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**Rubber, vulcanized or
thermoplastic—Determination of
abrasion resistance—Part 2: Testing
methods**

ICS 83.060

Reference number : JIS K 6264-2 : 2005 (E)

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Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal of establishing a Japanese Industrial Standard from The Japan Rubber Manufacturers Association (JRMA)/Japanese Standards Association (JSA), with a draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

This Standard has been made based on **ISO 4649:2002** *Rubber, vulcanized or thermoplastic—Determination of abrasion resistance using a rotating cylindrical drum device* for the purposes of making it easier to compare this Standard with International Standard; to prepare Japanese Industrial Standard conforming with International Standard; and to propose a draft of an International Standard which is based on Japanese Industrial Standard.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

JIS K 6264 consists of the following 2 parts under the general title “*Rubber, vulcanized or thermoplastic—Determination of abrasion resistance*”:

Part 1: Guide

Part 2: Testing methods

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In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

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Contents

	Page
Introduction	1
1 Scope	1
2 Normative references	1
3 Definitions	2
4 Classification of tests	2
5 General conditions of test	3
5.1 Standard conditions in laboratory	3
5.2 Test temperature	3
5.3 Storage of sample and test piece	3
5.4 Conditioning of test pieces	3
5.5 Standard sample and reference sample	3
6 DIN abrasion test	4
6.1 Purpose	4
6.2 DIN abrasion machine	4
6.3 Test pieces	6
6.4 Test methods	7
6.5 Calculation	10
6.6 Record	11
7 Williams abrasion test	11
7.1 Purpose	11
7.2 Williams abrasion machine	12
7.3 Test piece	13
7.4 Testing methods	14
7.5 Calculation	17
7.6 Record	18
8 Akron abrasion machine	19
8.1 Purpose	19
8.2 Akron abrasion machine	19

8.3	Test piece	21
8.4	Testing methods	21
8.5	Calculation	23
8.6	Record	24
9	Improved Lambourn abrasion machine	24
9.1	Purpose	24
9.2	Improved Lambourn abrasion machine	24
9.3	Test piece	26
9.4	Testing methods	27
9.5	Calculation	29
9.6	Record	29
10	Pico abrasion machine	30
10.1	Purpose	30
10.2	Pico abrasion machine	30
10.3	Test piece	32
10.4	Testing methods	33
10.5	Calculation	36
10.6	Record	37
11	Taber abrasion machine	37
11.1	Purpose	37
11.2	Taber abrasion machine	37
11.3	Test piece	41
11.4	Testing methods	41
11.5	Calculation	42
11.6	Record	42
Annex 1 (normative)	Compounds and vulcanization time of standard sample and reference sample for abrasion test.....	43
Annex 2 (informative)	Mixing method for reference compound for Pico abrasion test	45
Annex 3 (informative)	Comparison table between JIS and corresponding International Standard	47

Rubber, vulcanized or thermoplastic— Determination of abrasion resistance— Part 2: Testing methods

Introduction In this Japanese Industrial Standard, clause 6 has been prepared based on the second edition of **ISO 4649** *Rubber, vulcanized or thermoplastic—Determination of abrasion resistance using a rotating cylindrical drum device* published in 2002 with some modifications of the technical contents.

The portions given sidelines or dotted underlines in clause 6 of this Standard are the matters modified from the original International Standard. A list of modifications with the explanations is given in Annex 3 (informative).

WARNING : Persons using this Standard shall be familiar with normal laboratory practice. This Standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices.

1 Scope This part of **JIS K 6264** specifies the testing methods for the determination of abrasion resistance of rubber, vulcanized or thermoplastic (hereafter referred to as “vulcanized rubber”).

Remarks : The International Standard corresponding to this part of **JIS K 6264** is as follows.

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21**.

