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Indian Standard

METHODS OF TEST FOR VULCANIZED RUBBERS

PART VIII RESISTANCE TO CRACK-GROWTH

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NEW DELHI 1

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METHODS OF TEST FOR VULCANIZED RUBBERS

PART VIII RESISTANCE TO CRACK-GROWTH

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 8 December 1967, after the draft finalized by the Rubber Products Sectional Committee had been approved by the Chemical Division Council.

0.2 This method of test is intended for comparing the resistance of vulcanized rubbers to crack-growth when crack is initiated and is subjected to repeated bending or flexing. Repeated bending or flexing of a rubber vulcanizate causes this initiated crack to extend in a direction perpendicular to the stress.

0.3 The tests described here are intended for use in comparing the resistance of rubbers to the formation and growth of cracks. The relative magnitudes of the two resistances — resistance to crack initiation and resistance to crack-growth differ in different rubbers. It is, therefore, imperative that both the resistance to crack initiation and the resistance to crack-growth be measured. A method for determining the resistance to flex-cracking is prescribed in IS : 3400 (Part VII)-1967*.

0.4 The variation between the results obtained for resistance to crack-growth with nominally identical test pieces increases as the period of testing is prolonged, the variation being approximately proportional to the period of flexing with a coefficient of variation of 30 to 60 percent. The mean of the results obtained on six test pieces has a coefficient of variation of 12 to 24 percent.

0.5 While preparing this standard, assistance has been drawn freely from the following:

ISO Recommendation R133-1959 Determination of resistance to crack-growth of vulcanized natural or synthetic rubber (De Mattia type machine). International Organization for Standardization.

B.S. 903 : Part A 11 : 1956 Determination of resistance to crack-growth. British Standards Institution.

ASTM Designation : D813-1959 Resistance of vulcanized rubber or synthetic elastomers to crack-growth. American Society for Testing and Materials.

*Methods of test for vulcanized rubbers : Part VII Resistance to flex-cracking.

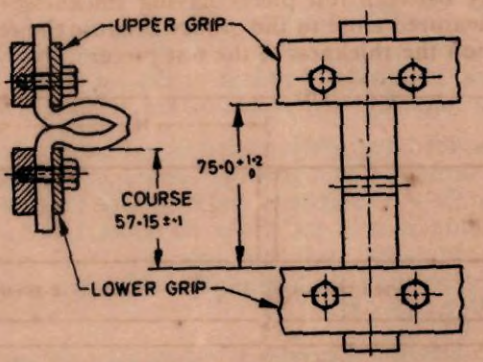
0.6 In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

1. SCOPE

1.1 This standard prescribes a procedure for comparing the resistance of rubbers to crack-growth when subjected to repeated flexing or bending under specified conditions and known periods on the De Mattia type machine.

2. APPARATUS

2.1 The essential features of the De Mattia machine are shown in Fig. 1.



All dimensions in millimetres.

FIG. 1 DE MATTIA TYPE MACHINE

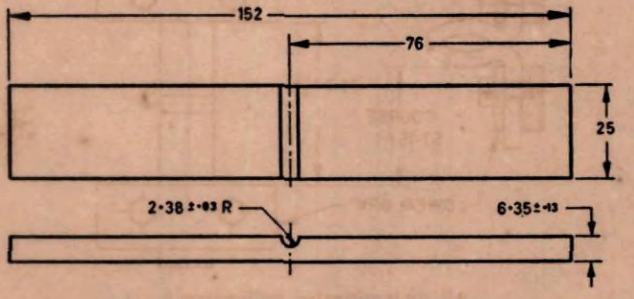
2.2 There shall be stationary parts, provided with grips for holding one end of each of the test pieces in a fixed position, and similar but reciprocating parts for holding the other ends of each of the test pieces. The travel of the reciprocating parts shall be 57·15 ± 0·10 mm and such that the maximum distance between each set of opposing grips is $75{\cdot}0 \begin{smallmatrix}+1{\cdot}2\\-0{\cdot}0\end{smallmatrix}$ mm. The reciprocating parts shall be so arranged that their motion is in the direction of and in the same plane as the common centre lines of each opposing pair of grips. The planes of the gripping surfaces of each opposing pair of grips shall remain parallel throughout the motion. The eccentric which actuates the reciprocating parts shall be driven by a constant speed motor to give 300 ± 10 flexing cycles per minute, with sufficient power to flex at least 6, and preferably 12, test pieces at one test. The grips shall hold

*Rules for rounding off numerical values (*revised*).

the test pieces firmly without undue compression and shall enable individual adjustment to be made to the test pieces to ensure accurate insertion. The test pieces shall be arranged in groups of three or six so that one group is being flexed while the other group is being straightened, thus reducing the vibration in the machine.

