UDC 629.113-592.51 : 621.643.3 : 678.06-462

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BRITISH STANDARD : AUTOMOBILE SERIES

SPECIFICATION FOR

VACUUM BRAKE HOSE (HEAVY DUTY) OF OIL-RESISTANT RUBBER

FOREWORD

This British Standard, which is published under the authority of the Automobile Industry Standards Committee of the B.S.I., is based upon data-sheet SMMT 203 : 1961 of the Society of Motor Manufacturers and Traders Ltd.

NOTE. If it is required to convert the figures in this standard from British units into metric units it is recommended that the conversion factors and the tables contained in B.S.350, 'Conversion factors and tables', be used. Attention is also drawn to B.S.2856, 'Precise conversion of inch and metric sizes on engineering drawings'.

SPECIFICATION

SECTION ONE : GENERAL

SCOPE

1. This British Standard specifies dimensional and physical requirements for hose manufactured from oil-resistant rubber, for heavy duty use in the vacuum braking systems of single vehicles or as connecting or transmission lines in combinations of vehicles or vehicle systems.

MANUFACTURE

2. The construction of the hose shall embody a smooth bore tube of flexible, oil-resistant rubber, reinforced with cord or duck plies, or a combination of both, with a weather, sunlight and abrasive-resistant cover. The cover material shall have a tensile strength not less than 1200 lbf/in² and a minimum elongation at break of 200 per cent.

DIMENSIONS AND TOLERANCES

3. The hose shall conform to the dimensional requirements given in Table 1.

TABLE 1. DIMENSIONS AND TOLERANCES

All dimensions are in inches

Inside diameter	Tolerance	Outside diameter	Tolerance
¼	)	9/16	)
	)		)
⅜	)	13/16	)
	) +0·008		) ± 1/32
½	)	15/16	)
	) −0·020		)
⅝	)	1 1/16	)
	)		)
¾	)	1 3/16	)
1	+0·010 −0·022	1 15/32	)

continued overleaf

MARKING

4. The following information shall be branded on the outer cover of the hose at intervals not exceeding 15 in, or by continuous branding.

(1) The name or trade mark of the manufacturer or hose assembler, or both

(2) The number of this British Standard, i.e. B.S. AU 109.

TEST REQUIREMENTS

5. *a. Initial tests for compliance.* Representative samples of the hose, selected as described in Clause 6, shall initially pass all the tests prescribed in Section Two.

b. Subsequent production tests. Production shipments or lots of the hose shall be regularly sampled in accordance with Clause 6, and submitted to the testing procedures described in Clauses 10 to 15 inclusive, and shall satisfy all the relevant requirements.

In addition, the purchaser may, before accepting the shipments, take samples from any or all of the production shipments, and test them in accordance with Clauses 8 and 9.

c. Retests. The provisions of Clause 7 apply equally to Subclauses *a* and *b* above.

SAMPLING

6. A representative sample of hose approximately 15 ft long shall be selected from each production batch to be tested. If a single length of 15 ft is not available, several sections, each of sufficient length to provide the required test specimens, may be selected.

The samples shall be not less than 7 days nor more than 120 days old.

RETESTS

7. Should any sample fail in one or more tests, four additional samples shall be selected from the batch which failed, and these samples shall be subjected to the test or tests which the original sample failed to pass.

If all four samples pass all the retests, the batch shall be deemed to comply with the standard.

If any of the four additional samples fails any of the retests, the entire batch shall be deemed not to comply with the standard.

SECTION TWO : TEST REQUIREMENTS

AGEING

8. When examined after having been tested in accordance with Appendix A, the hose shall show no cracks, charring or disintegration externally or internally.

LOW TEMPERATURE

9. When subjected to the procedure described in Appendix B, the hose shall not break or crack.

BURSTING

10. When tested in accordance with Appendix C, the hose shall not burst, leak or show signs of failure at a hydrostatic pressure lower than that given in Table 2.