ISO 4649:2002 *Rubber, vulcanized or thermoplastic—Determination of abrasion resistance using a rotating cylindrical drum device* (MOD)

2 Normative references The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS K 1410 *Zinc oxide*

JIS K 3331 *Hardened oils and fatty acids for industrial use*

JIS K 6200 *Rubber—Vocabulary*

JIS K 6220-2 *Rubber compounding ingredients—Test methods—Part 2: Organic accelerators and vulcanizing agents*

JIS K 6220-3 *Rubber compounding ingredients—Test methods—Part 3: Anti-degradants*

JIS K 6222-1 *Rubber compounding ingredients—Sulfur—Methods of test*

JIS K 6250 *Rubber—General rules of physical testing methods*

JIS K 6264-1 *Rubber, vulcanized or thermoplastic—Determination of abrasion resistance—Part 1: Guide*

JIS K 6268 *Rubber, vulcanized—Determination of density*

JIS K 6299 *Rubber—Preparation of test pieces*

JIS R 6111 *Artificial abrasives*

JIS R 6210 *Vitrified grinding wheels*

JIS R 6212 *Resinoid grinding wheels*

JIS R 6251 *Abrasive cloths*

JIS R 6252 *Abrasive papers*

3 Definitions For the purposes of this Standard, the definitions given in **JIS K 6200** and clause **3** of **JIS K 6264-1** and the following definitions apply.

- a) **running-in operation** the operation for the purpose of letting a new abradant, by running it for sometime prior to the abrasion test, attain a stabilized and approximately constant abrasion capability
- b) **fitting operation** the preliminary operation carried out prior to the regular operation for the purpose of removing the vulcanized film of abrasion test piece prepared by mould vulcanization and improving the fitting of the contact surface with abradant

It is also called surfacing or preliminary grinding.

- c) **standard sample** the sample to be used for the evaluation of abrasion capability of abradants
- d) **reference sample** the sample to be used for the relative comparison of test results

4 Classification of tests The classification of tests shall be the following six types:

- a) DIN abrasion test
- b) Williams abrasion test
- c) Akron abrasion test
- d) Improved Lambourn abrasion test
- e) Pico abrasion test
- f) Taber abrasion test

Remarks 1 The selection of any one of these tests shall be subjected to the agreement between the parties concerned with delivery.

2 The test results obtained according to different types of tests can not be mutually compared directly.

5 General conditions of test Unless otherwise specified in each abrasion testing method, the general conditions of test shall be as follows:

5.1 Standard conditions in laboratory The standard temperature in laboratory shall be in accordance with **5.1** of **JIS K 6250**. For the humidity in laboratory, **6.1** of **JIS K 6250** is desirable.

5.2 Test temperature It is difficult in abrasion test to measure and control the temperature of abrasion surface strictly, therefore the ambient temperature shall be the test temperature. The test temperature shall be selected from **5.2** or **5.3** of **JIS K 6250**.

5.3 Storage of sample and test piece The storage of sample and test piece shall be in accordance with **8.2** of **JIS K 6250**.

5.4 Conditioning of test pieces The conditioning of test pieces shall be in accordance with **8.3** of **JIS K 6250**.

5.5 Standard sample and reference sample The standard sample and reference sample shall be as follows:

5.5.1 Compounds and vulcanization conditions of standard sample and reference sample for each abrasion test The compounds and vulcanization conditions of standard sample and reference sample for each abrasion test shall be in accordance with Annex 1. The other compounds may be used according to the agreement between the parties concerned with delivery, in which case it shall be recorded in the test results.

5.5.2 Preparation of standard sample and reference sample The preparation of standard sample and reference sample, unless specially specified, shall be as follows:

- a) **Mixing** The mixing shall be in accordance with **JIS K 6299**.
- b) **Vulcanization** The vulcanization shall be carried out under the specified vulcanization conditions by using the mould for sample corresponding to each abrasion test.

5.5.3 Method for using standard sample and reference sample For the general method for using standard sample, unless specially specified, if the test is to be carried out on the same day, the test piece of standard sample shall be added as the test is conducted continuously. When the test is carried out for two days or longer, it is desirable to add the test piece of standard sample every day. The method for using the reference sample shall be in accordance with each testing method.

5.5.4 Storage and term of validity of standard sample and reference sample The vulcanized sample is wrapped with a sheet of aluminium foil, put in a desiccator, etc. and stored in dark and cool place. Unless specially specified, the term of validity for sample shall be one year after vulcanized.

