
**Textiles — Determination of the abrasion
resistance of fabrics by the Martindale
method —**

Part 1:
Martindale abrasion testing apparatus

*Textiles — Détermination de la résistance à l'abrasion des étoffes
par la méthode Martindale —*

Partie 1: Appareil d'essai d'abrasion Martindale



Contents	Page
1 Scope	1
2 Normative references	1
3 Definitions	2
4 Principle	2
5 Apparatus	2
6 Auxiliary materials	6
7 Assembly and maintenance of the apparatus	7
Annex A (normative) Method for checking the Lissajous figure	10
Annex B (normative) Method for measuring the indentation hardness of foam	11
Bibliography	12

© ISO 1998

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet iso@iso.ch

Printed in Switzerland

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 12947-1 was prepared by Technical Committee ISO/TC 38, *Textiles*.

ISO 12947 consists of the following parts under the general title *Textiles – Determination of the abrasion resistance of fabrics by the Martindale method*:

- *Part 1: Martindale abrasion testing apparatus*
- *Part 2: Determination of specimen breakdown*
- *Part 3: Determination of mass loss*
- *Part 4: Assessment of appearance change*

Annexes A and B form an integral part of this part of ISO 12947.

Introduction

The choice of method of abrasion testing is established before the start of the testing and recorded in the test report, since the results of the different methods cannot be compared with each other.

The determination of resistance to pilling of fabrics using the Martindale apparatus is given in ISO 12945, *Textiles — Determination of the resistance to pilling and change of appearance of fabrics*, parts 1, 2 and 3¹⁾.

1) These three parts of International Standard ISO 12945 are yet to be published.

Textiles — Determination of the abrasion resistance of fabrics by the Martindale method —

Part 1: Martindale abrasion testing apparatus

1 Scope

This part of ISO 12947 specifies requirements for the Martindale testing apparatus and auxiliary materials for use in the test methods specified in parts 2 to 4 of ISO 12947 for determination of the abrasion resistance of fabrics.

This part of ISO 12947 is applicable to apparatus for the testing of:

- a) woven and knitted fabrics;
- b) pile textiles having a pile height of up to 2 mm;
- c) nonwovens.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 12947. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 12947 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 137:1975, *Wool — Determination of fibre diameter — Projection microscope method.*

ISO 286-2:1988, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts.*

ISO 845:1988, *Cellular plastics and rubbers — Determination of apparent (bulk) density.*

ISO 2060:1994, *Textiles — Yarn from packages — Determination of linear density (mass per unit length) — Skein method.*

ISO 2061:1995, *Textiles — Determination of twist in yarns — Direct counting method.*

ISO 2286-3:1998, *Rubber- or plastics-coated fabrics — Determination of roll characteristics — Part 3: Method for the determination of thickness.*

ISO 3074:1975, *Wool — Determination of dichloromethane — Soluble matter in combed sliver.*

ISO 3801:1977, *Textiles — Woven fabrics — Determination of mass per unit length and mass per unit area.*

ISO 5084:1996, *Textiles — Determination of thickness of textiles and textile products.*

ISO 7211-2:1984, *Textiles — Woven Fabrics — Construction — Methods of analysis — Part 2: Determination of number of threads per unit length.*

ISO 12947-2:1998, *Textiles — Determination of the abrasion resistance of fabrics by the Martindale method — Part 2: Determination of specimen breakdown.*

ISO 12947-3:1998, *Textiles — Determination of the abrasion resistance of fabrics by the Martindale method — Part 3: Determination of mass loss.*

3 Definitions

For the purposes of this part of ISO 12947, the following definitions apply.

3.1 abrasion rub

one revolution of the two outer drives of the Martindale abrasion tester

3.2 abrasion cycle

completion of all the translational abrasion movements tracing a Lissajous figure comprising 16 rubs, i.e. 16 revolutions of the two outer drives and 15 revolutions of the inner drive of the Martindale abrasion tester

3.3 inspection interval

number of continuously performed rubs

3.4 Lissajous figure

figure created by movement which changes from a circle to gradually narrowing ellipses, until it becomes a straight line, from which progressively widening ellipses develop, in a diagonally opposite direction before the pattern is repeated

3.5 work station

abrading table

4 Principle

The Martindale abrasion tester subjects a circular specimen to a defined load and rubs it against an abrasive medium (i.e. standard fabric) in a translational movement tracing a Lissajous figure. The specimen holder, containing either specimen or abrasive medium depending on which method (ISO 12947, Parts 2, 3 or 4) is being used, is additionally freely rotatable around its own axis perpendicular to the horizontal plane.

