BRITISH STANDARD

BS 3424-24: 1990

Testing coated fabrics —

Part 24: Methods 27A and 27B. Methods for determination of abrasion resistance

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

Foreword

In preparing this Part of this British Standard consideration has been given to the various phenomena, which, although not a direct measure of abrasion resistance, are nevertheless related. In particular attention is drawn to the fact that materials having low values of kinetic coefficient of friction and which also exhibit a ratio of static to kinetic friction approaching unity, will generally have better resistance to abrasive wear than similar materials having a high coefficient of kinetic friction and a wide band between static and kinetic friction coefficients. In this regard reference can be made to BS 3424-10.

It has also to be borne in mind that materials that are particularly temperature sensitive, such as plasticized polyvinyl chloride (PVC), should be, as far as possible, protected from heat build-up during laboratory abrasion tests, if the results are to be representative of the use characteristics and if the test is not to suffer from poor reproducibility.

In addition, apart from the change in appearance following abrasion testing, some end products will require post abrasion performance testing in order to assess the extent to which the product will continue to fulfill its utilitarian role.

There is however no simple relationship between abrasion resistance and wear life and consequently it is inadvisable to extrapolate abrasion results as being too indicative of other factors.

As a consequence of these many considerations it is not possible to specify a single type of abrasion test that is universally applicable to all circumstances and so two methods have been selected. Attention is drawn however to a related scuff/snag test in method 34 of BS 3424-31.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 8, 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.

This British Standard, having been prepared under the direction of the Fibres, Yarns, Fabrics and Production Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 31 October 1990

The following BSI references relate to the work on this standard:
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Amendments issued since publication

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Contents

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1 Scope

This Part of BS 3424 describes two methods of assessing the abrasive wear characteristics of coated fabrics.

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

2 Method 27A. Determination of abrasion resistance using a Martindale abrasion machine

2.1 General

The abrasion test using the Martindale abrasion machine is presented in two modes of operation.

Mode A employs the instrument in the conventional manner and produces an abraded disc of coated fabric 38 mm in diameter. This is convenient where only the loss of finish or appearance or the mass or volume of abrasion loss is to be determined and requires only small amounts of coated fabric to be tested. Any post-abrasion tests that can be conducted are however limited with this specimen size, but it is possible to conduct liquid penetration tests (see BS 4724-1 and BS 4724-2) or cold crack tests (see BS 3424-8).

Mode B employs the instrument in inverted mode, i.e. the test specimen is placed on the abradant table instead of in the specimen holder and the abradant is mounted in the specimen holder. This provides a test specimen of approximately 125 mm × 125 mm which enables a much wider range of post-abrasion testing to be carried out, including hydrostatic head testing.

2.2 Precision

The precision statements given in Appendix A of BS 5690:1988 are based on the Martindale abrasion machine operating in the conventional mode, i.e. mode A, using a crossbred worsted abradant and 100 % wool fabric. If mode B is employed using a silicon carbide abradant on a polymer coated fabric, these precision statements will not apply.

2.3 Apparatus[1)]

2.3.1 *Abrasion machine*, complying with that described in BS 5690:1988.

NOTE Information concerning the assembly, maintenance and calibration of the abrasion machine is given in Appendix A. It is essential that these recommendations are followed if excessive variability is to be avoided.

2.3.2 *Silicon carbide cloth abradant*, of "J" weight, grade P180 complying with BS 871.

2.3.3 *Crossbred worsted abradant*, as specified in BS 5690:1988.

2.3.4 *Polyurethane foam backing*, 3 ± 0.02 mm thick having a density of 0.043 ± 0.001 g/cm^3, with a compressed thickness of 2.95 ± 0.02 mm under a pressure of 4.9 kPa.

2.3.5 *Felt backing*, as specified in BS 5690:1988.

2.3.6 *Punch or press cutter*, to cut a circle of at least 38 mm in diameter.

2.4 Conditioning and testing atmosphere

Condition the test specimens in accordance with method 4 of BS 3424-2.

