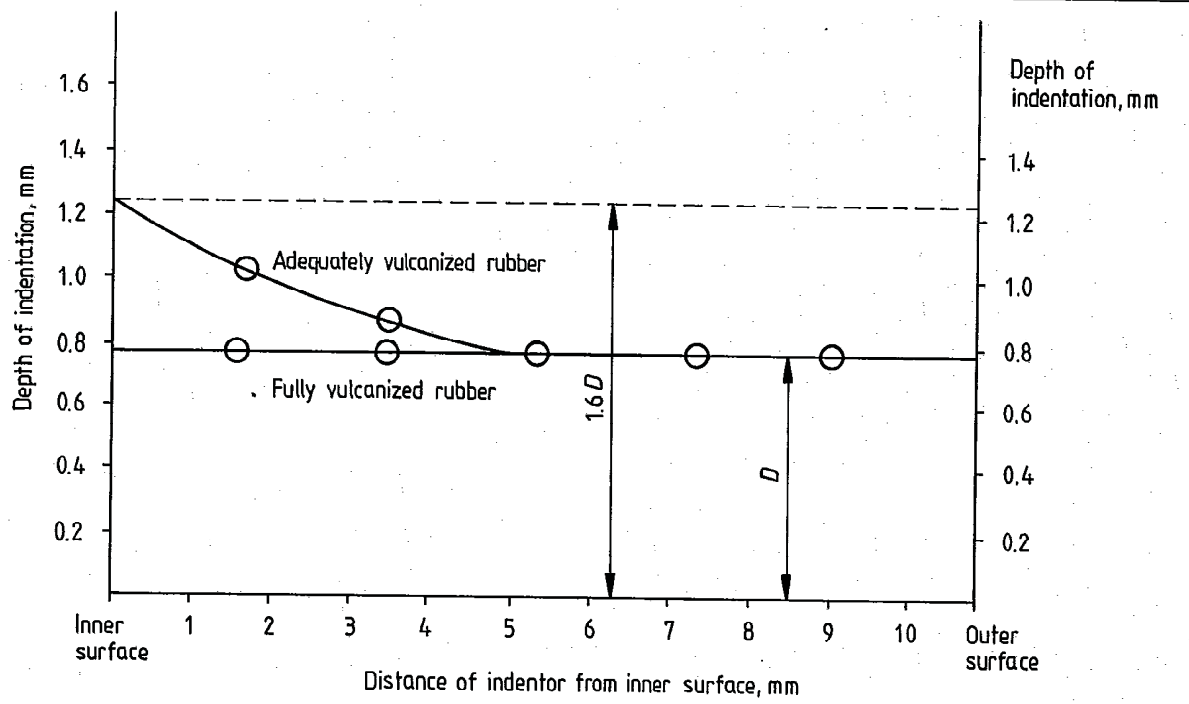


Figure 5.2/5 Graphs indicating extremes of vulcanization for a satisfactorily vulcanized position on a sole

Publication(s) referred to

See national foreword.

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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