TABLE 2. MINIMUM PRESSURE

Hose inside diameter	Minimum pressure
in	lbf/in²
¼	1200
⅜	1200
½	1000
⅝	1000
¾	800
1	800

continued

VACUUM

11. When tested in accordance with Appendix D, the hose shall not suffer vacuum collapse or any related failure, judged by the criteria laid down in that Appendix.

BENDING

12. When tested in accordance with Appendix E, the hose shall not suffer collapse of the outside diameter at the middle point of the test length in excess of the values given in Table 3.

TABLE 3. COLLAPSE OF OUTSIDE DIAMETER DURING BEND TEST

Hose inside diameter	in	1/4	3/8	1/2	5/8	3/4	1
Maximum collapse of outside diameter	in	3/32	5/32	7/32	7/32	7/32	9/32

DEFORMATION

13. When the specimen of hose is compressed five times, as described in Appendix F, the load required to compress the specimen to the relevant dimension *D* shall not exceed 70 lbf on the first application, and shall be not less than 40 lbf on the fifth application.

After each application, the specimen shall return immediately to at least 90 per cent of the original outside diameter.

SWELLING

14. After having been conditioned in accordance with Appendix G1, a sample of the hose 12 inches in length shall be immediately subjected to the testing procedures described in Appendix clauses G2, G3 and G4 in that order. All the following requirements shall be met.

a. The steel ball described in Clause G2 shall pass freely through the full length of the hose.

b. During the test prescribed in Clause G3, no leakage of air shall occur through the hose.

c. When sectioned and examined as described in Clause G4, there shall be no sign of separation of the inner tube from the fabric ply.

ADHESION

15. When samples of the hose are tested as described in Appendix H, using a load of 10 lbf minimum, the adhesion

(i) between inner tube and plies

(ii) between plies

(iii) between plies and outer cover,

shall be such that the rate of separation does not exceed one inch per minute.

APPENDIX A. AGEING TEST

A1. Air oven. The internal dimensions of the air oven required for this test shall not exceed 1 x 1 x 1·5 m. No copper or copper alloy shall be within the ageing chamber. Provision shall be made for suspending test pieces so that they are not within 1 cm of each other or of the sides of the oven.

Provision shall be made for a slow circulation of air through the oven of not less than three changes in one hour. The incoming air shall be heated to the temperature of the oven before coming into contact with the test pieces. Suitable means shall be provided for controlling and measuring the rate of air flow.

The temperature of the oven shall be thermostatically controlled so that the test pieces are kept within 2 degF (1 degC) of the ageing temperature specified in Clause A2. A thermometer shall be placed amongst the test pieces to record the actual ageing temperature.

A2. Method. A specimen hose of the length prescribed in Table 4 shall be bent around a former of the dimensions specified in the Table and held in place by a band or cord (see Fig. 1).

The assembly shall then be placed in the oven described in Clause A1 for a period of 70 hours at a temperature of 212 ± 2°F (100 ± 1°C).

After removal from the oven, the assembly shall be allowed to cool to room temperature and shall then be removed from the former. It shall then be opened out to a straight length and cut lengthwise for examination.