Store the abradant in an atmosphere of approximately 20 °C and 65 % relative humidity.

Conduct the test in the atmosphere for conditioning and testing described in method 4 of BS 3424-2.

2.5 Procedure: mode A

2.5.1 *Test specimens*. Using the punch or press cutter (**2.3.6**) take at least four specimens at random from the coated fabric under test, ensuring as far as practicable that embossed areas, if present, are represented.

If the end point of the test required by the relevant product specification is expressed in terms of mass loss, determine the mass of each test specimen taken.

2.5.2 *Setting up the machine*

2.5.2.1 *Mounting test specimens*. Place the ring of the specimen holder in position on the mounting plate provided on the base of the machine. Insert the test specimen face side downwards, centrally in the ring. Place the metal insert carefully and centrally on top of the specimen, so that its hollowed side faces upwards, and press down.

While ensuring that the ring containing the specimen and metal insert is held firmly in the mounting plate, start to screw the top of the specimen holder on to the ring, taking care that the screw threads are not crossed. Having started the screwing down operation, use both hands to maintain a continuous downward pressure on the assembly, against the mounting plate.

NOTE This procedure will normally ensure that the specimen is securely retained in the holder in a wrinkle-free condition, and that it is ready for testing.

[1)] For information on the availability of test apparatus, apply to Enquiry Section, BSI, Linford Wood, Milton Keynes MK14 6LE, enclosing a stamped addressed envelope for reply.

2.5.2.2 *Mounting abradant*. Mount a new piece of abradant on each of the four tables with a piece of foam backing (**2.3.4**) when using silicon carbide abradant (**2.3.2**), or with a piece of felt backing (**2.3.5**) when using the crossbred worsted abradant (**2.3.3**), of the same dimensions beneath the abradant. Flatten the abradant by placing the weight supplied with the machine for this purpose on its surface, and then position and tighten the retaining frame evenly using diagonally opposite screws in sequence.

2.5.2.3 *Mounting test specimen holders*. Clamp the test specimen holders on the top plate under a pressure of 9 ± 0.2 kPa or 12 ± 0.3 kPa.

2.5.3 *Operation*. After mounting the test specimen holders switch on the machine. At intervals of approximately 350 cycles remove by suction any abrasion debris and dust from the surface of the abradant.

Replace the silicon carbide abradant every 700 cycles and after every test, and replace the crossbred worsted abradant every 5 000 cycles and after every test.

2.6 Procedure: mode B

NOTE The test results using mode B cannot be compared in any meaningful way with the test results using mode A. Mode B was originally employed to enable subsequent hydrostatic head tests to be conducted.

2.6.1 *Test specimens*. Select at least four test specimens, each measuring 125 mm × 125 mm, from non-adjacent areas of the test sample.

2.6.2 *Setting up the machine*

2.6.2.1 *Mounting test specimens*. Carefully position the test specimen on the abrading tables with a piece of felt backing (**2.3.5**) and arrange so that they are free from creases, but without stretching. Flatten the test specimen by placing the weight supplied with the machine for this purpose on its surface, and then tighten the retaining frame evenly using diagonally opposite screws in sequence.

2.6.2.2 *Mounting abradant*. Mount the abradant as described in **2.5.2.1**, but back the abradant (**2.3.2** or **2.3.3**) with foam (**2.3.4**).

While ensuring that the ring containing the abradant and metal insert is held firmly in the mounting plate, start to screw the top of the specimen holder onto the ring taking care that the screw threads are not crossed. Having started the screwing down operation, use both hands to maintain a continuous downward pressure on the assembly, against the mounting plate.

NOTE This procedure will normally ensure that the abradant is securely retained in the holder in a wrinkle-free condition.

2.6.2.3 *Mounting test specimen holders*. Clamp the test specimen holders on the top plate under a pressure of 9 ± 0.2 kPa or 12 ± 0.3 kPa.