3. TEST PIECE

3.1 The test piece shall be a strip 25 mm wide with a moulded groove as shown in Fig. 2. The strips may be moulded individually in a multiple cavity mould or may be cut from a wide slab having a moulded groove. The groove in the test piece shall have a smooth surface and be free from irregularities from which cracks may start prematurely. The groove shall be moulded into the test piece or slab by a half round ridge in the centre of the cavity, the ridge having a radius of $2{\cdot}38 \pm 0{\cdot}03$ mm. The results shall be compared only between test pieces having thicknesses agreeing within 0·13 mm when measured close to the groove because the results of the tests are dependent upon the thickness of the test piece.



All dimensions in millimetres.

FIG. 2 DE MATTIA TEST PIECE

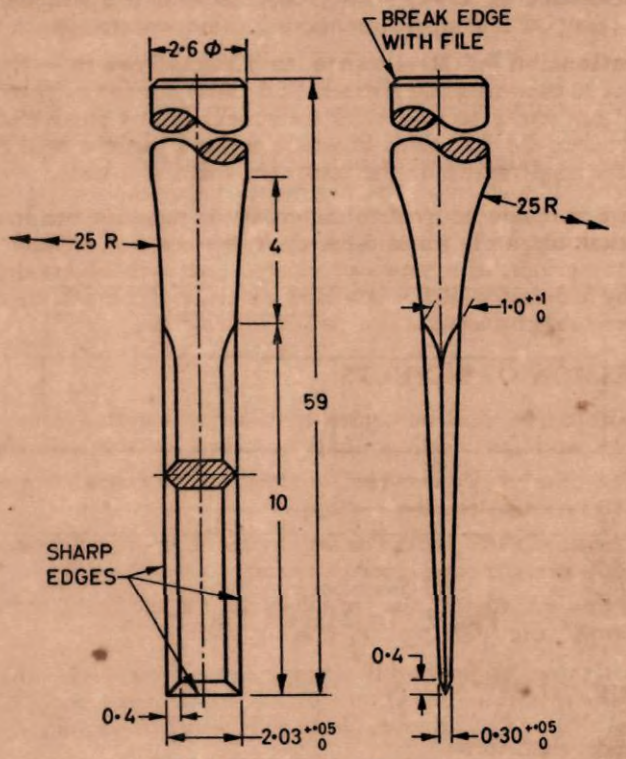
3.2 At least three, or preferably six, test pieces from each rubber shall be tested and the results averaged, one or more test pieces being tested simultaneously with those of other rubbers with which the comparison is to be made.

3.3 Preparation of the Test Piece — Each test piece shall be prepared by piercing the bottom of the groove at a point equidistant from the sides, using a jig. The piercing tool shall be maintained perpendicular to both the transverse and longitudinal axes. The cut shall be parallel to the longitudinal axis of the groove and accomplished by a single insertion and withdrawal of the tool. Soap water may be used as lubricant.

3.3.1 Although it is not necessary to include exact details of a suitable jig for holding the cutting tool, it may be useful to state the basic principles governing the design of such a jig. The test piece shall be held flat on a

solid support; the cutting tool shall be normal to the support and placed centrally with respect to the groove of the test piece, with the edge of the chisel parallel to the axis of the groove. Means shall be provided for passing the cutting tool through the entire thickness of the rubber and the support shall have a hole of a size just sufficient to permit the cutting tool to project through the base of the test piece to a minimum distance of 3 mm.

3.3.2 The piercing tool shall conform to the dimensions given in Fig. 3.



All dimensions in millimetres.

