SPECIFICATION FOR

LEATHER FOR FOOTWEAR
(FIRST REVISION)

SRI LANKA STANDARDS INSTITUTION

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SLS 588 : 1998

Gr. 12

SRI LANKA STANDARD
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(First Revision)

FOREWORD

This standard was approved by the Sectoral Committee on Textiles, Clothing and Leather and was authorized for adoption and publication as a Sri Lanka Standard by the Council of the Sri Lanka Standards Institution on 1998-05-14.

This is the first revision of SLS 588 : 1982 which was published on shoe upper leather for direct moulding processes. In this revision the scope of the standard has been broadened to accomodate leather used for all parts of the shoe irrespective of the method of manufacture.

The test methods in the previous edition have also been changed in order to be in line with the test methods of International Organization for Standardization, wherever applicable.

For the purpose of deciding whether a particular requirement of this specification is complied with, the final value, observed or calculated, expressing the result of a test or an analysis shall be rounded off in accordance with **CS 102.** The number of significant places retained in the rounded off value shall be the same as that of the specified value in this specification.

In the preparation of this standard the assistance derived from the following publications is gratefully acknowledged:

ISO/DIS 8782-1-2   Safety protective and occupational footwear for professional use
                      Part 1 Requirements and test methods

BS EN 345 : 1993   Specification for safety footwear for professional use

1 SCOPE

This specification prescribes the requirements and methods of test for leather for footwear.

2 REFERENCES

SLS   62   Determination of colour fastness of textile materials to daylight
CS   102   Presentation of numerical values
SLS   374   Standard atmospheric conditions for conditioning and testing
SLS   402   Leather - sampling - number of items for a gross sample
SLS   404   Leather - physical testing
          Part 1   Measurement of thickness
          Part 3   Determination of tearing load
          Part 6   Determination of tensile strength and elongation
SLS   428   Random sampling methods
SLS   537   Method for chemical testing of leather
          Part 2   Determination of pH
          Part 7   Determination of chromic oxide
SLS   623   Methods for testing the resistance of leather to surface fungal growth
SLS 1013   Code of Practice for curing and preservation of hides and skins
SLS 1015   Glossary of terms for leather
SLS 1075   Leather - Test for colour fastness - Colour fastness to water
SLS 1076   Leather - Test for colour fastness - Colour fastness to small samples to dry cleaning
          solutions
SLS 1078   Measurement of area of leather
SLS 1079   Leather - Test for colour fastness - Colour fastness to cycles of to-and-fro rubbing

3 DEFINITIONS

3.1 For the purpose of this standard, the definitions given in **SLS 1015** shall apply.

4 REQUIREMENTS

4.1 Material

4.1.1 The leather shall be prepared from well preserved and suitably tanned hides and skins conforming to **SLS 1013** and finished leather shall be uniform and of gloss finish.

4.1.2 Fungicides and other chemicals used to promote mildew resistance and to obtain soft and shining effects shall be non-toxic.

4.1.3 The material shall show no growth of mildew when examined after the completion of the test prescribed in **SLS 623** and the maximum rating of fungal growth after the test shall be 1.

4.1.4 The leather shall not contain any prohibitive materials given in Appendix **B.**

4.1.5 If required, the leather of all types may be finished with applying a surface coating and this application shall not effect the quality of the base leather during usage.

4.1.6 The leather may be dyed to obtain the required shade and the shade obtained which is dye-through shall be agreed to between the purchaser and the supplier.

4.1.7 The leather shall not crack when folded grain side outward around a mandrel of 1.5 m diameter through an angle of 180^0 .

4.2 Types of leather

The leather shall be of one of the following types:

a) Full grain
b) Corrected grain
c) Printed leather
d) Nubuck (with a fine nap)
e) Suede leather.

4.3 Grade

The leather shall be graded as 1,2,3,4, R,D,E or F. The guidelines for grading of leather is given in Appendix **C**. The grade selected shall be as agreed to between the purchaser and the supplier.

4.4 Thickness of leather

The thickness of leather used for construction of various components of footwear, when determined by the method prescribed in **Part 1 of SLS 404,** shall be as agreed to between the purchaser and the supplier.

The permitted tolerance on the agreed value shall be such that for leather of which thickness is less than 2.5 mm shall be ± 0.1 mm and elsewhere ± 0.3 mm.

4.5 Measurement of area

The measurement of area of leather shall be done in accordance with **SLS 1078** and reduction in the area declared shall be not more than 2.5 per cent.

4.6 Tear strength

The tearing force of leather in two principle directions (parallel to back bone and perpendicular to back bone), when determined in accordance with **Part 3 of SLS 404,** for different components shall be not less than the values given in Table **1.**

TABLE 1 - Tearing strength

Component of footwear	Tearing force, N, min.
Upper	120
Vamp lining	30
Quarter lining	30
*Tongue	36
Outsole	-

* If leather is different from that of used in the upper

4.7 Tensile strength

The tensile strength of leather being used for uppers, when determined in accordance with Part 6 of **SLS 404** shall be not less than 15 N/mm^2.

4.8 Water penetration and water absorption

When tested in accordance with the method described in Appendix **D,** the water absorption shall be not more than 30 per cent for upper and 35 per cent for insole after 60 min. from the start of the test and water penetration shall not occur during this period, nor exceed 2 g after a further 30 min.

4.9 Water vapour permeability and co-efficient

When tested in accordance with the method described in Appendix **E,** the water vapour permeability of upper and lining shall be not less than 0.8 mg/cm^2 h and 2.0 mg/cm^2 h respectively and the water vapour co-efficient shall be not less than 20 mg/cm^2 and 30 mg/cm^2 respectively.