The specimen is subjected to abrasive wear for a predetermined number of rubs. The number of abrasion rubs making up the inspection interval depends upon the product type and method of assessment.

5 Apparatus

5.1 General

The test apparatus consists of a baseplate on which are mounted the abrading tables and drive mechanism. The drive mechanism consists of two outer drives and an inner drive which cause the specimen holder guide plate to trace a Lissajous figure (see annex A).

NOTE The Martindale apparatus does not generate a perfect Lissajous motion.

The specimen holder guide plate is moved horizontally by the drive mechanism in such a way that every point of the guide plate describes the same Lissajous figure.

The specimen holder guide plate is fitted with bearing housings and low friction bearings which carry the specimen holder guide spindles. The lower end of each specimen holder spindle is inserted into each corresponding specimen holder body. On the upper end of the spindle, loading pieces can be fitted. The specimen holder consists of a body, insert and nut.

The apparatus is fitted with a pre-settable counting device which counts each revolution of one of the outer drives.

5.2 Drive and base plate attachments

5.2.1 Drive

The drive shall be arranged so that the heated exhaust air from the motor ventilation cannot reach the abraded surface. The movement of the specimen holders takes place by means of:

- a) two outer synchronised drive units, in which:
 - the distance of the axis of the drive units from their central axis is $(30,25 \pm 0,25)$ mm;
 - the rotational frequency of the outer drive units is $(47,5 \pm 2,5)$ min⁻¹;
- b) an inner drive unit, in which:
 - the distance of the axis of the drive unit from its central axis is $(30,25 \pm 0,25)$ mm;
 - the rotational frequency of the drive unit is $(44,5 \pm 2,4)$ min⁻¹.

The ratio of the rotation of the outer drive units to that of the inner drive unit shall be 16:15, i.e. after 16 revolutions of the outer units, the inner unit has carried out 15 revolutions and it has returned to the starting position of the Lissajous figure.

The maximum length of stroke of the specimen holder guide plate in both the longitudinal and transverse directions is $(60,5 \pm 0,5)$ mm.

5.2.2 Counter

The counter for counting the abrasion rubs shall measure to an accuracy of one rub.

5.2.3 Abrading table

Each of the abrading tables consist of the following elements:

- a) abrading table (see figure 1);
- b) clamping ring (see figure 2);
- c) clamping mechanism to fasten the clamping ring;
- d) pressing weight of mass $(2,5 \pm 0,5)$ kg and of diameter (120 ± 10) mm.

5.3 Specimen holder guide plate

The specimen holder guide plate is a plate in which three guides engage the drive units. These guides interact so as to ensure a uniform, smooth and low vibration movement of the specimen holder guide plate.

The specimen holder guide spindles are located in bearing housings secured to the guide plate central to each abrading table. Each bearing housing carries two bearings. The guide spindles are freely moving and free from play in the bearings (see also 7.2). These essential requirements are fulfilled by bearing housings and bearings in which:

- a) the overall length of the bearing housing is $(31,75 \pm 0,127)$ mm;

- b) the bearing bore is 7,950 mm with ISO tolerance field H9, the specimen holder guide spindle to be fitted has a diameter of 7,950 mm with ISO tolerance field f7 in accordance with ISO 286-2.

5.4 Specimen holder

The specimen holder assembly consists of the following elements:

- specimen holder spindle (see figure 3);
- specimen holder body (see figure 4);
- specimen holder insert (see figure 5);
- specimen holder nut (see figure 6).

The combined mass of these components shall be (198 ± 2) g.

The specimen holder assembly (without spindle) is illustrated in figure 7.