2.6.3 *Operation*. After mounting the test specimen holders switch on the machine. Replace the crossbred worsted abradant every 5 000 cycles and after every test and replace the silicon carbide abradant every 700 cycles and after every test.

2.7 Method of assessment

Determine the end point in accordance with the relevant product specification.

NOTE The following end point determinations are recommended:

a) change of colour of the abraded portion assessed by reference to the grey scales for change of colour (see BS 1006);

b) loss of gloss or specular reflectance assessed by reference to BS 3900-D5;

c) increase of light transmittance assessed by reference to a suitable colorimeter;

d) exposure of substrate or expanded layer, when the centre of the test specimen is viewed through a 15 mm diameter hole punched in a 50 mm diameter opaque disc placed in the specimen;

e) reference to a relevant physical property assessed by the use of a recognized method of test, e.g. liquid penetration using BS 4724-1 and BS 4724- 2, or BS 3424-26.

2.8 Test report

The test report shall include the following information:

a) the description of the coated fabric;

b) reference to this method of test, i.e. method 27A of BS 3424-24 and the mode of operation used, i.e. mode A or mode B;

c) the number of cycles of abrasion applied;

d) the pressure applied, i.e. 9 kPa or 12 kPa;

e) details of abradant employed;

f) details of changes in characteristics of the coated fabric as required by the product specification;

g) details of any deviations from the standard test.

3 Method 27B. Determination of abrasion resistance using a rotary platform double head abraser

3.1 General

The rotary platform double head abraser provides a test specimen of approximately 114 mm diameter with a central 6 mm diameter hole, thus providing an effective 54 mm wide available test strip.

3.2 Apparatus

3.2.1 *Rotary platform double head abraser*[2)] (see Figure 1), consisting of a housing of compact design, a flat circular specimen table, a pair of pivoted arms to which abrasive wheels are attached, a motor for rotating the table in the plane of its surface, a counter for indicating the revolutions of the specimen table and a vacuum attachment for removing debris.

The abrasive wheels which are attached to the free end of the pivoted arms, are free to rotate and have, when resting on the test piece, a peripheral engagement with the surface of the test piece, the direction of travel of the periphery of the wheels and the test piece at the contacting portions being at acute angles, and the angle of travel of one wheel periphery being opposite to that of the other. Motion of the abrasive wheels, in opposite directions, is provided by the friction between them and the rotating test piece. The position of the abrasive wheels relative to the centre of the specimen table is shown in Figure 2.

The test piece is clamped to the table by means of a central threaded rod with nut and washer. The vertical distance from the centre of the pivot point of the abraser arms to the top surface of the specimen table is approximately 25 mm.

The speed of rotation of the platform shall be 60 ± 2 r/min.

NOTE 1 This angular velocity of the platform is based on an electrical supply of 240 V 50 Hz.

The abrasion machine is provided with a mass adjustment for varying the contact pressure between the abrasive wheels and the test piece.

NOTE 2 The pivoted arms without auxiliary masses or counter masses should be designed to apply a force against the test piece of 2.5 N per wheel. Additional masses should increase the force to 5.0 N and to 10.0 N. A counter mass attachment may be added to permit a reduction of force against the test piece to 1.25 N per wheel. The preferred force is 10.0 N.

3.2.2 *Double sided adhesive tape.*

3.2.3 *Balance*, accurate to 1 mg.

3.2.4 *Abrasive wheels*, complying with BS 4481-1 or solid wheels wrapped with "C" weight, grade P180 silicon carbide paper complying with BS 871 may be used.

3.3 Test specimens

Cut from the sample of coated fabric at positions non-adjacent and randomly distributed throughout the sample, six test specimens each of 114 mm diameter, with a central hole of 6 mm diameter.

3.4 Conditioning and testing atmosphere

Condition the test specimens in accordance with method 4 of BS 3424-2.

If silicon carbide paper is used as the abradant instead of silicon carbide abrasive wheels, store the paper away from direct sunlight and heat in an atmosphere of approximately 20 °C and 50 % relative humidity and condition for 1 h in accordance with method 4 of BS 3424-2.