4.10 Water absorption and desorption of insoles

When tested in accordance with the method described in Appendix **F,** water absorption shall be not less than 35 per cent (m/m) and the water desorption shall be not less than 40 per cent (m/m) of the water absorbed.

4.11 pH value

When tested in accordance with the method described in **Part 2 of SLS 537,** pH value of leather used for upper, lining, tongue and insole shall be between 3.5 and 9.

4.12 Chromium content

Chromium per cent, by mass, of leather, when tested in accordance with Part 7 of **SLS 537** shall contain not less than 3.5 per cent of chromium (III) oxide ($Cr_2 O_3$) and not more than 2 ppm chromium (VI) oxide (CrO_3) based on the dry, fat free leather.

4.13 Colour fastness for upper

The leather shall be fast to various agencies listed in Table **2** and the colour fastness ratings shall be in accordance with the requirements specified therein when tested by the corresponding test methods.

TABLE 2 - Colour fastness requirements

Sl. No. (1)	Requirement (2)	Rating, min. (3)	Test method (4)
i)	Colour fastness to light	3	**SLS 62**
ii)	Colour fastness to rubbing: Wet rubbing (Change in shade after 50 cycles)	3	**SLS 1079**
	Dry rubbing (Change in shade after 200 cycles)	3	**SLS 1079**
iii)	Colour fastness to water (Change in shade and staining)	3	**SLS 1075**

4.14 Flexing resistance

When flexing resistance for outsole leather is determined in accordance with the method described in Appendix **G,** the cut growth shall be not greater than 4 mm before 30 000 flex cycles.

5 MARKING

The leather shall be legibly marked on the flesh side of each piece with the area in square decimetres.

NOTES

1 The marking should not cause any disfiguration to leather or migrate itself to the grain surface of leather coming in contact with it.

2 Attention is drawn to the certification marking facilities offfered by the Sri Lanka Standards Institution. See the inside back cover of this standard.

6 PACKING

6.1 The leather shall be packed as agreed to between the purchaser and the supplier.

6.2 Each package shall be provided with following information marked or labelled indelibly on it:

a) Name and address of manufacturer;
b) Registered trade mark, if any;
c) Number of pieces;
d) Thickness, in mm;
e) Total area, in square metre (square feet may also be given);
f) Month and year of manufacture; and
g) Country of origin.

7 METHODS OF TEST

7.1 Tests for the requirements given in **4** shall be carried out as prescribed in the relevant Sri Lanka Standards given therein and Appendices **D,E,F** and **G** of this specification.

7.2 The conditioning and testing atmosphere shall be the standard atmosphere for conditioning and testing leather as defined in **SLS 374**; that is, a relative humidity of 65 ± 2 per cent temperature of 27 ± 2 °C.

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APPENDIX A
COMPLIANCE OF A LOT

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The sampling scheme given in this Appendix should be applied where compliance of a lot to the requirements of this standard is to be assessed based on statistical sampling and inspection. Where compliance with this standard is to be assured based on manufacturer's control systems coupled with type testing and check tests or any other procedure, an appropriate scheme of sampling and inspection should be adopted.

A.1 LOT

In any consignment all the pieces of leather of the same type and the same grade belonging to one batch of manufacture or supply shall constitute a lot.

A.2 SCALE OF SAMPLING

A.2.1 Samples shall be tested from each lot for ascertaining conformity to the requirements of this specification.

A.2.2 The number of pieces of leather to be selected from a lot for testing shall be, in accordance with Table **3**.

TABLE 3 - Scale of sampling

Lot size (1)	Number of pieces to be selected (2)	Sub sample size 1 (3)	Sub sample size 2 (4)
Up to 150	10	3	2
151 to 280	15	5	3
281 to 500	20	8	3
501 to 1200	25	13	4
1201 and above	30	20	5

A.2.3 The pieces shall be selected at random and in order to ensure randomness of selection, tables of random numbers as given in **SLS 428** shall be used.

A.3 LOCATION FOR CUTTING OUT TEST PIECES

A.3.1 Test pieces from the pieces selected as in **A.2.3** which may be categorized as whole hides and skins, sides and backs, bends (buts), shoulders and bellies (flanks) etc. shall be cut out for both physical and chemical testing as illustrated in Figures **1,2,3** and **4** of **SLS 402.**

A.3.2 Areas free from all kinds of obvious defects such as scratches and flay cuts shall be taken for testing. If the selected area as by **A.3.1** is with defects, additional material can be taken from the area immediately adjacent to the sampling position.

A.4 NUMBER OF TESTS

A.4.1 Each package shall be inspected for packing and marking requirements.

A.4.2 Each piece selected as in Column **2** of Table **3** shall be inspected for marking and visual inspection.

A.4.3 Each piece selected as in Column **3** of Table **3** shall be inspected for physical, chemical and colour fastness requirements.

A.5 CRITERIA FOR CONFORMITY

A lot shall be declared as conforming to the requirements of this specification, if the following conditions are satisfied:

A.5.1 Each package as in **A.4.1** satisfies the packaging and marking requirements.

A.5.2 Each piece as in **A.4.2** satisfies the marking and visual inspection requirements.

A.5.3 Each piece as in **A.4.3** satisfies the physical, chemical and colourfastness requirements.

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APPENDIX B
LIST OF PROHIBITIVE MATERIALS TO LEATHER

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4-Aminodiphenyl
Benzidine
4-Chloro-0-toluidine
2-Naphthylamine
0-Aminoazotoluol
2-Amonl-4-nitrotoluol
p-Chloraniline
2,4-Diaminoankol -
4,4-Diaminodiphenylmethen
3,3-Dichlorbenzindine
3,3-Dimethyloxybenzidine
3,3-Dimethylbenzidine
3,3-Dimethyl-4,4 diaminodiphenylmethane
p-Kresidin
4,4 Methylen-bis-(2-chloranilin)
4,4 Oxydianilin
4,4 Thiodianilin
0-Toluidin
2,4-Toluylendiamin
2,4,5- Trimethylanilin
Penta chloro phenates (P.C.P.)