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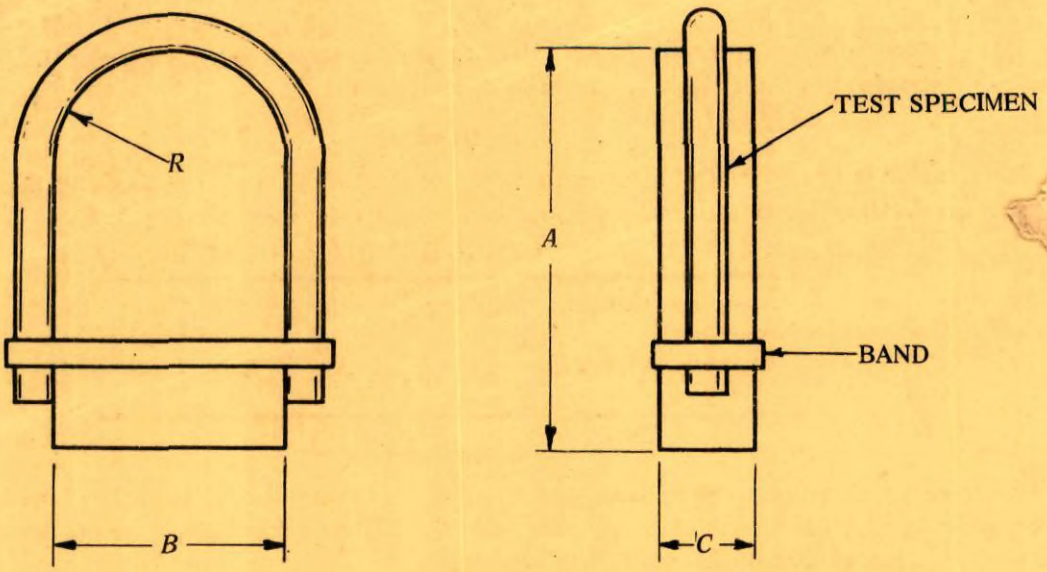

Fig. 1. Hose and former assembly for ageing test

TABLE 4. REQUIREMENTS FOR AGEING TEST (see Fig. 1)

All dimensions are in inches

Dimensions of specimen		Dimensions of former			
Inside dia.	Length	Radius *R*	Height *A*	Width *B*	Thickness *C*
¼	9	1½	4½	3	½
⅜	10	1¾	4¾	3½	¾
½	11	2	5	4	¾
⅝	12	2¼	5½	4½	⅞
¾	14	2½	6	5	⅞
1	16	3¼	6½	6½	1

APPENDIX B. COLD TEST

A specimen of the hose, maintained in a straight position, and a mandrel, the diameter of which shall be ten times the outside diameter of the hose, shall be conditioned together in a cold box at a temperature of –40°F (–40°C) for a period of 72 hours.

At the end of this period, and without removal from the cold box, the hose shall be bent around the mandrel. It shall then be examined for compliance with the requirements of Clause 9.

APPENDIX C. BURSTING TEST

C1. Apparatus. The apparatus shall consist of a suitable pressure system in which the hose is so connected that controlled and measured liquid pressure may be applied internally. The pressure shall be obtained by means of a hand or power driven pump or an accumulator system and shall be measured with a calibrated gauge. Provision shall be made for filling the hose with distilled water and allowing all air to escape through a valve prior to application of pressure. This is important as a safety measure.

C2. Method. The specimen for test shall be at least 18 in long but shall not exceed 36 in.

The specimen shall be connected to the pressure system and completely filled with water, allowing all air to escape. The removal of air bubbles may be facilitated by moving the hose back and forth. The valve shall then be closed and pressure applied at a uniform rate of increase of approximately 1000 lbf/in² per minute until the specimen bursts. The maximum pressure recorded on the calibrated gauge shall be considered as the bursting strength of the specimen.

continued

APPENDIX D. VACUUM TEST

A sample of the hose of the length specified in Table 5 shall be cut from the hose and assembled with test fittings. A metal ball of the diameter specified in Table 5 shall be placed in one end of the hose.

A vacuum equal to 26 inHg shall be applied internally to the hose for a period of 5 minutes, and during this time it shall be possible for the ball to pass freely throughout the length of hose (contact of the ball with the end fittings will be indicated audibly). For the purposes of this test the fixture shall be pivoted or otherwise arranged to permit movement of the ball through the hose.

Upon completion of this test the sample shall be sectioned at several points to enable a visual examination to be carried out for signs of vacuum collapse or other indications of failure such as lack of adhesion of materials etc.

