BRITISH STANDARD

BS 5131 :
Section 1.2 :
1991

Methods of test for

Footwear and footwear materials

Part 1. Adhesives

Section 1.2 Resistance of adhesive joints to peeling

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

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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 It supersedes BS 5131 : Subsection 1.1.2 : 1976, which is withdrawn.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 measuring the strength, in terms of resistance to peeling, of a bond between two sheet materials that have been bonded together. The method is applicable to a great variety of combinations of upper materials, soling materials and adhesives, where at least one of the adherends is flexible.

NOTE 1. The purpose of the method is to test joints rather than to compare adhesives. As a consequence, unlike BS 5131 : Section 1.1, no recommendations are given concerning appropriate adherends. In BS 5131 : Section 1.1 the two adherends are subjected to a constant separating force, and therefore in principle the test specimen may remain intact. In this Section, the two adherends are pulled apart at a constant rate; the test specimen will inevitably fail, and it is the forces required to cause the test specimen to fail and the nature of the failure that are under investigation. This test is more destructive in its philosophy than the test described in BS 5131 : Section 1.1. In BS 5131 : Section 1.1 the failures (e.g. cohesive failure of the adhesive layer, or failure of adhesion to one adherend) are associated with the adhesive. In this Section, however, alternative types of failure which may take place within the adherend are described.

NOTE 2. For the peel bond strength of specimens cut from made-up footwear see BS 5131 : Section 5.4.

NOTE 3. The titles of the publications referred to in this standard are listed on the inside back page.

2 Principle

The two adherends of a bonded assembly are peeled apart by forces acting at an angle of 180° to each other. The peel angle depends on the flexibility of the adherends. The peeling force is recorded continuously and the mean peeling force is calculated.

3 Apparatus[1)]

3.1 *Conditioning cabinet or room*, maintaining an atmosphere at a preferred condition of 20 ± 2 °C and 65 ± 2 % r.h., or an allowed condition of 23 ± 2 °C and 50 ± 5 % r.h.

NOTE. The conditioning atmosphere for footwear and footwear materials is normally 20 °C and 65 % r.h., whereas the conditioning atmosphere for adhesives is normally 23 °C and 50 % r.h.

3.2 *Tensile testing machine*, of low inertia, with a constant rate of extension, with continuous recording and with a jaw separation rate of 100 ± 20 mm/min.

3.3 *Cutting device*, suitable for cutting test assemblies into test specimens, which neither compresses nor tends to split the layers of the test assembly at the edges produced by cutting.

NOTE. A rotary disc cutter or a sharp hand knife, for example, is a suitable tool. A press knife is not suitable because of the large compression force that it applies to the test assembly.

4 Preparation and bonding of test assemblies

Prepare the materials and bond the test assemblies, incorporating a paper or tape insert, as described in BS 5131 : Section 1.7 for hot melt adhesive bonds and as described in BS 5131 : Section 1.3 for all other types of bond. Produce test assemblies of sufficient size and number so as to enable four or eight test specimens (see clauses **5** and **8**) to be prepared.

5 Conditioning

Between bonding the test assemblies and cutting them into test specimens, store the test assemblies in the conditioning cabinet or room (**3.1**).

In cases where it is known that the bond is formed rapidly within a short period of time, after which there is no change in the bond, condition one set of test assemblies for a period of 48 ± 4 h. In other cases, condition one set of test assemblies for a period of 48 ± 4 h and a second set of test assemblies for a period of 14 ± 2 days so that any change in bond strength due to changes in the adhesive (e.g. increased curing or crystallization) may be assessed.

NOTE. By determining the bond strength after various conditioning periods, any change in the bond strength due to changes in the adhesive (e.g. increased curing or crystallization) may be assessed.

