

## STANDARDS ASSOCIATION OF AUSTRALIA

Australian Standard  
METHODS OF TEST FOR RUBBER

## AS 1683.21

# RUBBER VULCANIZED—DETERMINATION OF ABRASION RESISTANCE USING A ROTATING CYLINDRICAL DEVICE

### PREFACE

This standard was prepared by the Association's Committee on Rubber Analysis and Testing as a result of requests by the Association's Committee for Industrial Hose and Conveyor and Elevator Belting, which had a long-standing need for a method for determining abrasion resistance in certain types of hose and belts.

The method is derived from Doc. ISO/TC 45 WG6 N 641 which is an updated (as of 25 March 1979) version of ISO/DIS 4649 entitled 'Rubber—Determination of Abrasion Resistance Using a Rotating Cylindrical Drum Device'.

The standard requires reference to the following standards:

|             |                                                                                              |
|-------------|----------------------------------------------------------------------------------------------|
| AS 1152     | Test Sieves                                                                                  |
| AS 1180     | Methods of Test for Hose Made from Elastomeric Materials                                     |
|             | 1180.9A Hardness of Vulcanized Rubbers of Standard Hardness (35 to 85 IRHD)                  |
| AS 1683     | Methods of Test for Rubber                                                                   |
|             | 1683.4 Density of Vulcanized Rubber                                                          |
|             | 1683.20 Standard Temperatures, Humidities and Times for Conditioning and Testing Test Pieces |
| ASTM D 1765 | Standard Classification System for Carbon Blacks Used in Rubber Products                     |
| ISO/R 275   | Zinc Oxide for Paints.                                                                       |

### METHOD

**1 SCOPE.** This standard sets out a method for determining the resistance of rubber to abrasive forces using a rotating cylindrical drum device.

**2 APPLICATION.** The method applies primarily to vulcanized rubber. However, it may also be used with a range of other materials, e.g. certain plastics.

NOTE: The method involves the determination of the volume loss of a rubber test piece through abrasive action by rubbing over a specified grade of abrasive cloth. Because factors such as the grade of abrasive particles and adhesive used in the cloth manufacture, and contamination and wear by previous testing lead to variations in the absolute values of abrasion loss, all tests must be comparative, standard rubbers being included so that the results are expressed as a volume loss referred to a calibrated abrasive cloth. No close relation between the results of the abrasion test and service performance can be inferred.

**3 DEFINITIONS.** For the purposes of this standard, the following definitions apply:

**3.1 Abrasion resistance**—the resistance to wear resulting from mechanical action upon a surface.

NOTE: In this standard, it is expressed relative to a standard rubber as relative volume loss.

**3.2 Relative volume loss**—the volume loss, in cubic millimetres, caused by an 'abrasive grade' of cloth equal to 200 mg loss of the standard rubber measured under the same specified conditions.

NOTE: The higher the relative volume loss, the lower is the abrasion resistance.

**3.3 Smearing rubber**—a rubber which, when interposed between successive tests in standard rubbers, produces a mass loss greater than 10 percent.

**4 PRINCIPLE.** A cylindrical rubber test piece is subjected to the action of an abrasive cloth (see Clause 5.2) of a specified abrasive grade at a specified contact pressure and over a given area. Abrasion takes place over one of the flat, end surfaces of the cylindrical test piece. The abrasive cloth is attached to the surface of a rotating cylindrical drum against which the test piece is held and across which it is traversed. The loss in mass of the test piece is accurately determined and the volume loss is calculated from the density of the material.

## 5 APPARATUS.

**5.1 Abrasion Machine.** The test apparatus (see Fig. 1) consists of a laterally movable test piece holder and a rotatable cylinder to which the abrasive cloth is fixed.

The cylinder shall have a diameter of  $150 \pm 0.2$  mm and a length of about 500 mm and shall be rotated at  $40 \pm 1$  r/min, the directions of rotation being as indicated in Fig. 1.

The test piece holder (see Fig. 2) consists of a cylindrical opening, the diameter of which can be altered from 15.5 mm to 16.3 mm and a device for the adjustment, to a depth of  $2 \pm 0.2$  mm, of the test piece protruding from the opening. The holder shall be mounted on a spindle which can be moved laterally, the lateral displacement being  $4.20 \pm 0.04$  mm per revolution of the drum.

NOTE: With this lateral movement, the number of times the test piece passes over any one area of the abrasive paper is four.

The centre axis of the holder shall have an inclination of 3 degrees to the perpendicular in the direction of rotation (see Fig. 1), and shall be placed directly above the longitudinal axis of the cylinder.