APPENDIX C
GUIDELINES FOR GRADING OF LEATHER

C.1 SCOPE

This method provides guidelines to classify different types of leather in finished or semifinished stage into different grades based on their cutting value.

The cutting value of leather is agreed upon between the purchaser and the supplier and is entirely dependent on the extent of spread in leather.

C.2 DEFINITIONS

C.2.1 Cutting value: the total defect free area of leather against the total area of leather, in percentage.

C.3 PROCEDURE

C.3.1 Finished leather or semifinished leather, if required by the purchaser, are only considered for grading.

C.3.2 First lay the leather piece flat on a smooth surface and remove all wrinkles so as the piece of leather to prevail evenly on the surface and by suitable means measure the total area of leather. A suitable measuring instrument with an accuracy of ± 2 per cent is recommended for this purpose.

C.3.3 First examine both the sides of pieces of leather for defects, which can affect the serviceability and usability of the product being manufactured, like holes, flay cuts and remove those areas from the leather. Measure such areas as described in **C.3.5**.

C.3.4 After removing defective areas as in **C.3.3**, examine both sides of the piece of leather again for other defects listed in **C.4**. Measure the areas which can affect the piece of leather by the same method as done in **C.3.5**.

C.3.5 Mark defective areas observed on each side of leather on the grain side by colour chalk. Measure the total area represented by all defects by suitable means. In case of dispute between interested parties or where more accuracy of measurements are required, use a square ruled transparent (flexi glass) sheet of sufficient area having squares of 1/10 square feet or 100 square centimetres. Place the transparent sheet over any defective area on the leather and trace it onto the sheet by chalk. Then move on to the other defect and take the area represented by it on to the sheet, likewise fill the squares, if possible one after the other, in the sheet to measure all defective areas appeared in leather. Finally calculate the total area covered by defects, in square feet or square decimetres.

C.3.6 As agreed upon between the purchaser and the supplier, the defects which can be available on the piece of leather may be given more or less consideration depending on the extent and depth of defects.

For example, a purchaser who is needing larger pieces for manufacturing certain products may give much consideration to defects like brand marks, holes in the buff, flay cuts etc. and in turn that particular pieces of leather might produce less cutting value

C.3.7 Calculate the cutting value/usable area of leather using the following;

$$\text{Cutting value or usable area; per cent} = \frac{(A - A_1)}{A} \times 100$$

where,

A   is the total area of piece of leather in square feet or square decimetre; and

A_1 is the total areas represented by the defects observed as in **C.3.3** and **C.3.4** in square feet or square decimetre

C.3.8 Classify the pieces of leather as given in Table 4.

TABLE 4 - Grading of leather

Grades	Usable area, per cent
1	100
2	between 90 and 99
3	between 80 and 89
4	between 70 and 79
R	between 60 and 69
D	between 50 and 59
E	between 40 and 49
I	39 and below

C.4 DEFECTS IN LEATHER

The following common defects may be observed in leather:

(a)   Scratches or blemishes in the grain,
(b)   Brand marks,
(c)   Growth marks,
(d)   Warbles and tick marks,
(e)   Holes,

(f)   Thorn marks and fox marks,

(g)   Stain marks,

(h)   Loose grain,

(i)   Hair slips,

(j)   Flaying cuts,

(k)   Poor trimming; and

(l)   Process defects.

APPENDIX D
DETERMINATION OF WATER PENETRATION AND WATER ABSORPTION

D.1 SCOPE

This test method prescribes the determination of water penetration and water absorption for upper and insole.

D.2 PRINCIPLE

The material is partially immersed in water and flexed on a machine in a manner simulating conditions of wear. Measurements are made of :

a) the percentage gain in mass of the test piece due to water absorption after 60 min from the start of the test;

b) the time taken from the start of the test for water just to penetrate through the test piece;

c) the mass of water which has passed through the test piece after a further 30 min.

D.3 APPARATUS

D.3.1 Two cylinders, 30-mm diameter, made of inert rigid material, mounted with their axes horizontal and co-axial. One cylinder is fixed and the other is movable along the direction of its axis.

D.3.2 Electric motor, which drives the movable cylinder backwards and forwards along its axis with crank motion at 50 cycles/min and with amplitude which can be carried from 1.0 mm to 3.0 mm about its mean position. When the movable cylinder is at its greatest distance from the fixed one, the adjacent flat faces of the two cylinders are 40 mm apart.

D.3.3 Ring-shaped clamps, to clamp the longer edges of the test piece round the adjacent ends of the cylinders so that it forms a trough whose ends are closed by the cylinders.

D.3.4 Tank, containing distilled water, in which the trough-shaped test piece can be partly immersed.

D.3.5 Mass of fine spiral brass lathe turnings, forming an easily compressible conducting cushion which occupies two-thirds of the space in the trough formed by the test piece when positioned in the apparatus.

D.3.6 Metallic plate electrode, carried by a spring, to make contact with the top of the brass turnings and which when resting on the turnings or the roll of absorbent cloth applies a load of 1 N to 2 N.

D.3.7 Suitable electric circuit, which gives a signal when the electrical resistance between the plate electrode and the water in the tank decreases below a fixed value, thus indicating that penetration of water through the test piece has occurred.

D.3.8 Absorbent cloth, used to absorb water transmitted to the interior of the trough formed by the test piece. A suitable cloth consists of a rectangle of towelling-type textile of approximately 120 mm x 40 mm with a mass of approximately 300 g/m^2.

NOTE

The absorbency of the material may not be optimal when new. It is therefore advisable to wash the cloths before their first use.