6 DIN abrasion test

6.1 Purpose This test is an abrasion test of vulcanized rubber carried out for the purpose of determining the abrasion resistance by using DIN abrasion machine (rotating cylindrical abrasion machine). Each item of this testing method is equivalent to the relevant items in **ISO 4649**.

6.2 DIN abrasion machine The DIN abrasion machine is composed of the drum rotating in one direction at a specified rotation speed, the abrasive cloths wound on the surface of drum, the test piece holder, the traverse moving apparatus by which the test piece holder is moved in parallel to the rotation shaft of drum, the pressure apparatus by which the test piece is pressed to the abrasive cloths by a specified load (applied force), the test piece rotating apparatus in which the test piece is rotated around the central axis of the test piece holder during the test and the test piece lifting apparatus, and it is recommended that the suction apparatus and brush for removing the abrasion dust are provided.

The DIN abrasion machine, by rotating the drum on which abrasive cloths are wound at a definite speed, abrades the test piece by pressing it by a definite load. An example of DIN abrasion machine is shown in figure 1.

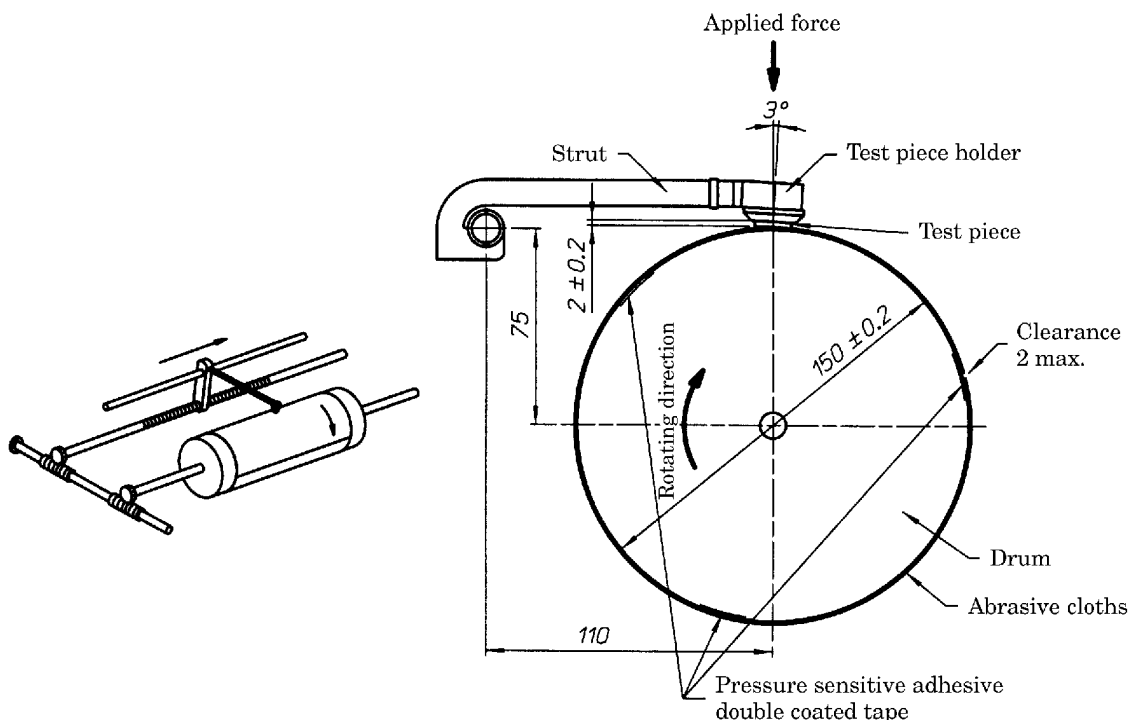


Figure 1 An example of DIN abrasion machine

6.2.1 Drum The drum shall have a diameter of $150.0\text{ mm} \pm 0.2\text{ mm}$ and a length of about 500 mm and shall be rotated at a speed of 40 rpm, the direction of rotation being as indicated in figure 1.