The spindle and test piece holder shall be free from vibration during operation, and so disposed that the test piece is pressed against the drum with a force of  $10 \pm 0.2$  N obtained by adding weights to the top of the test piece holder. Where specified in the product standard, other forces shall be used. Rotation of the test piece by rotation of the test piece holder shall be at a rate of 1 revolution per 50 revolutions of the drum, unless otherwise specified.

### NOTES:

1. Different results may be obtained depending upon the force used and whether or not the test piece is rotated. For measurements intended to be comparable, the same conditions should be used.
2. The results in the rotational mode generally give less variability in repeat runs on the same rubber.
3. Individual values from three test pieces can vary from their mean by up to 20 percent for a confidence level of 95 percent.

The abrasive cloth may be attached to the drum using three evenly spaced strips of double-sided adhesive tape extending along the complete length of the cylinder. One of the strips shall be placed where the ends of the abrasive cloth meet. Ideally the ends should meet exactly, but any gap left between them shall not exceed 2 mm. The adhesive tape shall be about 50 mm wide and not more than 0.2 mm thick. Alternatively a suitable contact adhesive may be used for attaching the adhesive cloth to the drum.

Setting of the test piece on to the cloth at the beginning of a test run, and its removal after an abrasion run of 40 m (equivalent to 84 revolutions), shall be automatic. Where specified in the product standard, an abrasion distance of only 20 m (equivalent to 42 revolutions) may be used. For ease of determining 20 m, a revolution counter may be connected to the drum.

To protect the abrasive cloth from damage by the test piece holder, a device for switching off the apparatus just before the lower edge of the test piece holder touches the cloth is recommended.

**5.2 Abrasive Cloth\*.** An abrasive cloth at least 400 mm wide and 474 mm long and 1 mm average

thickness to which is bonded aluminium oxide of grain size 60 (i.e. passing through a test sieve complying with AS 1152, having a nominal aperture size of  $250 \mu\text{m}$  (60 mesh), and resin coated).

The abrasive cloth shall be replaced when the abrasive grade has fallen below 180 mg for an abrasive distance of 40 m. The direction of rotation of the cloth will remain the same for all test runs.

NOTE: The abrasive cloth, when new, has an abrasive grade of about 300 mg (i.e. it gives an abrasion loss of about 300 mg when the standard rubber specified in Appendix A Paragraph A2 is tested in accordance with Clause 8). It is necessary to perform a sufficient number of test runs with a steel test piece to give an abrasion loss of  $200 \pm 20$  mg.

**5.3 Hollow Drill.** The drill is required for preparation of test pieces. A suitable drill is shown in Fig. 3. The rotational frequency of the drill shall be such as to yield a suitable test piece (see Clause 6.1).

**5.4 Balance.** The balance shall be of sufficient accuracy to enable the mass loss of a test piece to be determined to within 1 mg.

**5.5 Standard Rubbers.** Standard rubbers shall be as specified in Appendix A.

## 6 TEST PIECES.

**6.1 Type and Preparation.** The test pieces shall be cylindrical in shape,  $16 \pm 0.2$  mm diameter, with a minimum height of 6 mm.

Test pieces are normally prepared using the hollow drill (see Clause 5.3). During cutting, the cutting edge should be lubricated with water to which a wetting agent has been added. Punching of the test pieces is not permitted.

Alternatively, test pieces may be vulcanized in a mould.

If test pieces of the required thickness are not available, the necessary thickness may be obtained by bonding the test piece to a base element.

When testing finished products which contain materials such as embedded fabrics (e.g. conveyor belts), the test piece taken from the product may contain the fabric. Special care shall be taken to ensure that these test pieces are not abraded down to the fabric or adhesive layer during test.

**6.2 Number of Test Pieces.** Three test runs shall be carried out and for this three test pieces are required. Repeat tests shall not be carried out on the same test piece.

**6.3 Time-lapse Between Vulcanization and Testing.** For all test purposes, the minimum time between vulcanization and testing shall be 16 h. For non-product tests, the maximum time between vulcanization and testing shall be 4 weeks and, for evaluations intended to be comparable, the tests, as far as possible, shall be carried out after the same time-interval. For product tests, whenever possible, the time between vulcanization and testing shall not exceed 3 months. In other cases, tests shall be made within 2 months of the date of receipt by the customer of the product.

**6.4 Conditioning.** All test pieces shall be conditioned in accordance with AS 1683.20 for a minimum period of 16 h immediately before testing.