3.5 Procedure

3.5.1 *Preparation and mounting of test specimens.* Carefully apply to the reverse side of each test specimen double sided adhesive tape, ensuring that wrinkles or creases are not introduced into the test specimen or the adhesive tape and that the adhesive tape does not distort the specimen or cover the central 6 mm diameter hole. Determine the mass of each specimen to the nearest milligram.

Carefully mount the coated fabric test specimen onto the rotary platform of the machine and press into place evenly.

3.5.2 *Preparation of abrasive surface.* If silicon carbide abrasive wheels are used re-dress them before every test and at intervals of 2 000 cycles. Re-dress the wheels by traversing, across the face of each wheel, the tip of a diamond dressing tool so that a double traverse of the dressing tool (i.e. one forward and one backward movement) takes 25 s. Apply the minimum force necessary to the wheel by the dressing tool to produce an effective re-dressing. During this re-dressing operation rotate the wheel at a speed of not less than 6 r/min and not greater than 10 r/min.

If silicon carbide abrasive paper is used secure it around the periphery of a solid wheel using a suitable adhesive and butt joint the two ends. Replace the abrasive paper every 500 cycles.

3.5.3 *Operation.* Lower the abrasive wheel on to the surface of the test specimen and set the machine in motion. Ensure that the compressed air supply is operating at the correct pressure. Unless the machine is fitted with a vacuum hood remove abraded debris from the surface of the test specimen every 30 s by suction.

3.6 Method of assessment

3.6.1 *Number of cycles to end point.* Determine the end point in accordance with the relevant product specification.

NOTE The following end point determinations are recommended:

a) change of colour of the abraded portion assessed by reference to the grey scales for change of colour (see BS 1006);

[2)] For information on the availability of suitable apparatus, apply to Enquiry Section, BSI, Linford Wood, Milton Keynes MK14 6LE, enclosing a stamped addressed envelope for reply.

b) exposure of substrate or expanded layer;
c) total mass loss expressed in milligrams or as a percentage of the original mass of test specimen;
d) reference to a relevant physical property assessed by the use of a recognized method of test, e.g. cold crack performance using method 10A of BS 3424-8.

3.6.2 *Average rate of loss in mass.* Calculate the loss in mass in milligrams per 100 cycles.

3.7 Test report

The test report shall include the following information:

a) the description of the coated fabric;

b) reference to this method of test, i.e. method 27B of BS 3424-24;

c) number of cycles of abrasion applied;

d) type of abrasive used;

e) details of changes in characteristics of the coated fabric as required by the product specification;