6.2.2 Abrasive cloths and attaching method of abrasive cloths

- a) The abrasive cloth shall have a width of not less than 400 mm, a length of 474 mm $\pm$ 1 mm and an average thickness of 1 mm, and the abrasives of alumina with P60 in particle size according to **JIS R 6251** shall be used.
- b) For the abrasive cloths, the pressure sensitive adhesive double coated tape of about 50 mm in width and not more than 0.2 mm in thickness shall be used to supply a uniform abrasion surface in whole area of drum, and fixed tightly over the whole length of drum at three positions equally divided along the circumference of drum. At this time, one of the adhesive tapes shall be applied at the position where the ends of abrasive cloth meet and the clearance between the ends of abrasive cloth shall be not more than 2 mm (see figure 1).

Remarks : As an alternative method for attaching the abrasive cloths, the apparatus in which the abrasive cloth is wound on the drum and attached by an abrasive cloth presser may be used as shown in figure 2. In such a case, when the test piece comes to the position of the abrasive cloth presser, the test piece shall be lifted once and returned again to the original position. At the time, the effective abrasion distance of test piece for one revolution of the drum shall be adjusted to be 400 mm $\pm$ 8 mm.

- c) The abrasive cloth shall be attached to the central part of longitudinal direction of drum.

Unit: mm

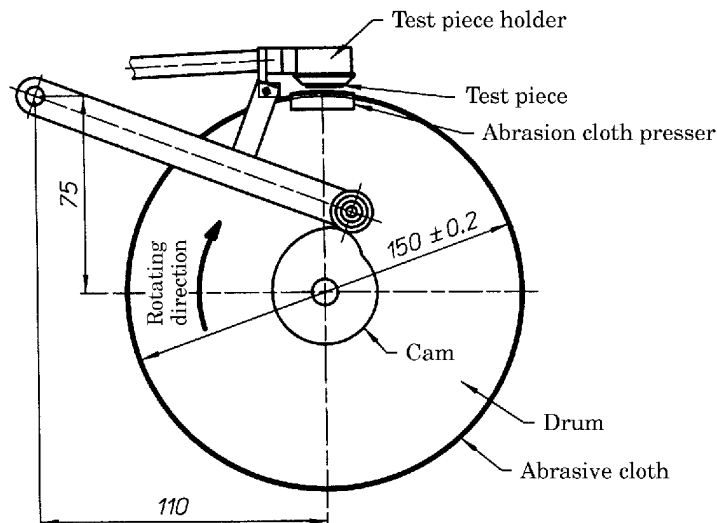


Figure 2 Alternative method for attaching of abrasive cloth

6.2.3 Test piece holder The test piece holder shall be held by the strut capable of traverse movement, the central axis of test piece holder shall have an inclination of 3° in angle to the perpendicular in the direction of rotation (see figure 1), and shall be placed directly above the central axis of the drum to within $\pm$ 1 mm.

The test piece holder shall have a cylindrical opening, the diameter of which can be adjusted from 15.5 mm to 16.3 mm, and a device for adjusting the length of the test piece protruding from the opening to 2.0 mm $\pm$ 0.2 mm.

The vibration which influences the test results shall not be present in the test piece holder and strut.

6.2.4 Traverse moving apparatus The traverse moving apparatus shall be capable of moving the strut in parallel to the shaft of drum as linking to the rotation of drum by $4.20 \text{ mm} \pm 0.04 \text{ mm}$ per revolution.

6.2.5 Pressure apparatus The pressure apparatus shall be capable of adding weight on the test piece holder so that the test piece can be pressed onto the drum with a force of $10.0 \text{ N} \pm 0.2 \text{ N}$ or $5.0 \text{ N} \pm 0.1 \text{ N}$.

6.2.6 Test piece rotation apparatus The test piece rotation apparatus shall be capable of rotating the test piece around the central axis of holder as linking to the rotation of drum during the test corresponding to the testing method. It is recommended that the rotation speed is such that the test piece is rotated by one revolution every 50 revolutions of rotation of the drum.

6.2.7 Test piece lifting apparatus The test piece lifting apparatus shall be capable of carrying out automatically the operation to press the test piece to the drum at the beginning of test run and the operation to lift the test piece from the drum when coming to the specified abrasion distance. For the calculation of the specified abrasion distance, the rotation counter of drum may be used.