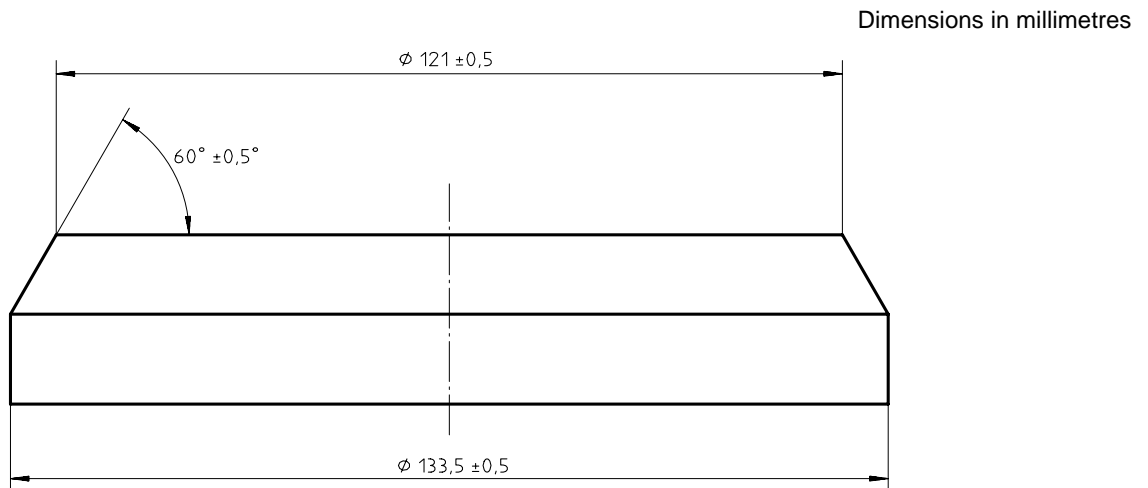


Figure 1 — Abrading table

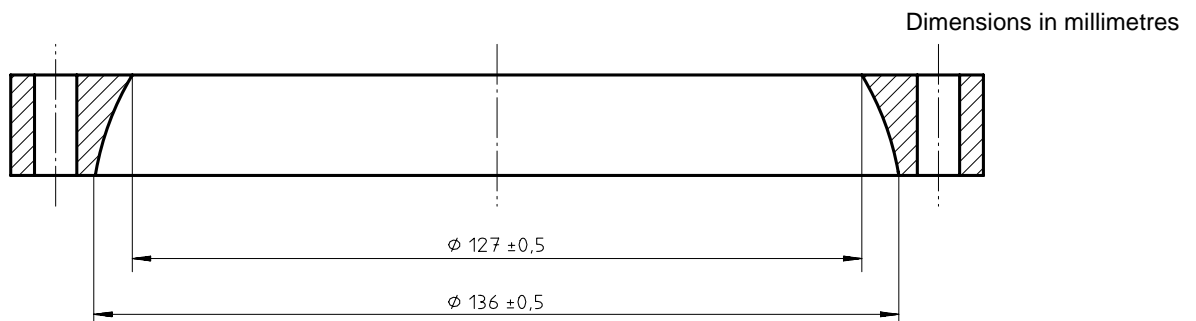


Figure 2 — Clamping ring

Dimensions in millimetres

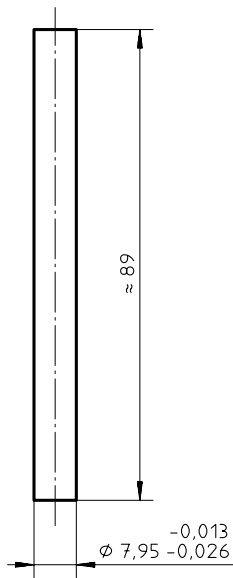


Figure 3 — Specimen holder spindle

Dimensions in millimetres

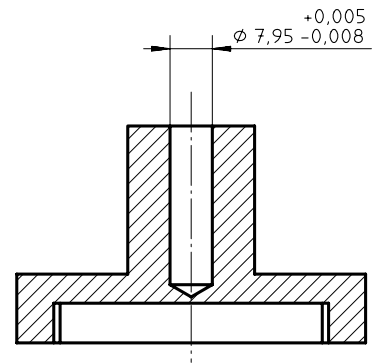


Figure 4 — Specimen holder body

Dimensions in millimetres

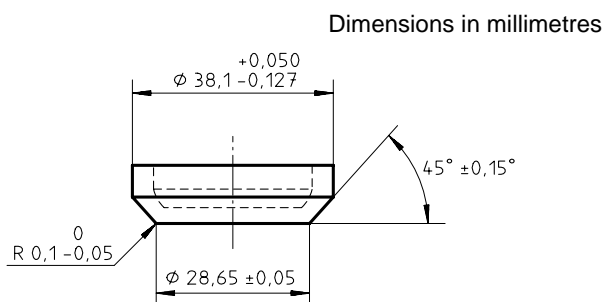
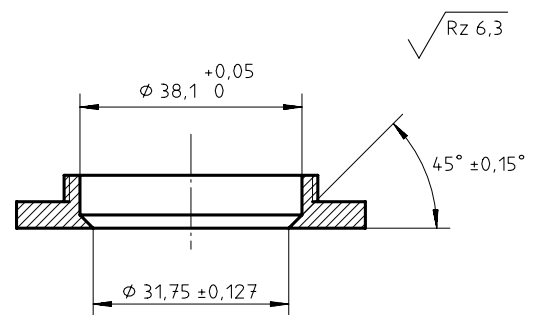