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

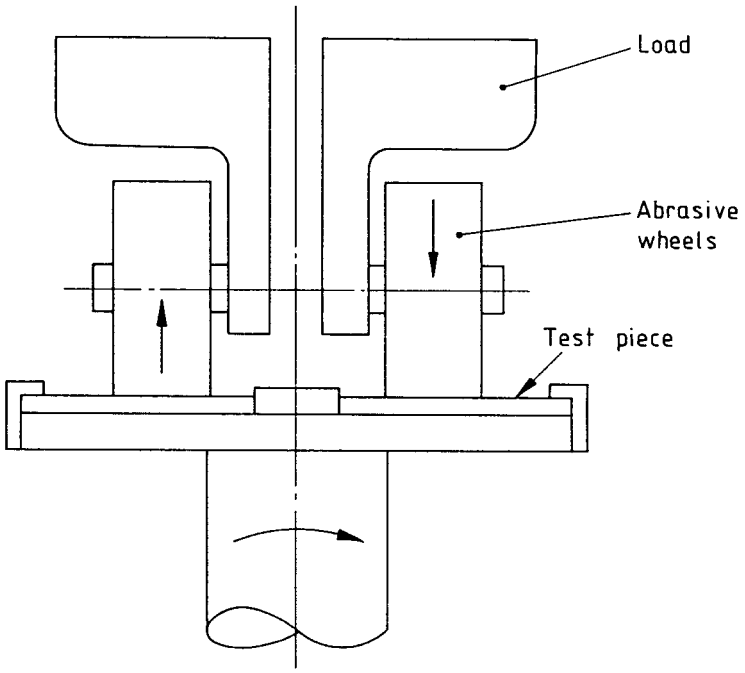
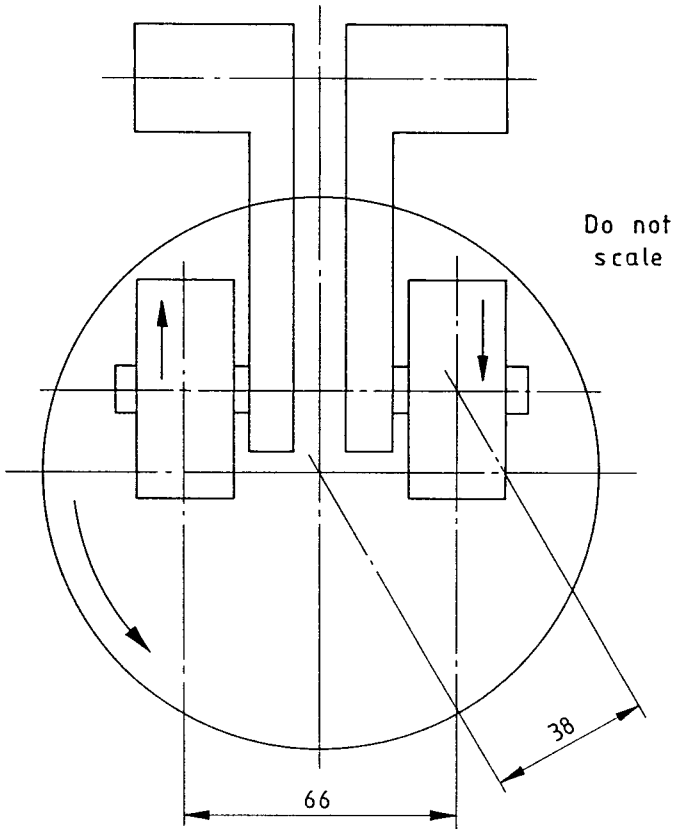


Figure 1 — Front elevation of abrasion machine for method B



Dimensions are in millimetres.

Figure 2 — Plan view of abrasion machine for method B

Appendix A Information relating to the assembly, maintenance and calibration of the Martindale abrasion machine

A.1 Assembling the machine

A.1.1 Place the machine on a firm table or bench, preferably with an anti-vibration mounting or a thick pad of rubber under each foot to reduce vibration and noise.

A.1.2 Clean all protective grease from the abrading tables, specimen holders, supporting cups and ball-bearings using tetrachloroethylene on a soft cloth or tissue.

A.1.3 Place one ball-bearing (as supplied with the machine) into each of the front two support cups and one or two ball-bearings into the rear cup, depending on the type of machine being used. Put a few drops of thick lubricating oil into each of the cups.

A.1.4 Put the top plate into position, ensuring that it is the correct way up and the correct way round.

A.1.5 Clean the grease from all the components of the specimen holder and make sure that dirt is not present which might otherwise prevent the specimen holder components fitting together properly. Make sure that the parts of the specimen holder bearing the same number are kept together. If machines are being used in which the specimen holders are connected to the weight by spindles, smear the spindles with a thin film of silicone grease before pushing them through the bearing into the corresponding specimen holder.

A.1.6 As a result of investigations carried out with the manufacturer of one particular design of machine the use of a general purpose needle bearing in conjunction with a hardened steel spindle has been introduced[3)]. Existing machines of this type can be modified easily and in view of the considerable reduction in variation of results which can be obtained, users of this standard and this machine are strongly recommended to make use of this modification.