6 Cutting of test specimens

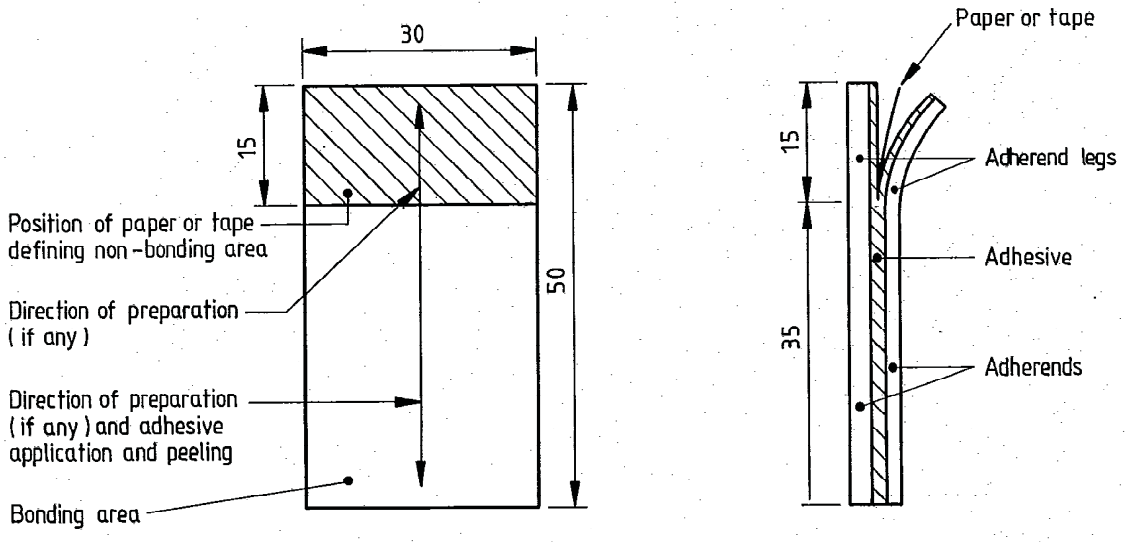
At the end of the conditioning period (see clause **5**), cut one set of test assemblies into four test specimens using the cutting device (**3.3**) as follows.

(a) Where the test assemblies have been prepared as described in BS 5131 : Section 1.3 or prepared by indirect bonding as described in BS 5131 : Section 1.7, cut test specimens 30.0 ± 0.5 mm by approximately 50 mm, discarding two marginal strips approximately 5 mm wide if the test assemblies are approximately 70 mm wide. A test specimen is shown in figure 1.2/1.

(b) Where the test assemblies have been prepared by indirect bonding as described in BS 5131 : Section 1.7, cut test specimens as in item (a) (preferred) and illustrated in figure 1.2/1, or cut test specimens 20.0 ± 0.5 mm by approximately 50 mm (allowed).

NOTE. Recent developments relating to indirect bonding using hot melt adhesives are such that in some cases it may be difficult or inconvenient to prepare test assemblies wide enough to produce test specimens 30 mm wide. In such cases, the allowed test specimen is as illustrated in figure 1.2/1 except that the width is 20.0 ± 0.5 mm instead of 30.0 ± 0.5 mm.

[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.



(a) Plan view of test specimen

(b) Side view of test specimen

All dimensions are in millimetres.

Figure 1.2/1. Test specimen (cut from test assembly prepared as described in BS 5131 : Section 1.3 or prepared by indirect bonding as described in BS 5131 : Section 1.7)

(c) Where the test assemblies have been prepared by direct bonding as described in BS 5131 : Section 1.7, cut each test assembly along the line AB as shown in figure 1.2/2 to produce test specimens 20.0 ± 0.5 mm by approximately 65 mm, as shown in figure 1.2/3.

7 Procedure

7.1 Separate by hand the two adherends at the end of a test specimen where the paper or tape is inserted so as to produce two free adherend legs. Clamp one leg in each jaw of the tensile testing machine (**3.2**). Operate the tensile testing machine at a jaw separation rate of 100 ± 20 mm/min until the jaws are separated by a distance of at least 30 mm, using the recording mechanism to provide a graph of the peeling load against extension.