TABLE 5. LENGTH OF HOSE SAMPLE AND DIAMETER OF BALL FOR VACUUM TEST

All dimensions are in inches

Hose inside diameter	Length of sample	Diameter of ball
¼	8	3/16
⅜	12	5/16
½	16	13/32
⅝	22	17/32
¾	28	⅝
1	36	⅞

APPENDIX E. BEND TEST

A sample of hose, as specified in Table 6, shall be bent until the ends touch. The outside diameter of the hose at the middle point of the test length shall then be measured for compliance with Clause 12.

TABLE 6. REQUIREMENTS FOR BEND TEST

All dimensions are in inches

Hose inside diameter	Length of sample
¼	8
⅜	12
½	16
⅝	22
¾	28
1	36

APPENDIX F. DEFORMATION TEST

F1. Apparatus. The apparatus shall consist essentially of an arbor press (see Fig. 2) or other suitable compression device for collapsing the diameters of hose specimens, a platform scale or other suitable means for measuring the load required to collapse the hose, and gauges for measuring the free distance between the inner tube faces of the collapsed hose.

The plates at either side of the test specimen shall be of such dimensions that they are greater than the length and width of the collapsed specimen. The weighing device shall have a capacity of at least 100 lbf and shall indicate the applied load on a dial or scale with an accuracy within ± 1 per cent. The gauges shall be of sufficient length to pass completely through specimens of hose 1 in long, and they shall be rectangular in cross section and conform to the dimensions given in Table 7.

F2. Method. The specimen for test shall be a piece of the hose 1 inch in length. It shall be placed in the press longitudinally with the fabric laps (if any) on either side and not in line with the applied pressure. The load measuring device shall be inserted in the press and the specimen placed on it.

The specimen shall be compressed five times in succession to the form indicated in Fig. 3 and to

continued overleaf

the collapsed inside dimension *D* as specified in Table 7. The specimen shall be held under load each time for 5 seconds, and allowed to recover for approximately 10 seconds between each application of the load.

The load required to compress the specimen to the specified form and dimension shall be recorded on the first and fifth application.

TABLE 7. REQUIREMENTS FOR DEFORMATION TEST

All dimensions are in inches

Hose inside diameter	Collapsed inside dimension *D*	Gauge width	Gauge thickness
1/4	1/16	1/8	1/16
3/8	3/32	3/16	3/32
1/2	1/8	1/4	1/8
5/8	5/32	1/4	5/32
3/4	3/16	1/4	3/16
1	1/4	1/4	1/4