A.2 Setting up and maintaining the machine

A.2.1 Ensure that the faces of the inserts of the specimen holders are parallel to the surfaces of the abrading tables. This should have been checked by the machine maker but it should be re-checked frequently, e.g. every 10 tests.

A.2.2 Check that the top plate and abrading tables are parallel. Insert a dial gauge through the spindle bearing and move the top plate by turning the drive shaft by hand. The needle movement of the dial gauge should be within ± 0.05 mm over the whole surface of an abrading table.

A.2.3 To ensure the accuracy of the parallelism of the abrading heads and tables it has been found advisable to "lap in" these elements annually or whenever a new head is installed. This operation is carried out as follows.

a) Prepare the Martindale machine with felt pads removed from the four base plates of the machine, and with the heads removed.

b) Smear a small quantity of light machine oil over the whole area of the base plates.

c) Make a mix of 4 : 1 or even thinner, of light machine oil to carborundum powder grade 2C F6.

d) Insert the complete heads, minus any samples or pads, etc. in the head plate (no weights being applied on top).

e) Place a small quantity of the oil/carborundum mix on the base plate, or base plates, to be lapped in.

f) Start the Martindale machine. Examine the head, or heads, undergoing lapping in at intervals of 20 cycles. Wipe the head with a clean tissue, and examine to see if the ground section extends to the full area of the head. If it does, discontinue the grind. If it does not, continue for a further 20 cycles and re-examine.

g) Finally clean heads and base plates with a suitable solvent to remove all traces of carborundum powder. Then smear with light machine oil 1 : 2 in a suitable solvent.

NOTE All the heads are employed in the lapping in operation even if only one new head is being ground, i.e. carborundum is used only on that one head. This is to avoid an unequal pressure being applied to the head which is not present during testing.

A.2.4 If machines are being used in which the specimen holders are connected to the weights by spindles, then assemble each empty specimen holder and place each one in position on the appropriate abradant table and insert the spindles. Use a feeler gauge to check for any gap between the face of the specimen holder insert and the table. On a new machine any gap should be not greater than 0.05 mm. Rock the spindle from side to side and re-check with the feeler gauge. To avoid damaging abrading tables and metal inserts, do not run the machine with metal inserts in contact with the uncovered abrading table.

[3)] For further information apply to Enquiry Section, BSI, Linford Wood, Milton Keynes MK14 6LE, enclosing a stamped addressed envelope for reply.

A.2.5 At intervals of not more than 1 week clean out the cups carrying the ball-bearings and apply two or three drops of thin oil. Also lubricate the three driving pins.

A.2.6 Periodically clean all the spindles and bearings and apply a thin layer of silicone grease to the spindles.

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Publications referred to

BS 871, *Specification for abrasive papers and cloths.*

BS 1006, *Methods of test for colour fastness of textiles and leather.*

BS 3424, *Testing coated fabrics.*

BS 3424-2:Method 4, *Conditioning and selection of test specimens.*

BS 3424-8:Method 10A, Method 10B and Method 10C, *Methods for determination of low temperature performance.*

BS 3424-10:Method 12A and Method 12B, *Determination of surface drag*[4)].

BS 3424-26:Method 29A, Method 29B and Method 29C, *Methods for determination of resistance to penetration by water.*

BS 3424-31:Method 34, *Method for determination of resistance to scuffing (snagging).*

BS 3900, *Methods of test for paints.*

BS 3900:Group D, *Optical tests on paint films.*

BS 3900-D5, *Measurement of specular gloss of non-metallic paint films at 20°, 60° and 85°.*

BS 4481, *Bonded abrasive products.*

BS 4481-1, *Specification for general features of abrasive wheels, segments, bricks and sticks.*

BS 4724, *Resistance of clothing materials to permeation by liquids.*

BS 4724-1, *Method for the assessment of breakthrough time.*

BS 4724-2, *Method for the determination of liquid permeating after breakthrough.*

BS 5690, *Method for determination of the abrasion resistance of fabrics.*

[4)] Referred to in the foreword only.

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