If the graph has an initial peak, as illustrated in figure 1.2/5 examine the small area of the test specimen at which separation commenced. Examine the remaining area produced by separation, noting the type(s) of failure and the percentage of the total peeled area over which each type of bond failure has occurred.

NOTE 1. Types of bond failure are illustrated in figure 1.2/4 and may be classified as follows:

(a) failure of adhesion to either adherend material;

(b) failure of surface layer of adherend material;

(c) deep failure of adherend material (continuous failure);

(d) deep failure of adherend material ('leg' tore off);

(e) cohesive failure of adhesive;

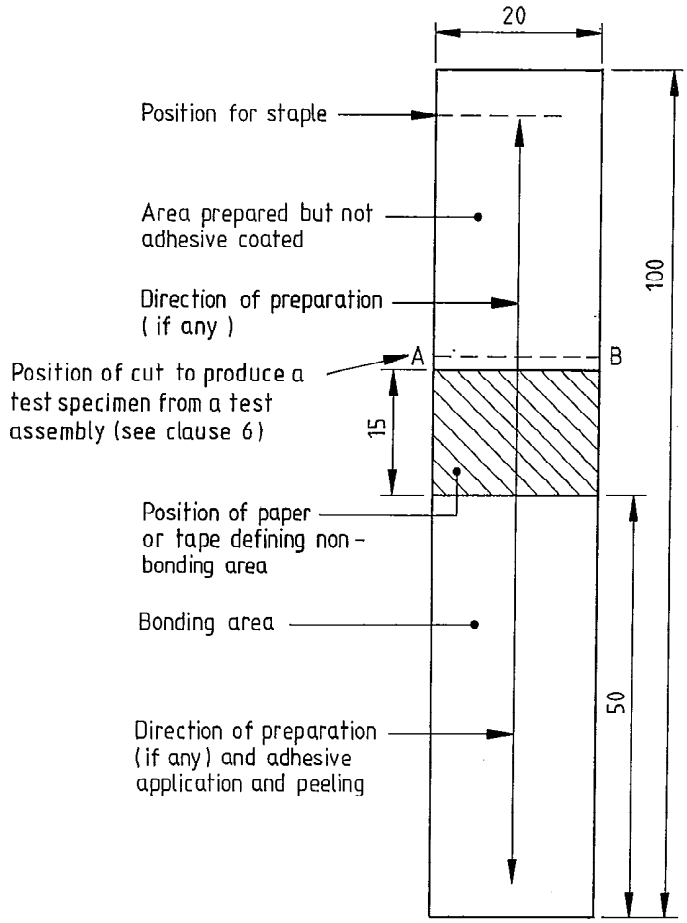
(f) non-coalescence of adhesive films.

Where the test specimens have been prepared by direct bonding using hot melt adhesives as described in BS 5131 : Section 1.7, check that the adhesive coverage on the areas of each test specimen after peeling is not less than 95 %. If this is not the case, reject the test results, prepare additional test specimens from additional test assemblies, and repeat the test until sufficient test results from acceptable test specimens are obtained.

NOTE 2. In direct bonding of hot melt adhesives, as described in BS 5131 : Section 1.7, the assembly is closed and bonded immediately after the application of adhesive (which is applied as a molten ribbon). The technique of application and the short open time result in a situation where it is difficult for the operator to ensure complete adhesive coverage. This problem does not arise where test assemblies have been prepared by the indirect bonding of hot melt adhesives as described in BS 5131 : Section 1.7 or by the methods given in BS 5131 : Section 1.3.