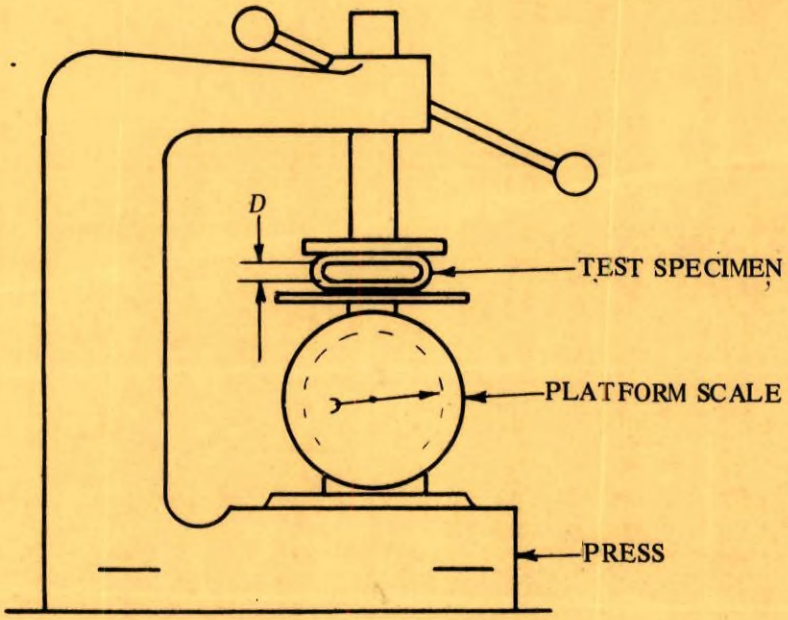

Fig. 2. Apparatus for deformation test

APPENDIX G. SWELL TEST

G1. Conditioning of sample. A sample of the hose, 12 inches in length, shall be filled with test fluid (ISO/octane) and enclosed by means of suitable cork stoppers to prevent loss by evaporation or leakage (a good seal can be obtained by applying shellac to the stoppers and joints). Care shall be taken in sealing the hose to avoid putting the test fluid under greater than atmospheric pressure.

The filled hose shall be allowed to stand at room temperature for 48 hours, after which the test fluid shall be drained off. The specimen shall be immediately submitted to the tests described in Clauses G2, G3 and G4, and the tests shall be carried out in that order.

G2. Steel ball test. A steel ball of the diameter specified in Table 5 shall be dropped through the test specimen.

G3. Vacuum test. Immediately after the test described in Clause G2, the specimen shall be subjected to a vacuum equal to 26 inHg for a period of 5 minutes, during which time it shall be examined for air leakage.

continued

G4. Sectioning of specimen. Following the test described in Clause G3, the specimen shall be sectioned longitudinally and examined for any signs of separation of the inner tube from the fabric ply.

APPENDIX H. ADHESION TEST

H1. Preparation and conditioning of test pieces. Sections of the hose having a length of 1 ± 0·02 in shall be produced by making cuts in planes perpendicular to the axis of the hose, the cut being made by a sharp tool which leaves clean edges. The sections may be conveniently prepared by mounting the hose on a smooth, close fitting, slightly tapered wooden mandrel which can be rotated in a lathe, and cutting 1 inch sections with a sharp pointed wet knife.

Two test pieces shall be taken for each adhesion determination, and only original, not aged, specimens shall be used.

The test pieces shall first be conditioned for at least 24 hours at 68 ± 9°F (20 ± 5°C).

Separate test pieces shall be used for tests (i), (ii) and (iii) as follows:

(i) adhesion between inner tube and plies;

(ii) adhesion between plies;

(iii) adhesion between plies and outer cover.

H2. Apparatus and mounting of test piece. A suitable apparatus for making the test is shown in Fig. 3. The test piece (a) shall be fitted snugly on a mandrel (b) (see also Fig. 4) with an outside diameter substantially equal to the internal diameter of the test piece.