D.3.9 Stopwatch

D.3.10 Balance, capable of weighing to 0.001 g.

D.4 PREPARATION OF TEST PIECE

Cut from the upper a rectangle of 75 mm x 60 mm. Buff the wear surface lightly by rubbing with a grade 180 emery paper and condition for 48 h at 27 °C $\pm$ 2 °C and 65 per cent $\pm$ 2 per cent relative humidity.

D.5 PROCEDURE

Adjust the apparatus to give an amplitude of 3 mm (7.5 per cent compression of the test piece).

Weigh the test piece to the nearest 0.001 g and record its mass, m_1 .

Fix the test piece in the apparatus, with the wear surface outside, as follows:

With the two cylinders at their maximum distance apart wrap the test piece round their adjacent ends so that it forms a trough whose upper edges, formed by the shorter sides of the test piece, are horizontal and at the same level. Keep the test piece between the cylinders under slight

tension to remove folds and with approximately the same length (about 10 mm) overlapping on each cylinder, clamp it using the ring clamps. The inner edges of the two ring clamps should lie as nearly as possible in the planes of the adjacent ends of the cylinders, so that the length of the trough is the same as the free length of the test piece between the clamps.

Place the brass turnings (**D.3.5**) into the trough, lower the plate electrode (**D.3.6**) to make contact with them and connect the electric circuit (**D.3.7**).

Raise the level of water in the tank until the water lies 10 mm below the top of the cylinders.

Start the motor and measure the time interval until water first penetrates through the test piece, as indicated by a signal from the electric circuit.
After 60 min from the start of the test, stop the motor and remove the plate electrode and brass turnings. Remove the test piece, blotting lightly to remove adhering moisture, and reweigh, recording its mass, m_2.

Replace the test piece. Weigh the absorbent cloth (**D.3.8**), recording its mass P_1 roll it up to form a cylinder of 40 mm length and immediately place it in the trough formed by the test piece. Replace the plate electrode (**D.3.6**) so that it rests on the cloth and restart the motor.

After a further 30 min, stop the motor, remove the cloth, if necessary mopping up any surplus water within the trough, and reweigh, recording its mass P_2.

D.6 CALCULATION AND EXPRESSION OF RESULTS

D.6.1 Calculate the water penetration, W_p, in g, from the equation:

$$W_p = P_2 - P_1$$

Where,

P_1 is the initial mass of the absorbent cloth, in g; and

P_2 is the final mass of the absorbent cloth, in g.

D.6.2 Calculate the water absorption, W_a, as a percentage by mass, from the equation:

$$W_a = \frac{m_2 - m_1}{m_1} \times 100$$

Where

m_1 is the initial mass of the test piece, in g; and
m_2 is the final mass of the test piece, in g.

APPENDIX E
DETERMINATION OF WATER VAPOUR PERMEABILITY
AND WATER VAPOUR COEFFICIENT

E.1 SCOPE

This test method prescribes the determination of water vapour permeability and water vapour co-efficient for upper and lining.

E.2 DETERMINATION OF WATER VAPOUR PERMEABILITY (WVP)

E.2.1 Principle

The test piece is fixed over the opening of a jar which contains a quantity of solid desiccant. This unit is placed in a strong current of air in a conditioned atmosphere.

The air inside the container is constantly agitated by the desiccant which is kept in movement by the rotation of the jar.

The jar is weighed in order to determine the mass of moisture that has passed through the test piece and been absorbed by the desiccant.

E.2.2 Apparatus

E.2.2.1 *Jars or bottles* fitted with a screw top with a circular opening whose diameter is equal to the diameter of the neck of the jar, approximately 30 mm (see Fig. 1).

E.2.2.2 *Holder* in the form of a disc which is rotated at 75 r/min ± 5 r/min by an electric motor. The jars are placed on this disc with their axes parallel to the axle of the disc and at a distance of 67 mm from it (see Fig. 2).

E.2.2.3 *Fan,* mounted in front of the mouths of the jars and consisting of three flat blades in planes that are inclined at 120° to one another. The planes of the blades pass through the prolongation of the axle of the disc. The blades are of dimensions approximately 90 mm by 75 mm, and the 90-mm long side of each blade nearest the mouths of the jars passes them at a distance of not more than 15 mm. The fan is driven by the motor at 1400 r/min. The apparatus is used in a conditioning atmosphere (27 °C ± 2 °C, 65 per cent ± 2 per cent r.h.) (see Fig. 3).

E.2.2.4 *Silica gel desiccant,* freshly regenerated by at least 16 h in a ventilated oven at 125 °C ± 5 °C then cooled to ambient temperature in a hermetically sealed vessel. The granular size of the crystals shall be such that they shall not pass through a 2-mm sieve.

NOTE

The silica gel should be sieved before regeneration in order to eliminate small particles and dust. At regeneration, the specified temperature should not be exceeded due to the risk of reducing the absorptive capacity of the gel. The ventilation of the oven by use of a fan is not necessary but the oven should not be sealed; it should allow continuous exchange of the air inside the oven with that outside. The gel should not be used whilst it is warmer than the test piece and since it cools slowly in a closed vessel, a long cooling time is needed.
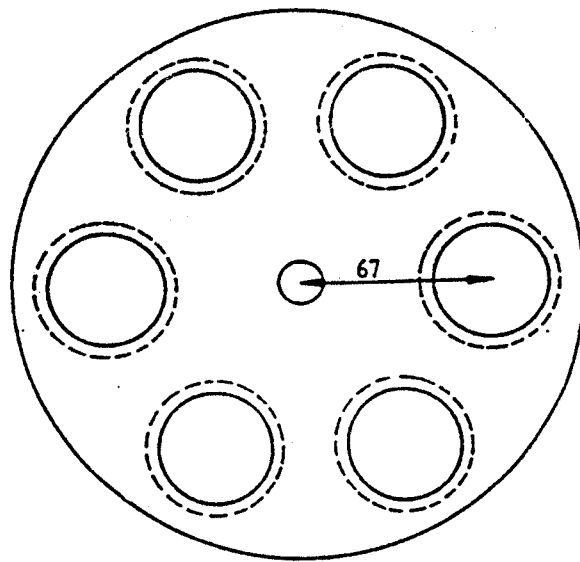
E.2.2.5 *Balance*, capable of weighing to 0.001 g.