Figure 5 — Specimen holder insert

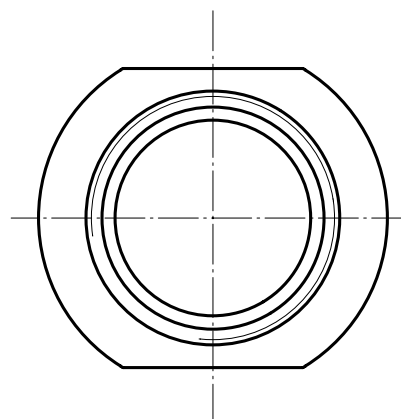


Figure 6 — Specimen holder nut

The specimen holder shall be made from corrosion-resistant metal. The screws of the specimen holder body and of the specimen holder nut shall be wear-resistant.

To provide for the testing of thicker textiles, the distance between the upper edge of the specimen holder body and the lower edge of the mounting for the bearing, shall be $(7,5 \pm 1)$ mm.

5.5 Loading pieces

A small or a large loading piece is added at each of the work stations to the spindle of the specimen holder or assembly for the methods described in ISO 12947-2 and ISO 12947-3.

The sum of the mass of the applied piece and the mass of the specimen holder assembly shall amount to:

- for the larger piece: (795 ± 7) g
- for the smaller piece: (595 ± 7) g

and serves to apply a nominal pressure of 12 kPa and 9 kPa on the test specimen during the abrasion test.

The loading pieces shall fit on the spindle of the specimen holder in such a way that there is no play between the piece and the spindle.

6 Auxiliary materials

6.1 Abradant

A flat woven wool fabric against which the test specimen is abraded, measuring at least 140 mm in diameter or length and width, meeting the requirements in table 1.

6.2 Felt

Circles of woven wool felt underlay, meeting the requirements in table 2, of diameter 140^{+5}_0 mm mounted on the abrading tables prior to mounting the abradant.

6.3 Foam

A polyetherurethane foam material meeting the requirements in table 3, used for fabrics having a mass per unit area less than $500 \text{ g}\cdot\text{m}^{-2}$ as an underlay for the test specimen or abradant mounted in the specimen holder.

Place circles of foam of diameter $38,0^{+5}_0$ mm between the test specimen or abradant and the specimen holder insert. Store the foam material in the dark at room temperature.

6.4 Control of auxiliary materials

Check the properties of the auxiliary materials described in 6.1 to 6.3 with every new delivery. Carry out comparative abrasion tests using internal tolerance fabrics relevant to the work of the laboratory and of known history on current and new deliveries of auxiliary materials. In addition, examine the abradant for faulty places and clear differences in the surface structure. Such places shall not be used for making measurements.

NOTE For details of the sources of supply of suitable apparatus and materials, contact the Secretariat of ISO/TC38.

Table 1 — Property requirements for wool abradant fabric

Property	Requirement		Method of determination
	Warp	Weft	
Mean fibre diameter, μm	$27,5 \pm 2,0$	$29,0 \pm 2,0$	ISO 137
Yarn linear density, tex	$R63 \pm 4/2$	$R74 \pm 4/2$	ISO 2060
Singles 'Z' twist, turns per metre	540 ± 20	500 ± 20	ISO 2061
Two-fold 'S' twist, turns per metre	450 ± 20	350 ± 20	ISO 2061
Threads per 10 centimetres	175 ± 10	135 ± 8	ISO 7211-2
Mass per unit area, $\text{g}\cdot\text{m}^{-2}$	215 ± 10		ISO 3801
Oil content, %	$0,8 \pm 0,3$		ISO 3074

Table 2 — Property requirements for woven wool felt

Property	Requirement	Method of determination
Mass per unit area, $\text{g}\cdot\text{m}^{-2}$	750 ± 50	ISO 3801
Thickness, mm	$2,5 \pm 0,5$	ISO 5084