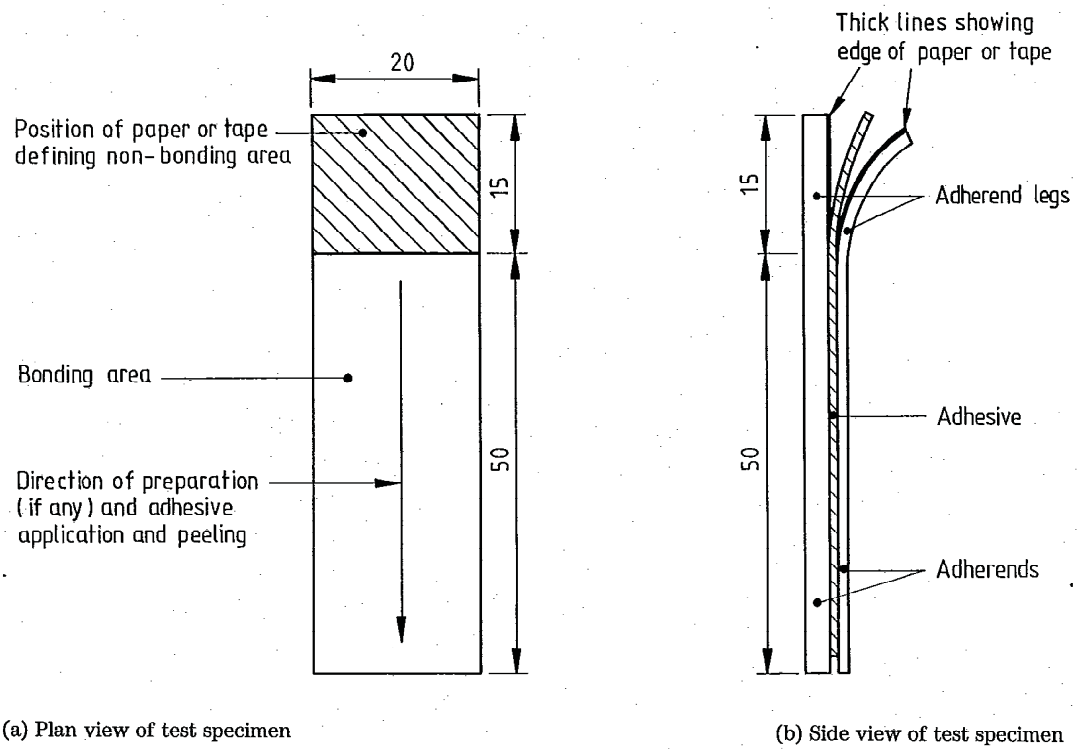
7.2 Test the remaining three test specimens by the procedure described in **7.1**.

7.3 Where it is not known that the bond is formed rapidly within a short period of time (see clause **5**), at the end of the second conditioning period cut the second set of test assemblies into four test specimens, as described in clause **6**, using a suitable cutting device (**3.3**) and repeat the procedure described in **7.1** and **7.2**.



All dimensions are in millimetres.

Figure 1.2/2. Test assembly prepared by direct bonding as described in BS 5131 : Section 1.7



(a) Plan view of test specimen

(b) Side view of test specimen

All dimensions are in millimetres.

Figure 1.2/3. Test specimen (cut from test assembly prepared by direct bonding as described in BS 5131 : Section 1.7)