6.3 Test pieces

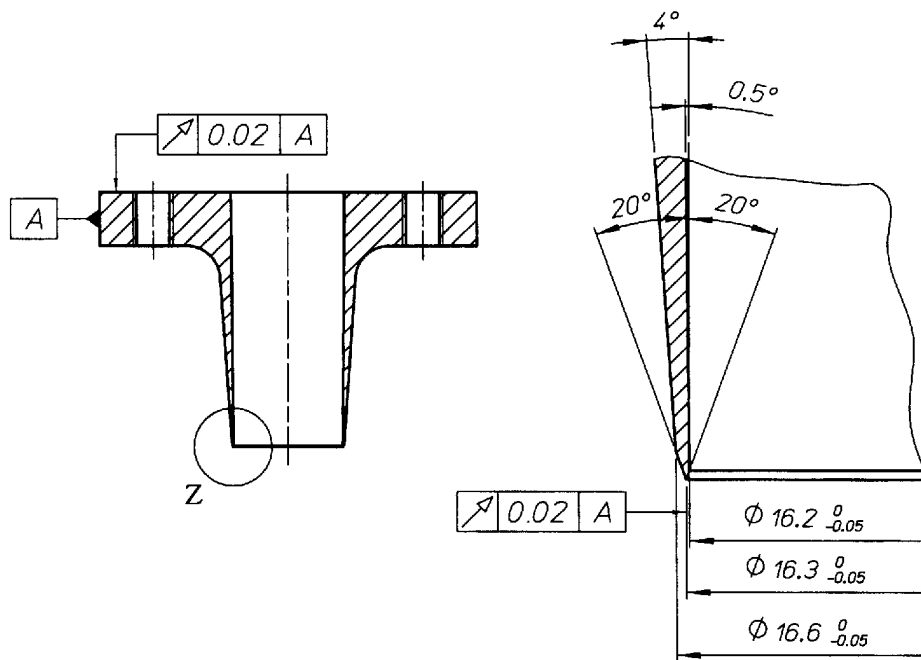
6.3.1 Type and dimension of test piece The test piece shall be disc-shaped, $16.0 \text{ mm} \pm 0.2 \text{ mm}$ in diameter and not less than 6 mm in thickness.

6.3.2 Sampling and preparation of test piece The test piece shall be prepared by cutting it off from a sheet not less than 6 mm in thickness by using the hollow drill⁽¹⁾. While the test piece is being cut off, the hollow drill shall be lubricated with water added with wetting agent. An example of a hollow drill is shown in figure 3. The test piece may be prepared by mould vulcanization, however, it shall not be prepared by punching.

Note ⁽¹⁾ The speed of rotation of the drill needs to be at least 1 000 rpm for most rubbers, and even higher for rubbers with a hardness of less than A50/S (50 IRHD/S/N).

Remarks : If the test pieces of the required thickness are not available, the necessary thickness may be obtained by bonding a piece of the test rubber to a base element of hardness not less than A80/S (80 IRHD/S/N). The thickness of the test rubber shall be not less than 2 mm.

Unit: mm



Enlarged figure of part Z

Information : The circumferential deflection should be within 0.02 mm.

Figure 3 An example of hollow drill

6.3.3 Standard test piece and reference test piece The standard test piece shall be prepared by using the compound D1 specified in Annex 1 table 1, the reference test piece shall be prepared by using the compound D1 specified in Annex 1 table 1 in the case of method A and the compound D2 in the case of method B. For the reference test piece, the compound other than those specified in Annex 1 table 1 may be used according to the agreement between the parties concerned with delivery.

6.3.4 Number of test pieces The number of test pieces shall be three or over.

6.3.5 Number of reference test pieces The number of reference test pieces shall be three. When the compound D1 or D2 in Annex 1 table 1 is used, the test may be carried out thrice by using the same reference test piece instead of testing by using three reference test pieces.

6.4 Test methods

6.4.1 Types of testing methods The types of testing methods shall be the following two according to the presence of the rotation of test piece.

- Method A** The method for testing without the rotation of the test piece.
- Method B** The method for testing as rotating the test piece by the test piece rotation apparatus.