Table 3 — Property requirements for polyetherurethane foam

Property	Requirement	Method of test
Thickness, mm	3 ± 1	ISO 5084
Density, $\text{kg}\cdot\text{m}^{-3}$	30 ± 3	ISO 845
Indentation hardness, kPa	$5,8 \pm 0,8$	annex B

7 Assembly and maintenance of the apparatus

7.1 Assembly

The assembly of the apparatus shall be carried out in accordance with the instructions of the apparatus manufacturer. Moreover, the apparatus shall be checked to confirm that it complies with the tolerances in 5.2.1 and 5.5 and that the Lissajous figure complies with annex A.

After assembly of the specimen holder, without materials, the distance between the circular surface of the test specimen holder insert and the ring of the specimen holder nut shall be $(1,05 \pm 0,1)$ mm (see figure 7).

7.2 Ease of running of the specimen holder in the bearing assembly

To assess the ease of running of the specimen holder in the bearing assembly, carry out the following procedure.

Remove materials and place a plain glass plate, e.g. microscope slide, on the abrading table, positioning the slide directly under the bearing housing.

Place the domed insert in the specimen holder (see figure 8).

Position the insert carefully on the glass slide.

Place the large loading piece on the specimen holder spindle. Using adhesive tape, fix one end of a filament yarn (mono or multi approximately 100 dtex to 200 dtex) to the specimen holder body. The yarn shall be approximately 1 m long and shall be wound spirally from bottom to top. Lay the other end of the yarn over a freely rotating pulley (see figure 9).

Support the pulley by means of an adjustable clamp. Fix the clamp in a convenient position to the specimen holder guide plate. The upper edge of the pulley shall be on the same level as the point at which the yarn comes off the top of the specimen holder body, so that the path of the yarn from body to pulley is horizontal. Initially, check friction of the pulley by suspending a mass of 500 mg on each end of the yarn. An additional mass of 100 mg, on one side, should make the pulley rotate. If not the friction is too high.

Attach a mass of 10 g to the yarn. Lightly rotate the specimen holder by hand so that the weighted yarn unrolls. If this figure is exceeded, clean the bearings and recheck and/or consult the apparatus manufacturer.

7.3 Parallelism between abrading table and specimen holder insert surface

To test the parallelism between the abrading table and the specimen holder insert, carry out following checks.

7.3.1 With no materials in the specimen holders or on the abrading tables, place the specimen holders and spindles in their respective bearing housings so that the specimen holder insert face meets the face of the abrading table under the weight of the specimen holder and spindle alone. Check all around the periphery of the specimen holder with feeler gauges that any gap between the two metal surfaces is not greater than 0,05 mm (see figure 10).

7.3.2 To check the parallelism of the abrading table surface to the top plate, carry out the following procedure. For each work station in turn, introduce a dial gauge to the bearing housing in place of the specimen holder guide spindle so that the dial gauge stem tip is positioned on the abrading table surface. The dial gauge shall have a resolution of 0,01 mm (corresponding to a one scale unit). Secure the dial gauge firmly to the specimen holder guide plate. Start the abrasion tester so that the gauge tip describes a Lissajous figure over the abrading table surface. The maximum difference between the lowest and highest reading on the dial gauge shall be 0,05 mm recorded over one complete Lissajous figure (16 abrasion rubs).

NOTE The dial gauge tip should not deface the abrading table surface during the test.

7.4 Maintenance of the apparatus

Maintain the machine so that it continues to conform to this part of ISO 12947.