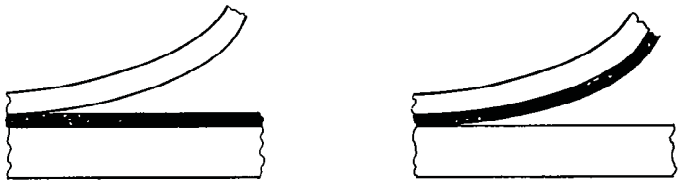
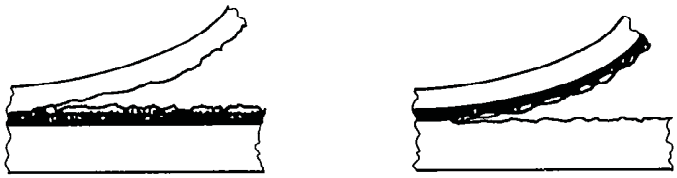
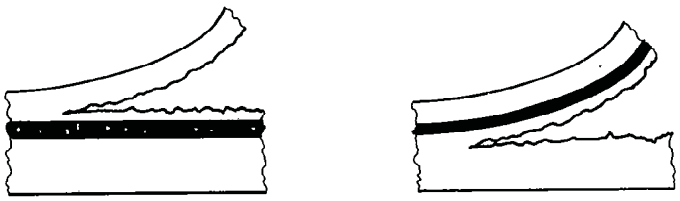
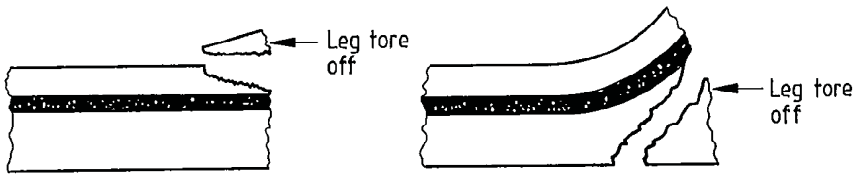
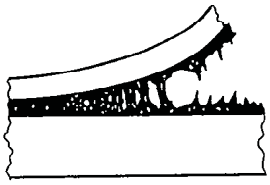
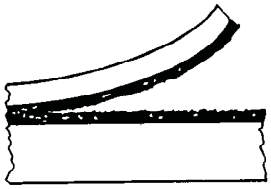
Failure of adhesion to either adherend material	 Adhesion to upper — Adhesion to sole
Failure of surface layer of adherend material	 Surface of upper — Surface of sole
Deep failure of adherend material (continuous failure)	 Deep failure within upper — Deep failure within sole
Deep failure of adherend material ('leg' tore off)	 Deep failure of upper — Deep failure of sole
Cohesive failure of adhesive	
Non-coalescence of adhesive films	

Figure 1.2/4. Types of bond failure (see **7.1**)