6.4.2 Test conditions The test conditions shall be in accordance with clause 5 and the following:

- a) **Rotation speed of drum** The rotation speed of drum shall be $40 \text{ rpm} \pm 1 \text{ rpm}$.
- b) **Force applied to test piece** The force applied to the test piece shall be $10.0 \text{ N} \pm 0.2 \text{ N}$ as the standard. For the softer rubber than A40/S (40 IRHD/S/N) in hardness, it may be $5.0 \text{ N} \pm 0.1 \text{ N}$.
- c) **Abrasion distance** The abrasion distance shall be $40.0 \text{ m} \pm 0.2 \text{ m}$ as the standard⁽²⁾.

Note ⁽²⁾ When relatively large mass losses (usually more than 400 mg in 40 m) occur, the test run may be stopped after 20 m, and the length of exposed test piece reset to $(2.0 \pm 0.2) \text{ mm}$ so that the remaining 20 m of the run may be completed. At no time shall the height of the test piece be less than 5 mm. If the mass loss is greater than 600 mg in 40 m, the abrasion distance shall be reduced to 20 m and this shall be stated in the test report. The results shall be multiplied by 2 so that the mass loss can still be given for an abrasion distance of 40 m.

Remarks : The abrasive distance of 40 m corresponds to 84 revolutions of the drum when the method for attaching of the abrasive cloths is as in figure 1, and in the case of figure 2, to 100 revolutions.

- d) **Traverse movement speed** The traverse movement speed shall be $4.20 \text{ mm} \pm 0.04 \text{ mm}$ per revolution of drum.

6.4.3 Calibration and adjustment of abrasion capacity of abrasive cloths The calibration and adjustment of abrasion capacity of abrasive cloth shall be as follows:

- a) The abrasion capability of abrasive cloths shall be expressed by the mean value of wear mass of at least three test pieces which have been tested for 40 m abrasion distance according to method A. The abrasive cloths to be used for test shall be 180 mg to 220 mg in abrasion capability.
- b) The new abrasive cloths exceed usually 300 mg in abrasion capability, therefore it shall be adjusted according to the following:
 - 1) The rotating direction shall be indicated on the abrasive cloth at the first use and the same direction shall be always used.
 - 2) The sample made of steel of the same shape and dimensions as test piece shall be attached to the test piece holder and the test of 40 m abrasive distance shall be carried out once or twice.
 - 3) The test of 40 m abrasive distance shall be carried out for each of the two standard test pieces according to method A and it shall be confirmed that the abrasion capability is between 200 mg and 220 mg.

Remarks : The adjusted abrasive cloth can be tested about 200 times to 300 times by using the reference test piece until the abrasive capability is reduced to 180 mg.

6.4.4 Operation method The operation method shall be as follows:

- 1) Measure the density of test piece according to **JIS K 6268**.
- 2) Remove the abrasion dust of rubber left on the abrasive cloth caused by the test up to the time by using a brush⁽³⁾ of hard nylon, etc. prior to the test.

Note ⁽³⁾ Brushes with metal bristles are not recommended as the life of the abrasive sheet will be shortened.

Remarks : In some cases, a blank test with a reference test piece will effectively remove the abrasion dust. The reference test piece used only for this purpose does not necessarily have to meet the stringent requirements of the reference test piece used for test purposes. The blowing of compressed air removes the abrasion dust left by some test rubbers better than brushing.

- 3) Set the machine to be with or without rotation of the test piece depending on whether test method A or method B is being used.
- 4) Weigh the mass of the test piece before testing to the nearest 1 mg.
- 5) Attach⁽⁴⁾ the test piece to the test piece holder, adjust so that the length of the test piece protruding from the opening is $2.0 \text{ mm} \pm 0.2 \text{ mm}$, and fix. Confirm this length by using a gauge.

Note ⁽⁴⁾ When the test piece is detached during the test according to method A, care shall be taken to ensure that it is always replaced in the same position.

- 6) Apply a force of $10.0 \text{ N} \pm 0.2 \text{ N}$ to the test piece holder and press the test piece against the drum. In the case of the rubber softer than 40A/S (40 IRHD/S/N), the applied force of $5.0 \text{ N} \pm 0.1 \text{ N}$ may be used.
- 7) Move the test piece holder to the starting point. Start the test and lift the test piece to stop at the point where the abrasion distance has reached 40 m. When the wear mass is large, stop once at the point of 20 m and reset the length of test piece protruding from the opening or shorten the abrasion distance to 20 m⁽²⁾ ⁽⁵⁾.