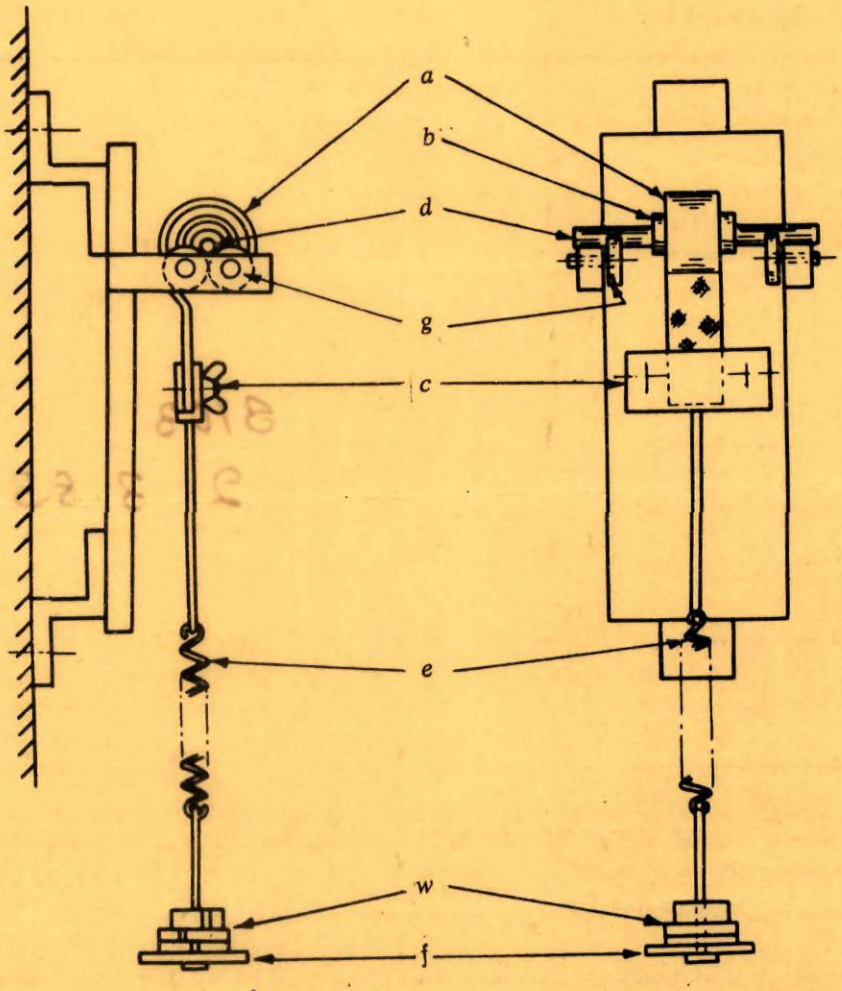

Fig. 3. Apparatus for adhesion test

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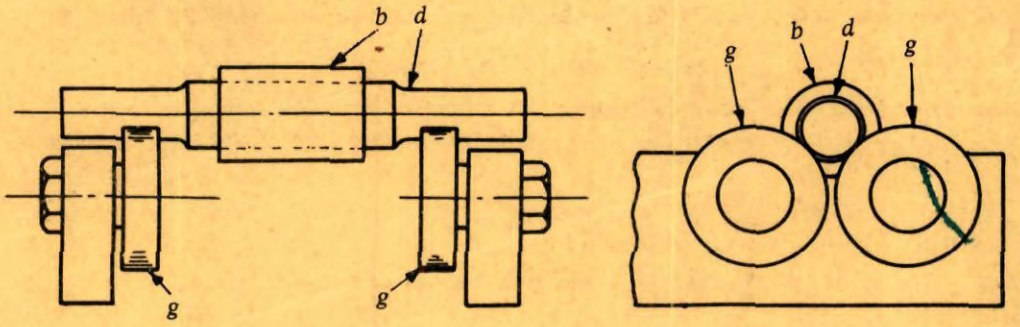

Fig. 4. Mounting of test piece and mandrel for adhesion test

The ply to be tested shall be separated sufficiently to permit the attachment of a clamp (c). With the mandrel mounted on a shaft (d) supported horizontally on the two sets of freely rotating light ball or roller bearings (g), the specified load consisting of the combined weights of the clamp (c), the light steel spring (e) the scale pan (f) and the added weight (w).

H3. Method. The rate of separation shall be determined by observing the duration of the test and by measuring, after the load has been removed, the lengths stripped between marks indicating the beginning and end of the test. The rate shall be taken as the average during a continuous four-minute period, unless the small size of the specimen makes a shorter period necessary.

This British Standard, having been approved by the Automobile Industry Standards Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council of the Institution on 26th November, 1965.

The Institution desires to call attention to the fact that this British Standard does not purport to include all the necessary provisions of a contract.

British Standards are revised, when necessary, by the issue either of amendment slips or of revised editions. It is important that users of British Standards should ascertain that they are in possession of the latest amendments or editions.

The following B.S.I. reference relates to the work on this standard:
Committee reference AUE/-

Grommets shall be tied so that diametrically opposite points of the bore are brought together and held there during exposure.