E.2.2.6 *Stopwatch*

E.2.2.7 *Instrument*, capable of measuring to the nearest 0.1 mm the internal diameter of the neck of the jars.
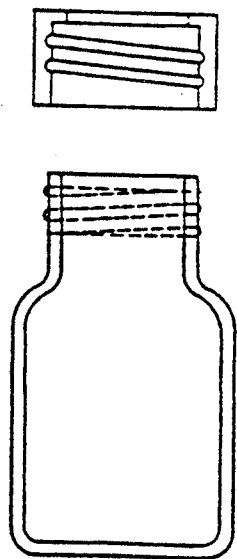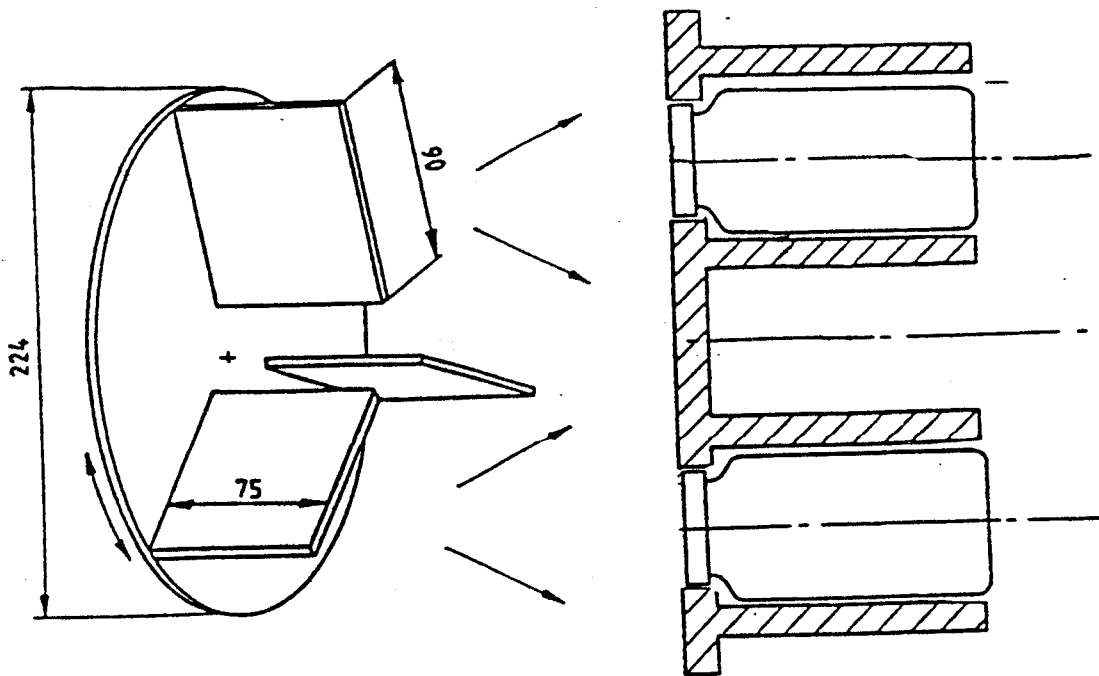
Figure 1 : Jar to be used in WVP

Dimensions in mm

Figure 2 : Holder for jars used in WVP test

Dimensions in mm

Figure 3 : Schematic diagram of apparatus to be used in WVP test

E.2.3 Preparation of test piece

E.2.3.1 Cut a test sample of dimensions 50 mm x 50 mm, and carry out 20,000 cycles of flexing using the flexing procedure in **Annex 1.**

E.2.4 Procedure

Half fill a jar with freshly regenerated silica gel. Fix the test piece over the opening of the jar by means of the screw top with the side facing the foot pointing outwards. Place the jar in the holder of the apparatus and switch on the machine.

Measure the internal diameter of the neck of a second jar (to the nearest 0.1 mm) in two directions perpendicular to each other and calculate the average diameter in millimetres.

If it is necessary to seal the junction between the test piece and the neck of the jar, warm the second bottle and apply a thin layer of wax to the flat end surface of the neck.

After more than 16 h but less than 24 h stop the machine, and remove the first jar. Half fill the second jar with freshly regenerated silica gel and immediately remove the test piece from the first jar and place into the second (with the same side facing outwards).

NOTE

If the opening of the jar has been coated with wax, warm the jar to around 50 ^0C before introducing the silica gel and fixing the test piece.

As quickly as possible, weigh the second jar with the test piece and silica gel, mass m_1, noting the time. Place the jar in the apparatus and switch on.

After not less than 7 h and not more than 16 h stop the machine and reweigh the jar, mass m_2, noting once again the time.

E.2.5 Calculation and expression of results

Calculate the water vapour permeability from the equation:

$$WVP = \frac{7739\, m}{d^2 t}$$

where,

WVP is the water vapour permeability, in $mg/(cm^2.h)$;
m is the increase in mass of the jar, $(m_2 - m_1)$, in mg;
d is the average diameter of the neck of the jar, in mm; and
t is the time between the first and the second weighings, in min.