Note ⁽⁵⁾ The test piece which has been bonded so that the necessary thickness is obtained shall not be abraded down to the adhesive layer. In such a case, if necessary, the test of 20 m abrasive distance may be carried out.

- 8) Weigh the mass of the test piece after tested to the nearest 1 mg. In some cases, especially in the test according to method A, a small edge hanging from the test piece has to be removed before weighing the mass.
- 9) As to the reference test piece, carry out the test similarly. Test three reference test pieces respectively before and after each test series⁽⁶⁾. The number of test pieces in one test series shall be ten at most, and when the tests using larger number of test pieces are carried out, the measurement of abrasion capability of abrasive cloths shall be carried out again and it shall be

confirmed that it is in the range between 180 mg and 220 mg. This test for abrasion capability of abrasive cloths shall not be carried out to split runs in a series.

For the sticky rubber, weigh the wear mass of the reference test piece after each run of test. In the cases of extremely sticky rubbers, the wear mass of the reference test piece after tested is considerably reduced as compared with that before tested. This is due to the fact that the abrasive cloth is being “cleaned” by the reference test piece, as opposed to the reference test piece being abraded by the sheet. Consequently, when the wear mass of the reference test piece is reduced by 10 % against the wear mass just before testing, this test is not an appropriate method.

Note (6) When three repeat runs are made on the same one piece of the reference test piece, the sufficient interval of time between runs shall be taken until the temperature of test piece returns to the standard temperature in laboratory.

6.5 Calculation The calculation shall be as follows:

- a) Obtain the mean value of wear mass from the results of the test pieces of the number specified in **6.3.4**. Also, obtain the mean value of wear mass of the reference test pieces from the results of three pieces (or three times) each before and after the test, namely six pieces (or six times).
- b) **Relative wear volume** The relative wear volume shall be calculated according to the following formula (1).

$$V_{\text{rel}} = V_t \times \left(\frac{m_{\text{const}}}{m_r} \right) = \left(\frac{m_t}{\rho_t} \right) \times \left(\frac{m_{\text{const}}}{m_r} \right) \dots\dots\dots (1)$$

where, V_{rel} : relative wear volume (mm³)

V_t : wear volume of test piece (mm³)

m_{const} : specified value of wear mass of reference test piece (mg)⁽⁷⁾

m_r : mean value of wear mass of reference test piece (mg)

m_t : mean value of wear mass of test piece (mg)

ρ_t : density of test piece (g/cm³)

Note (7) Defined as 200 mg for method A using reference test piece of compound D1 in Annex 1 table 1 and 150 mg for method B using reference test piece of compound D2. When other reference test piece is used according to the agreement between the parties concerned with delivery, its specified value shall be weighed.

- c) **Abrasion resistance index** The abrasion resistance index shall be calculated according to the following formula (2).

$$I = \frac{V_r}{V_t} \times 100 = \frac{\left(\frac{m_r}{\rho_r} \right)}{\left(\frac{m_t}{\rho_t} \right)} \times 100 \dots\dots\dots (2)$$

where, I : abrasion resistance index
 V_r : wear volume of reference test piece (mm³)
 V_t : wear volume of test piece (mm³)
 m_r : mean value of wear mass of reference test piece (mg)
 ρ_r : density of reference test piece (g/cm³)
 m_t : mean value of wear mass of test piece (mg)
 ρ_t : density of test piece (g/cm³)

6.6 Record For the test results, the following information shall be recorded.

- a) Number of standard applied
- b) Details of sample and test piece
- c) Sampling and preparing method of test piece
- d) Details of test
 - 1) Test temperature
 - 2) Type of test method used (method A or method B)
 - 3) Force applied to test piece
 - 4) Abrasion distance
 - 5) Any deviations from the standard test conditions
- e) Test results
 - 1) Relative wear volume and/or abrasion resistance index
 - 2) Standard deviation of test results (if needed)
 - 3) Density of reference sample and test piece
- f) Date of test
- g) Other matters to be noted

7 Williams abrasion test

7.1 Purpose This test is carried out for the purpose of obtaining the abrasion resistance by using Williams abrasion machine among the abrasion tests of vulcanized rubber.