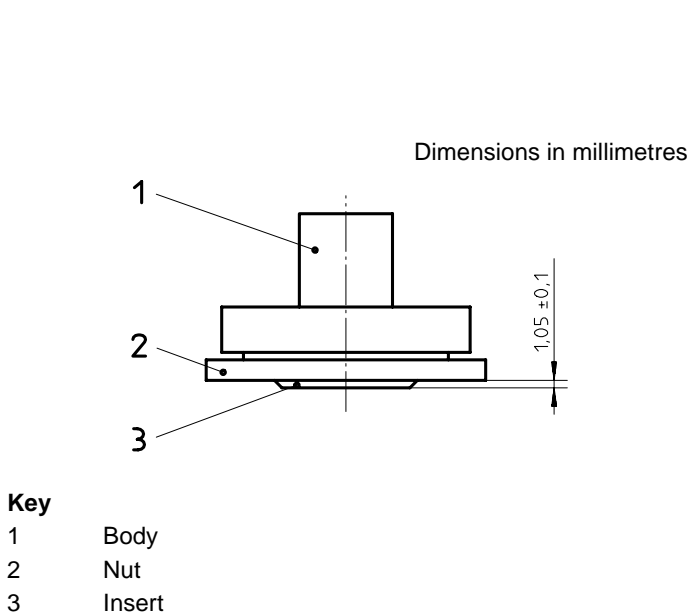


Figure 7 — Assembly specimen holder

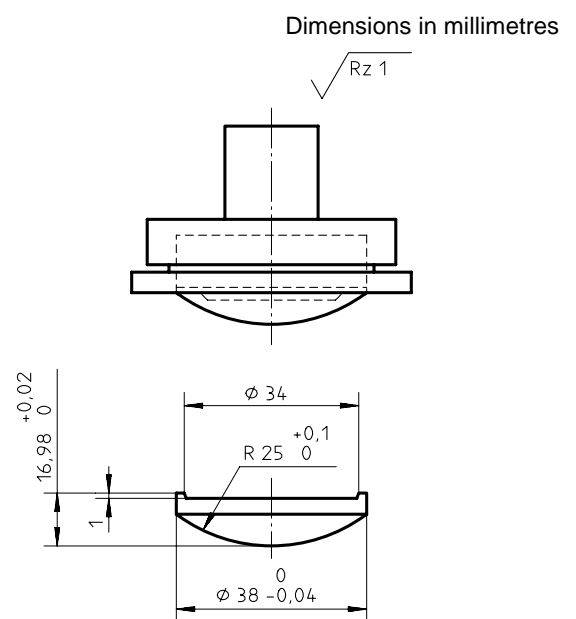


Figure 8 — Domed specimen holder insert (see 7.2)