\* A suitable cloth is produced by Vereinigte Schmingel-und Maschinenfabriken AG, D 3000 Hannam—Hainolz called Vitex KK 511  $\times$  p60. It may be obtained from the Bundesanstalt Für Materialprüfung (BAM), 1 Berlin 45, Unter den Eichen 87, Federal Republic of Germany.

**7 TEST TEMPERATURE.** The test shall be carried out at standard laboratory temperature of  $23 \pm 2^\circ\text{C}$  in accordance with Clause 3.1 of AS 1683.20.

During a test run there may be a considerable increase in temperature at the abrading interface, which may lead to the temperature rising within the test piece. For the purposes of this standard, such temperature rises are to be disregarded, the temperature of test being that of the ambient atmosphere and of the test piece before commencement of the test.

## 8 PROCEDURE.

**8.1 General Test Procedure.** Fix the test piece in the test piece holder in such a way that it protrudes from the opening to a depth of  $2.0 \pm 0.1$  mm. The test piece depth shall be controlled by a gauge. Move the test piece holder and sledge to the starting point and set the cylinder in motion. When each new sheet of cloth is first used, indicate the direction of motion on the sheet, as it is important that the same direction be used for all subsequent test runs.

NOTE: The cylinder is stopped automatically after an abrasive distance of 40 m. When relatively high mass losses (usually higher than 400 mg in 40 m) occur, the cylinder can be stopped after 20 m, and the original depth of  $2.0 \pm 0.1$  mm can be adjusted so that the test can be restarted and completed. At no time is the height of the test piece to be less than 5 mm. If the mass loss is higher than 600 mg in 40 m, the test should only be carried out for half the distance (i.e. 20 m) and this should be indicated on the test report. The results should be multiplied by 2 so that the mass loss can still be given for an abrasion distance of 40 m.

Before each test, any dust left from the previous abrasion test shall be removed with a strong bristle brush. In some cases, a blank test with a non-smearing rubber will effectively clean the abrasive cloth.

**8.2 Running-in.** Before any test runs are made, subject each test piece to a running-in period of a sufficient number of revolutions to ensure that any surface contamination is removed and that the test piece makes contact with the abrasive over the whole of its surface. This applies only for tests in which the test surface is not rotated.

**8.3 Test Runs.** Weigh test pieces to an accuracy of 1 mg before and after each test run. Sometimes a small edge hanging from the test piece has to be pulled off before weighing. For non-rotating test pieces, care must be taken to ensure that the test piece is replaced in the sample holder, in the same position following the running-in period.

If a series of different rubber compounds is being tested, then all three test runs on the same rubber shall be carried out consecutively.

**8.4 Abrasion of Standard Rubber.** The mass loss of a standard rubber shall be determined over a minimum of three runs both before and after each test series. There should be a maximum of three test rubbers in each test series. If the reduction in mass loss of the standard

rubber is greater than 10 percent, then the method is not valid.

The measured abrasion loss shall be within the range 180 mg to 220 mg for the standard rubber described in Appendix A, Paragraph A2. For rubbers which have a tendency to smear, the mass loss of the standard rubber shall be determined after each test. In extreme cases of smearing, there will be a considerable reduction in mass loss of the standard rubber measured after the test run compared to that measured before the test run. This is due to the fact that, after the test run, the abrasive cloth is being 'cleaned' by the standard rubber, as opposed to the standard rubber being abraded by the cloth. Thus, for extreme smearing, it is necessary to clean the abrasive cloth using a non-smearing rubber before using the standard rubber.

**8.5 Density.** Determine the density of the test material in accordance with AS 1683.4.

**9 CALCULATION AND EXPRESSION OF RESULTS.** Calculate the mean value of the mass losses of the test rubber  $m_t$  and of the standard rubber  $m_s$  from the three and six separate determinations respectively.

Calculate the relative volume loss,  $\Delta V$ , using the following expression:

$$\Delta V = \frac{m_t}{\rho_t} \times \frac{200}{m_s}$$

where  $\rho_t$  is the density of the test piece.

**10 TEST REPORT.** The following information shall be reported:

- (a) Sample details—
  - (i) full description and origin;
  - (ii) method of preparation of the test pieces from the sample, i.e. whether cut or moulded.
- (b) Test method—
  - (i) reference to this standard, i.e. AS 1683.21;
  - (ii) whether the sample is rotated or not.
- (c) Test result
  - (i) the relative volume loss;
  - (ii) reference to the standard rubber;
  - (iii) density.
- (d) Date of test.
- (e) Any deviations from this standard, especially the use of only half the abrasion distance, or force on the test specimen if other than  $10.0 \pm 0.2$  N.