7.2 Williams abrasion machine The Williams abrasion machine is composed of the abrasants to abrade a test piece, the test piece holder to attach a test piece, the lever arm to adjust the movement of test piece united to the test piece holder, the pressure apparatus to press a test piece against abrasants by a specified load (applied force), the air blowing apparatus to remove the abrasion dust of test piece, and the driving apparatus to rotate the abrasant, etc.

In the Williams abrasion machine, two plane test pieces, which are fixed to a horizontal arm in equal distance from the centre of abrasant surface, are pressed against the surface of the vertically held abrasant by the specified load, and the test pieces are abraded by the friction between surfaces as rotating the abrasant. An example of Williams abrasion machine is shown in figure 4. The Williams abrasion machine of the system in which the load is controlled by load cell is also included.

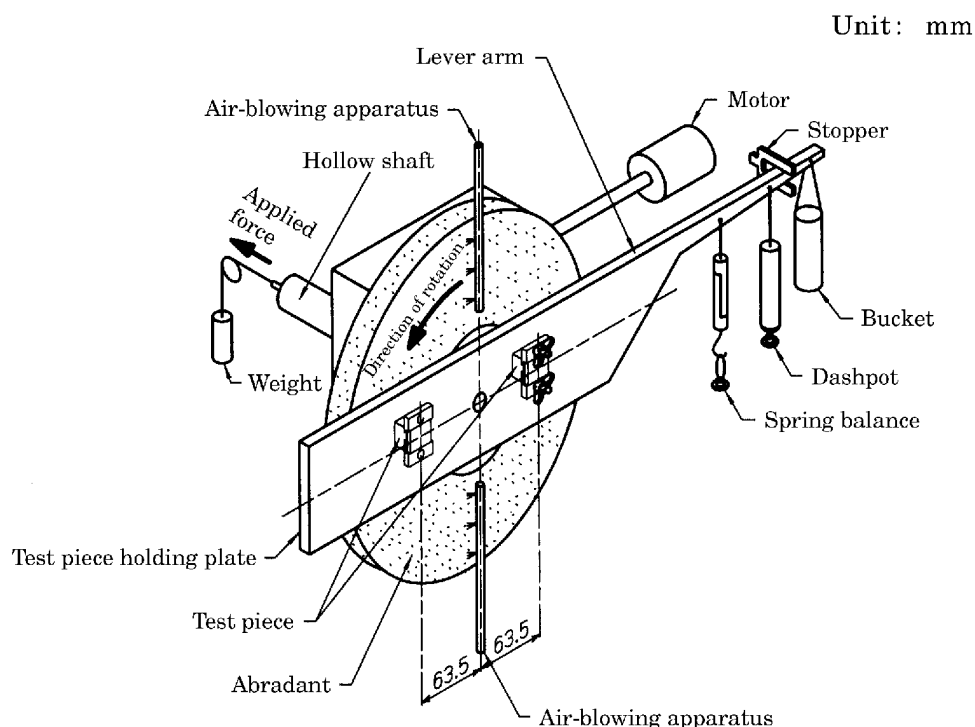


Figure 4 Example of Williams abrasion machine

7.2.1 Abradants The abrasants shall be a disc equipped with abrasive wheels, abrasive cloths or abrasive papers⁽⁸⁾, have a hollow shaft, be attached vertically and be rotated counterclockwise.

Note ⁽⁸⁾ Whether abrasive wheels, abrasive cloths or abrasive papers are used shall be subjected to the agreement between the parties concerned with delivery.

- a) **Shape and class** The abrasive wheels, abrasive cloths and abrasive papers, which are ring-shaped and 165 mm in outside diameter, 70 mm in inside diameter, are attached to abradant. For abrasive wheels, the vitrified grinding wheel (C70-M9-V) of quality of material for grinding stone: C, particle size: F70, degree of bonding: M, structure: 9 specified in **JIS R 6210**, for abrasive cloths, A-P180 specified in **JIS R 6251**, and for abrasive papers, A-P240 specified in **JIS R 6252** are used⁽⁹⁾.