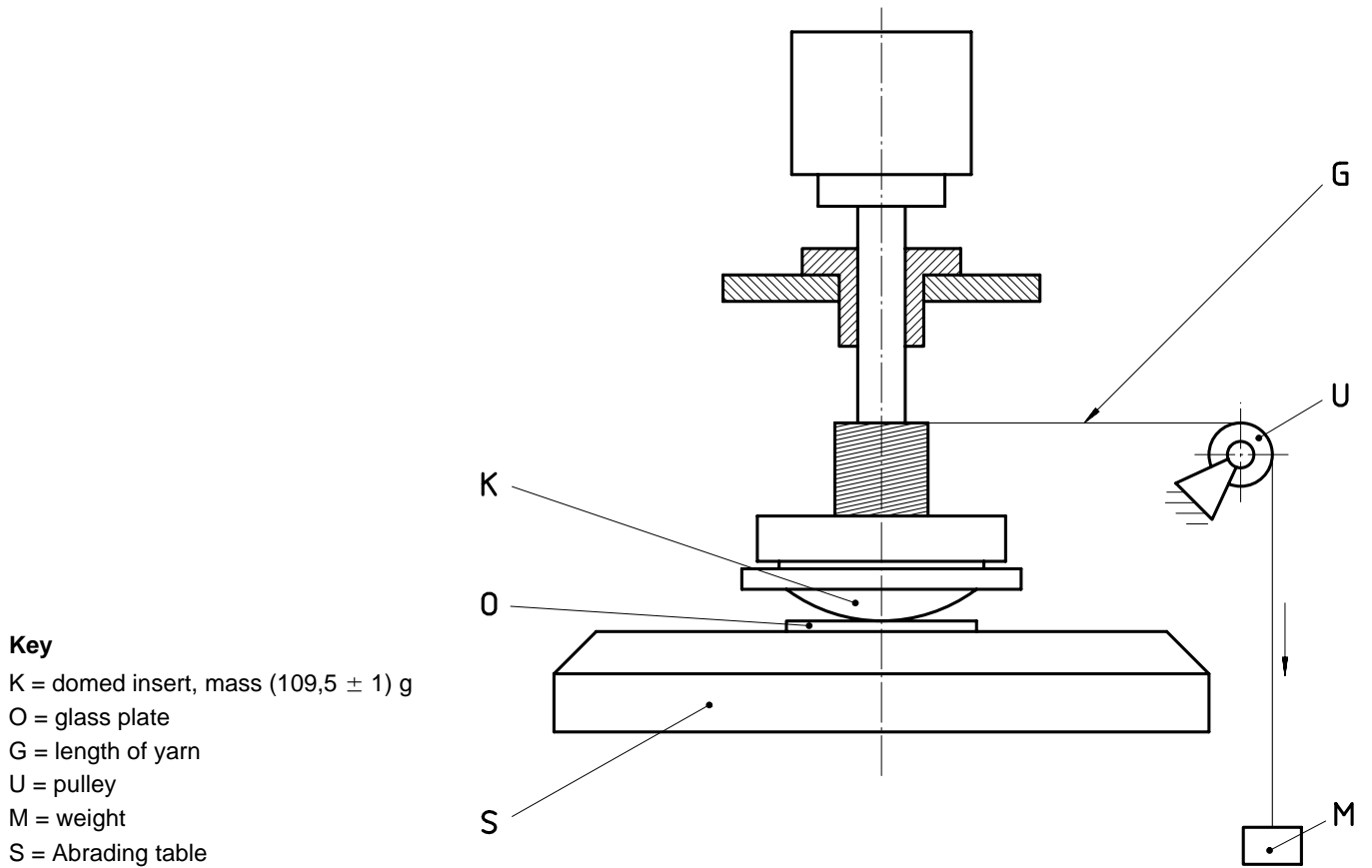


Figure 9 — Testing the specimen holder assembly (see 7.2)

Dimensions in millimetres

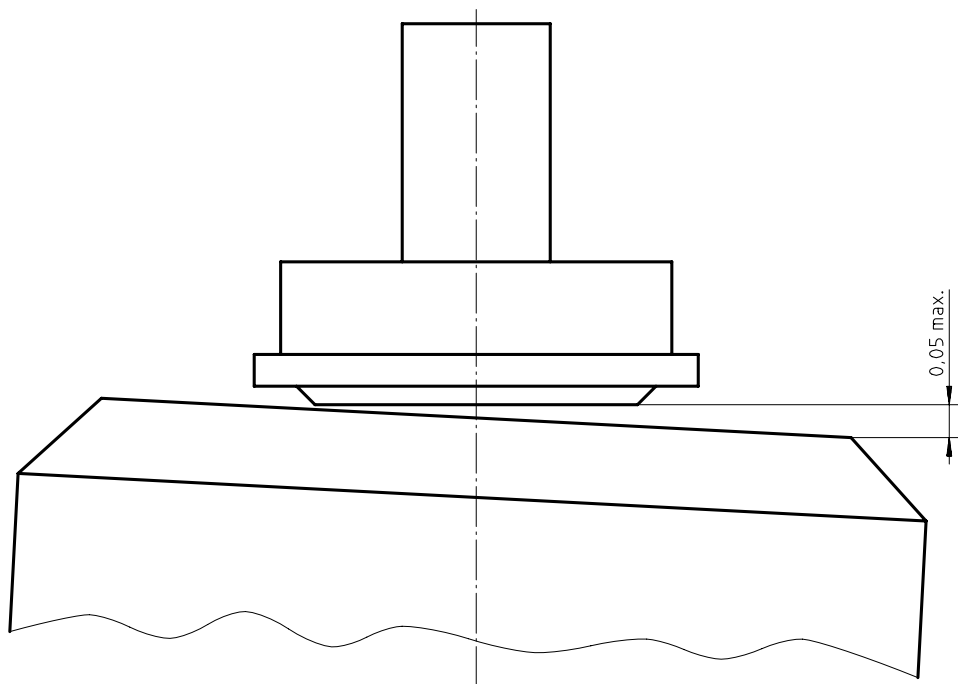


Figure 10 — Parallelism tolerance of specimen holder insert to abrading table

Annex A (normative)

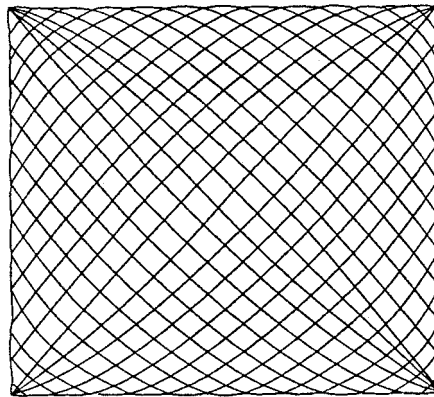
Method for checking the Lissajous figure

Obtain the Lissajous figure for each work station by means of the following method.