E.3   DETERMINATION OF WATER VAPOUR ABSORPTION (WVA)

E.3.1   Principle

An impermeable material and the test piece are clamped over the opening of a metal container, which holds 50 ml of water, for the duration of the test.

Water absorption of the test piece is determined by its difference in mass before and after the test.

E.3.2   Apparatus

E.3.2.1   *Circular metal container*, of volume 100 cm^3 and an upper ring, between which the impermeable material and the test piece are clamped (see Fig. 4). The container and the ring have an internal diameter of 35 mm which correspond to a test area of approximately 10 cm^2. The upper ring is clamped to the apparatus with three hinged bolts equipped with nuts.
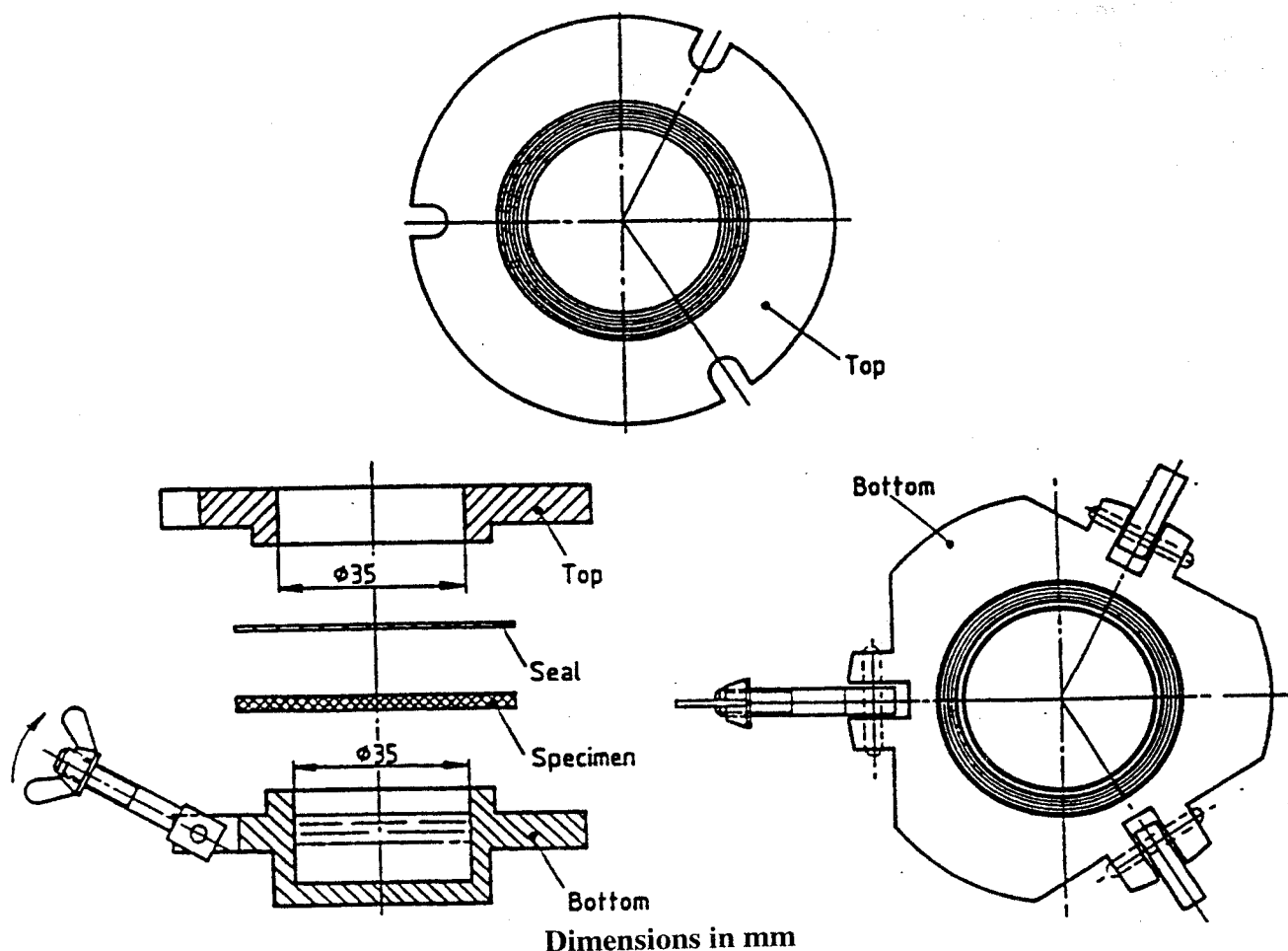

Dimensions in mm

Figure 4 : Apparatus for determination of WVA

E.3.2.2 *Balance*, capable of weighing to the nearest 0.0001 g.

E.3.2.3 *Stopwatch*

E.3.3 Preparation of tes piece

Cut a test piece of 43-mm diameter.

E.3.4 Test procedure

Carry out the test in a conditioning atmosphere of 27 ^{0}C $\pm$ 2 ^{0}C and 65 per cent $\pm$ 2 per cent r.h.

Weigh the conditioned test piece and record its mass, m_1.

Pleace 50 ml of water into the container and place the test piece over the container with the side facing the foot downwards. Place the rubber or metal disc and the upper ring over the test piece and screw down firmly. Ensure that no water laps against the bottom of the test piece.

Remove the test piece after 8 h and weigh immediately, recording its mass, m_2.

E.3.5 Calculation and expression of results

Calculate the water vapour absorption from the equation:

$$WVA = \frac{m_2 - m_1}{a}$$

where,

WVA is the water vapour absorption, in mg/cm^2;
m_1 is the initial mass of the test piece, in mg;
m_2 is the final mass of the test piece, in mg; and
a is the test surface area, in cm^2.

Round off the result to the nearest 0.1 mg/cm^2.