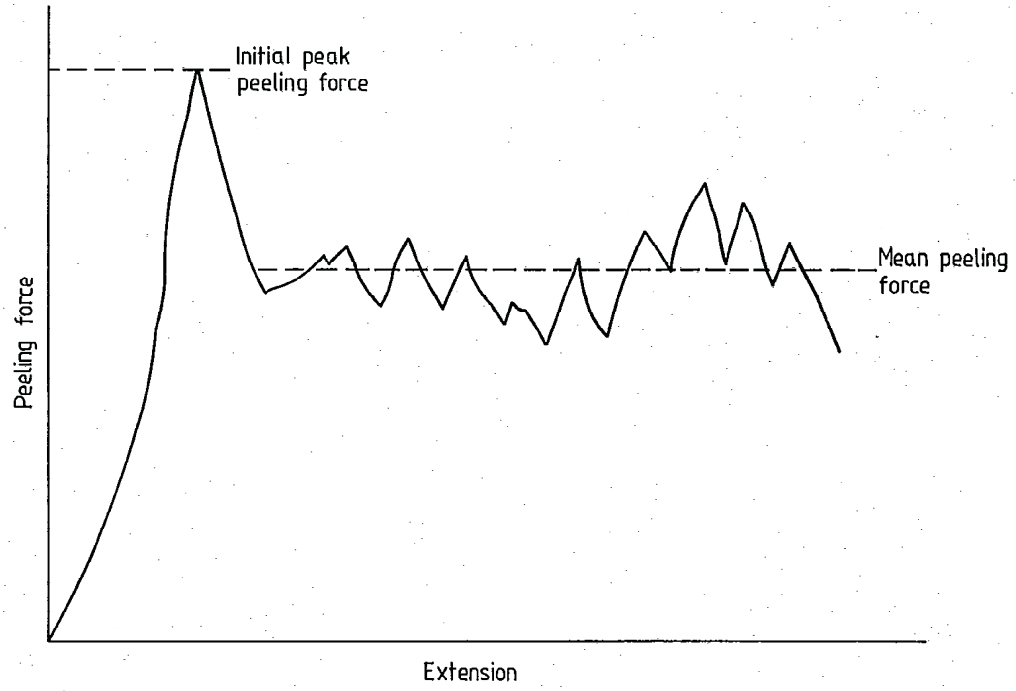


Figure 1.2/5. Example of a typical graph of peeling force against extension which includes an initial peak

8 Additional tests

Where one of the adherend materials (e.g. cellulose board insoles, polyurethane (PU) coated fabric uppers) exhibits directional properties, regard each of the following three directions as a different test condition:

(a) in the machine direction and with the run of the sheet;

(b) in the machine direction and against the run of the sheet;

(c) in the cross direction.

In such cases, prepare a set of four test specimens in each of the three directions, and carry out the procedure described in **7.1** and **7.2** on each of these three sets; where it is not known that the bond is formed rapidly within a short period of time (see **7.3**), prepare a further set of four test specimens in each of these three directions and carry out the procedure described in **7.3**.

9 Expression of results

9.1 Estimate the mean peeling force for each test specimen from the graph of the peeling force against extension by using a superimposed grid or by any other suitable means, excluding from the estimation of the mean any initial peak force.

NOTE. An example is given in figure 1.2/5.

9.2 If the type of failure is the same for each test specimen, calculate the arithmetic mean of the four mean peeling forces. Divide this value by the width of the test specimen and express the result, in newtons per millimetre (kilograms force per centimetre), as the bond strength of the bonded assembly.

9.3 If the type of failure is not the same for each test specimen, calculate the bond strength as described in **9.2** for each type of failure observed.

9.4 If the graph of the peeling force against extension shows an initial peak force record this for each test specimen. If it is evident that the initial peak force is caused by initial breaking through the adhesive rather than breaking through a surface layer of an adherend (e.g. the plastics layer of a plastics-coated fabric), ignore the initial peak force because this is due to the particular form of the test specimen and would not occur in a production item. If the type of failure is the same for each test specimen, calculate the mean initial peak force of the four test specimens and express this in newtons per millimetre (kilograms force per centimetre). If the type of failure is not the same for each specimen calculate the mean initial peak force in newtons per millimetre (kilograms force per centimetre) for each type of failure observed.

10 Test Report

The test report shall include the following items:

(a) results, expressed in accordance with clause **9**;

(b) types of failure observed and the percentage of the total peeled area that each failure type represents (see **7.1**);

(c) description of the adherends and their method of preparation;

(d) type of adhesive, method of application and numbers of coats applied;

(e) open times of the adhesive coats (see **5.4** of BS 5131 : Section 1.3 : 1991);

(f) methods of activation of adhesive and of bonding;

(g) width of the test specimen;

(h) full details of the conditioning of the test assemblies;

(i) reference to this method of test, i.e. BS 5131 : Section 1.2;

(j) date of testing.

Publication(s) referred to

BS 5131 Methods of test for footwear and footwear materials
Section 1.1 Resistance of adhesive joints to heat (creep test)
Section 1.3 Preparation of test assemblies using adhesives (other than hot melt adhesives) for heat resistance (creep) and peel tests
[1)]Section 1.7 Preparation of test assemblies using hot melt adhesives for heat resistance (creep) and peel tests
Section 5.4 Sole bond peeling strength

[1)] In preparation.

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 Standards Board and comes into effect on 30 April 1991

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The following BSI references relate to the work on this standard:
Committee reference TCM/39
Draft for comment 89/36217 DC

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Amendments issued since publication

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