FIG. 3 PIERCING TOOL

4. PROCEDURE

4.1 Storage of Samples and Conditioning of Test Pieces — The properties of vulcanized rubbers change continuously with time, these changes being particularly rapid during the first 24 hours after vulcanization. Therefore, carry out no test within this period. For accurate comparison

between different rubbers it may be necessary to ensure that these are tested at substantially the same interval after vulcanization.

4.1.1 Protect samples and test pieces from light as completely as possible during the interval between vulcanization and testing.

4.1.2 Keep the test pieces at a temperature of 27°±2°C, for a period of not less than 12 hours immediately prior to being measured and tested.

4.2 Temperature of Test — The recommended temperature for test is 27°±2°C. Any other temperature used shall be reported in the test report.

4.3 Determination of Resistance to Crack-Growth — Separate the pairs of grips to their maximum extent and insert the test pieces so that they are flat and not under tension, with the groove in any particular test piece midway between the two grips in which the test piece is held and on the outside of the angle made by the test piece when it is bent.

4.4 Stop the machine at frequent intervals to measure the length of the crack, for example, at 1, 3 and 5 kilocycle periods and at such further or intermediate periods, as appears necessary. At each observation separate the grips by a distance of 65 mm and measure the crack to the nearest 0·5 mm preferably by using a low power microscope.

5. EXPRESSION OF RESULTS

5.1 A smooth curve shall be drawn by plotting length against number of flexing cycles and the readings shall be taken for the following:

a) The number of kilocycles for the crack to extend from 2 to 4 mm (100 percent crack-growth);

b) The number of kilocycles for the crack to extend from 4 to 8 mm (300 percent crack-growth); and

c) If desired, the number of kilocycles for the crack to extend from 8 to 12 mm (600 percent crack-growth).

6. REPORT

6.1 The report shall state:

a) the number of kilocycles for the crack to extend from 2 to 4 mm (100 percent crack-growth);

b) the number of kilocycles for the crack to extend from 4 to 8 mm (300 percent crack-growth);

c) if desired, the number of kilocycles for the crack to extend from 8 to 12 mm (600 percent crack-growth);

d) the number of test pieces; and

e) the temperature of the test.

INDIAN STANDARDS

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Methods of Test on Rubber and Rubber Products

IS:		Rs
443-1963	Methods of sampling and test for rubber hoses (*revised*) ...	3·50
3400 (Part I)-1965	Methods of test for vulcanized rubbers: Part I Tensile stress strain properties	2·00
3400 (Part II)-1965	Methods of test for vulcanized rubbers: Part II Hardness	2·50
3400 (Part III)-1965	Methods of test for vulcanized rubbers: Part III Abrasion resistance — du Pont constant load method	1·50
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3400 (Part V)-1965	Methods of test for vulcanized rubbers: Part V Adhesion of rubber to textile fabrics	2·00
3400 (Part VI)-1967	Methods of test for vulcanized rubbers: Part VI Resistance to liquids (*under print*)	—
3400 (Part VII)-1967	Methods of test for vulcanized rubbers: Part VII Resistance to flex-cracking	4·00
3400 (Part VIII)-1967	Methods of test for vulcanized rubbers: Part VIII Resistance to crack-growth	2·50
3400 (Part IX)-1967	Methods of test for vulcanized rubbers: Part IX Relative density and density	2·00
3660 (Part I)-1966	Methods of tests for natural rubber: Part I Determination of dirt, volatile matter, ash, total copper, manganese, iron, rubber hydrocarbon, viscosity (shearing disc viscometer), and mixing and vulcanizing of rubber in standard compound	8·00
3708 (Part I)-1966	Methods of test for natural rubber latex: Part I Dry rubber content, total solids, coagulum content, viscosity, sludge content, density, total alkalinity, KOH-number, mechanical stability, volatile fatty acid number, *p*H, total nitrogen, total copper, total iron, total manganese and total ash	8·00
4511 (Part I)-1967	Methods of test for styrene butadiene rubber (SBR) latices: Part I Determination of dry polymer, total solids, coagulum, *p*H, surface tension, density, viscosity, residual styrene, bound styrene and soap content (*under print*)	—
4518 (Part I)-1967	Methods of test for styrene butadiene (SBR) rubber: Part I Determination of volatile matter, total ash, organic acid, soap, antioxidants, bound styrene and Mooney viscosity (*under print*)	—