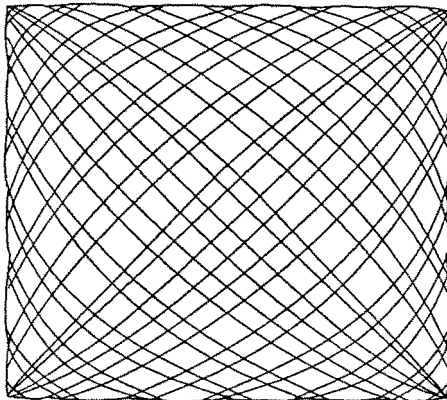
Remove materials from the abrading tables. Cover each abrading table surface with a plain white paper measuring (100 ± 5) mm in diameter of minimum mass per unit area $100 \text{ g}\cdot\text{m}^{-2}$ and secure paper to abrading table ensuring the surface is perfectly flat.

Insert a steel sleeve of the same diameter as the specimen guide spindle (see figure 3) counterbored to accept the introduction of a refill from a typical ballpoint pen through each of the specimen holder spindle bearings in turn in the specimen holder guide plate, so that the ball tip is resting on the surface of the paper. Set the machine for 16 abrasion rubs to produce one complete Lissajous figure.

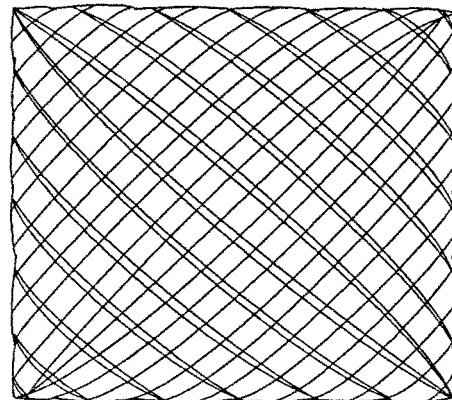
Draw two parallel lines which just touch the outermost curves on two opposing sides of the Lissajous figure. Draw two more parallel lines for the other two sides making sure the lines intersect at right angles. Measure each side to an accuracy of $\pm 0,2$ mm using suitable means. Check that 31 curves are drawn. It is important to check the symmetry of the Lissajous figures. If the curves run into one another or the spacing is uneven (see figure A.1) consult the machinery supplier.



a) acceptable



b) unacceptable



c) unacceptable

Figure A.1 — Examples of acceptable and unacceptable Lissajous figures

Annex B (normative)

Method for measuring the indentation hardness of foam

B.1 Apparatus

B.1.1 Set of ten weights, of mass $(50 \pm 0,01)$ g.

B.1.2 Small lightweight pan or tray, of known mass (approximately 60 g) to hold the weights.

B.1.3 Thickness gauge, meeting the requirements of ISO 2286-3.

B.2 Procedure

Cut out two squares of the foam, each approximately $5 \text{ cm} \times 5 \text{ cm}$. Put one on top of the other and immediately place on the anvil of the thickness gauge. Place the pan or tray on top of the gauge's own weight and immediately record the thickness of the foam. Place the first weight of mass 50 g on the pan. Wait (30 ± 1) s and record the thickness. Repeat this procedure until the total mass including weights, pan and gauge weight equals or exceeds 500 g.

B.3 Calculation and expression of results

Plot the readings on a graph with the mass on the horizontal axis and thickness on the vertical axis. Draw in the curve.

Use the first recorded thickness of the double layers of foam (when only the mass of the gauge weight, spindle and foot were present) as the initial thickness. Draw a line parallel to the horizontal axis at a point equal to 60 % of the initial thickness. Where the curve crosses this line read the mass in grams on the horizontal axis. Calculate the pressure applied in kilopascals, using the following equation:

$$p = \frac{m \times 9,31}{a}$$

where

p is the pressure in kilopascals

m is the mass in grams;

a is the area of the foot in square millimetres.

Bibliography

- [1] ISO 2439:1997, *Flexible cellular polymeric materials — Determination of hardness (Indentation technique)*.
- [2] ISO 12947-4:1998, *Textiles — Determination of the abrasion resistance of fabrics by the Martindale method — Part 4: Assessment of appearance change*.

ICS 59.080.30

Descriptors: textiles, fabrics, tests, abrasion tests, determination, abrasion resistance, test equipment, specifications.

Price based on 12 pages