E.4 DETERMINATION OF WATER VAPOUR CO-EFFICIENT

Calculate the water vapour co-efficient from the following equation:

$$WVC = 8WVP + WVA$$

Where,

WVC is the water vapour co-efficient, in mg/cm^2;
WVP is the water vapour permeability, in $mg/(cm^2.h)$; and
WVA is the water vapour absorption, in mg/cm^2.

Round off the result to the nearest $0.1\ mg/cm^2$.

APPENDIX F
DETERMINATION OF WATER ABSORPTION AND DESORPTION OF INSOLE

F.1 SCOPE

This test method prescribes the determination of water absorption and desorption for insole.

F.2 PREPARATION OF TEST PIECE

Take a test piece of dimensions 50 mm $\pm$ 1 mm x 50 mm $\pm$ 1 mm from the insole and condition for 24 h at 27 ^{0}C $\pm$ 2 ^{0}C and 65 per cent $\pm$ 2 per cent r.h.

F.3 PROCEDURE

F.3.1 Water absorption

Weigh the test piece to the nearest 0.01 g, and record its mass, m_o.

Place the test piece in distilled water at 27 ^{0}C $\pm$ 2 ^{0}C for 8 h. Then remove it, dry off any drops of water still adhering to it using filter paper and reweigh it, recording its mass, m_1.

Calculate the water absorption, W_A, as a percentage by mass using the following equation:

$$W_A = \frac{m_1 - m_o}{m_o} \times 100$$

Where,

m_o is the initial mass of the test piece, for example in the dry condition, in g; and

m_1 is the final mass of the test piece, for example in the wet condition, in g.

Report the water absorption to the nearest 1 per cent.

F.3.2 Water desorption

On completion of the test specified in **F.3.1**, condition the test piece for 16 h at 27 ^{0}C $\pm$ 2 ^{0}C and 65 per cent $\pm$ 2 per cent r.h. and then reweigh it, recording its mass, m_r.

Calculate the water desorption, W_D, as percentage by mass using the following equation:

$$W_D = \frac{m_f - m_r}{m_f - m_o} \times 100$$

Where,

m_o is the initial mass of the test piece, in g;

m_f is the final mass of the test piece, in g; and

m_r is the mass of the reconditioned test piece, in g.

Report the water desorption to the nearest 1 per cent.

APPENDIX G
DETERMINATION OF FLEXING RESISTANCE OF OUTSOLE

G.1 APPARATUS

G.1.1 Testing device, as illustrated in Fig. **5.** The test piece is guided in such a way that on one side it can be bent at an angle of 90° about a mandrel with a radius of 15 mm.

G.1.2 Cutting tool, as illustrated in Fig. **6.**

G.1.3 Measuring magnifier, to enable the cut growth to be measured to 0.1 mm.

G.2 PREPARATION OF TEST PIECE

Prepare a test piece as ressembled to be as the outersole which is intended to be used by the manufacturer.

G.3 PROCEDURE

Clamp the test specimen in the testing device (**G.1.1**) in such a way that the greatest bending stress is applied to the ball area (flexing zone). Pierce the sole between the cleats at three points along the line of maximum bending stress (twice in the edge zone of the sole 10 mm from the edge and once in the middle) using the cutting tool (**G.1.2**). Carry out 30 000 cycles starting from an extended or stretched state, with the test piece undergoing deformation at a constant stroke value between 125 cycles/min and 150 cycles/min.

After 30 000 cycles, measure the length of the cuts on the test piece surface in the secured state under the maximum bending angel using the measuring magnifier (**G.1.3**).
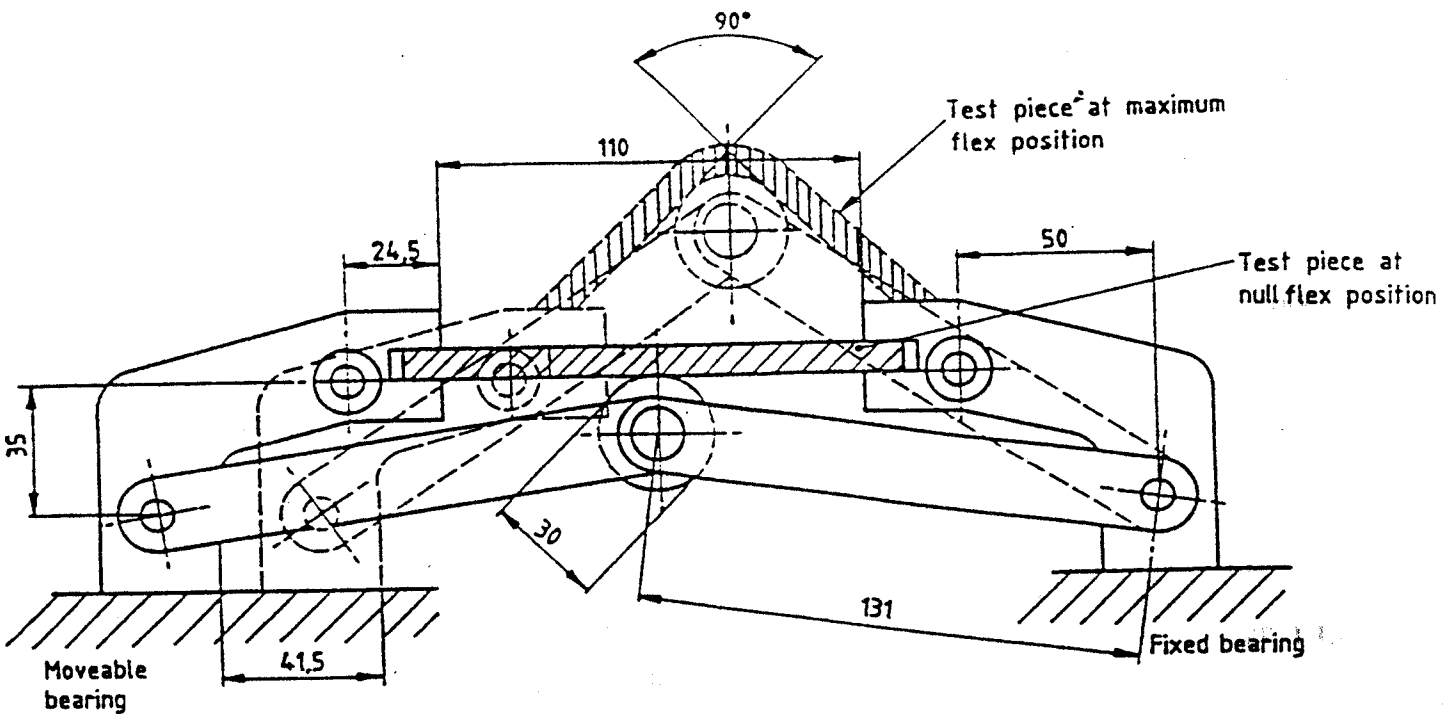
Dimensions in mm