Method B. The sample shall be tightly knotted, using a single over-hand knot, and subjected to the appropriate exposure period specified in Clause 4.

NOTE. Since the strain produced in a knotted specimen cannot be determined, it is possible to specify only that it be slightly knotted.

PERIOD OF EXPOSURE

4. The appropriate period of exposure shall be as given in Table 1.

TABLE 1. PERIOD OF EXPOSURE

Product	Exposure period	
	April - October	November - March
	weeks	weeks
Solid rubbers Nos. 1, 2, 3 and 4 to B.S.AU 106*	2	4
Solid rubbers Nos. 7 and 8 to B.S.AU 106*	6	12
Hose to B.S.AU 108† Natural rubber	2	4
Hose to B.S.AU 108† Synthetic rubber	6	12
Cellular (sponge) rubber without 'live' skin to B.S.AU 107‡	1	2
Cellular (sponge) rubber with natural rubber 'live' skin to B.S.AU 107‡	2	4
Cellular (sponge) rubber with synthetic rubber 'live' skin to B.S.AU 107‡	6	12
Cellular (expanded) rubber; natural to B.S.AU 107‡	1	2
Cellular (expanded) rubber; synthetic to B.S.AU 107‡	6	12

* B.S. AU 106, 'Solid rubbers'.
† B.S. AU 108, 'Plain and reinforced hoses of rubber'.
‡ B.S. AU 107, 'Cellular rubber components'.

EXAMINATION AFTER TEST

5. Upon completion of the prescribed exposure period, the test specimen shall be examined for compliance with the requirements of the appropriate material standard.

This British Standard, having been approved by the Automobile Industry Standards Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council of the Institution on 29th October, 1965.

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BRITISH STANDARD : AUTOMOBILE SERIES

SPECIFICATION FOR

METHODS FOR THE ATMOSPHERIC EXPOSURE TESTING OF RUBBER

FOREWORD

This British Standard, which is published under the authority of the Automobile Industry Standards Committee of the B.S.I., is based upon data-sheet SMMT 188 : 1962 of the Society of Motor Manufacturers and Traders Ltd.

METHODS

SCOPE

1. This British Standard describes two methods of test for rubber, to provide information regarding the resistance of the rubber to cracking or deterioration on exposure to normal outdoor weathering conditions.

Method A employs a standard form of dumb-bell test-piece, which is subjected to a precise degree of strain during exposure.

Method B, which is applicable to components of appreciable length in relation to their cross section, employs samples of the actual component, which are tied with an overhand knot.

TEST SPECIMENS

2. **Method A.** A dumb-bell test specimen of the 'C' or 'D' type (B.S.903, Part A2*) shall be preferably cut from a convenient part of the component, or alternatively, from a slab or sheet sample.

Where it is not possible to cut a dumb-bell from the component because of its size or shape, or the fact that it is a cellular rubber which may have a protective skin that would be damaged, the whole component or suitable length cut from the full section of the component shall be used.

Grommets shall be tied so that diametrically opposite points of the bore are brought together and held there during exposure.

Method B. The test specimen shall be a component of appreciable length in relation to its cross section. A convenient length is 12 inches.

PROCEDURE

3. The test specimens, to be strained in accordance with the following requirements, shall be mounted vertically on an open wooden frame so that all surfaces of the test specimens are freely exposed to the atmosphere. The frame shall be placed in a location free from shadows from surrounding structures.

The strain shall be imposed on the test specimens as follows :

Method A. The dumb-bell, or length of component if needed, shall be held in suitable grips or clamps and a 1 in (2·5 cm) gauge-length lightly marked on it. The specimen shall then be stretched until the gauge-length has increased by 10 per cent, and held in that position during the appropriate exposure period specified in Clause 4.

Higher degrees of strain may be required but these shall be used by mutual consent between the purchaser and supplier.

* B.S.903, 'Methods of testing vulcanized rubber', Part A2, 'Determination of tensile stress-strain properties'.

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