Figure 5- Testing device for flexing resistance of outsole
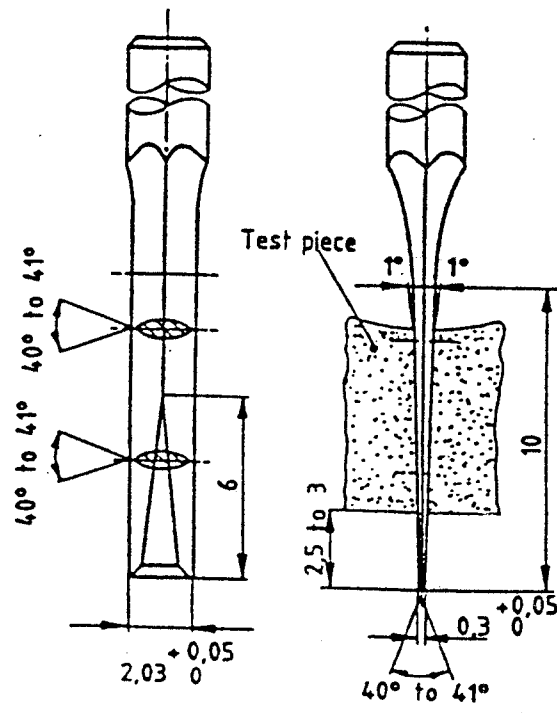
Dimensions in mm

Figure 6 - Cutting tool

ANNEX 1

PROCEDURE OF FLEXING

1.1 Apparatus

1.1.1 Upper clamp, consisting of a pair of flat plates. One has the shape of a trapezium ABCD (see Fig. 7) but with the sharp corner at D rounded to a radius of 2 mm. It has a ledge EF on which the folded test sample rests. The other plate has the shape EGHCF. The two plates can be screwed together, so as to hold one end of the sample between them as shown in Fig. **8**. The screw K which draws the plates together acts also as a stop, which prevents the end of the sample from being thrust too far towards the back of the clamp. Between the plates near the edge AB is a stop which prevents them from coming together near AB, and so ensures that they clamp the sample firmly near F. The upper clamp can be reciprocated by a motor about a horizontal axle J. In the position shown in Fig. 7 the ledge EF is horizontal, and the end F is its highest point. The clamp descends through an angle of 22.5^0 and returns (100 ± 5) times/min. The number of cycles is recorded by a counter.

1.1.2 Lower clamp, fixed and lying in the same vertical plane as the upper clamp. It consists of a pair of plates which can be screwed together to hold the other end of the sample between them. If the upper clamp has been turned to the position where the ledge EF is horizontal (Fig. 7) the upper edges of the plates of the lower clamp are 25 mm below the ledge EF.

Figure 7 : Upper clamp

1.2   Procedure

Turn the motor until the ledge EF is horizontal.

Fold the test sample in two, with the grain side inwards, and clamp it in the upper clamp as shown in Fig. **8.a**, with one end of the sample against the stop and the folded edge against the ledge.

Draw the free corners of the sample outwards and downwards as shown in Fig. **8.b** so that the surface which is turned inwards in the clamp is turned outwards below it. Draw the sample down, bringing together its two corners which have not been clamped; clamp it in the lower clamp as shown in Fig. **8.c** which the part of the fold between the clamps vertical, and using no more force than is needed to make the sample just taut.

Switch on the motor and carry out 20 000 flex cycles.

Switch off the motor and remove the test sample from the clamps.

Cut a circular test piece of diameter 34 mm centrally about the point at which the flexing creases meet
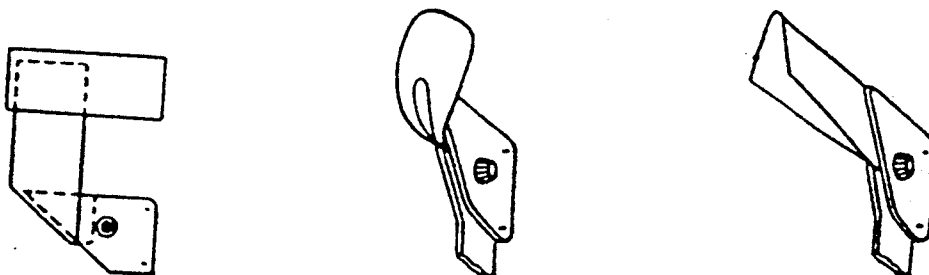
a) **Sample in upper clamp**   b) **Sample folded back**   c) **Sample clamped in**
                                                                          upper and lower clamps

Figure 8 : Insertion of the test sample in the clamps

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