भारतीय मानक
Indian Standard

IS 5914 (Part 6/Sec 1) : 2023
ISO 5402-1 : 2022

चमड़े की भौतिक परीक्षण पद्धतियाँ
भाग 6 फ्लेक्स प्रतिरोध का निर्धारण
अनुभाग 1 फ्लेक्सोमीटर विधि

Methods of Physical Testing of Leather
Part 6 Determination of Flex Resistance
Section 1 Flexometer Method

ICS 59.140.30

भारतीय मानक ब्यूरो
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June 2023 **Price Group 7**

Leather, Tanning Materials and Allied Products Sectional Committee, CHD 17

NATIONAL FOREWORD

This Indian Standard (Part 6/Sec 1) which is identical with ISO 5402-1 : 2022 'Leather — Determination of flex resistance — Part 1: Flexometer method' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendation of the Leather, Tanning Materials and Allied Products Sectional Committee and approval of the Chemical Division Council.

The Indian Standard IS 5914 : 1970 Methods of physical testing of leather prescribes the methods for carrying out physical tests for all types of leathers. The Committee responsible for formulating this standard has decided to harmonize the methods of test prescribed in IS 5914 with those prescribed in ISO/IULTCS standards. Accordingly, the committee decided to retain IS 5914 and publish the harmonized/ adopted test methods published by ISO/IULTCS in various parts of IS 5914 as this standard is widely recognized by the Indian Leather Industry.

The Committee further decided to publish the adopted/harmonized standards in the following manner:

a) Wherever an existing test method is being replaced by the corresponding ISO/IULTCS test method, the relevant part will be published as revision with the information in the national foreword about the method of IS 5914 being superseded; and
b) When a new test method is being incorporated in IS 5914, the same will be published as a new standard and as subsequent part of IS 5914.

This part is an adoption of ISO 5402-1 : 2022 which specifies a method for determining the dry or wet flex resistance of leather and finishes applied to leather.

This standard has been published in several other parts. The other parts of this series are:

IS No.	*Title*
IS 5914	Methods of physical testing of leather:
(Part 1) : 2018	Determination of water vapour absorption
(Part 2)	Determination of abrasion resistance,
(Sec 1) : 2022	Taber method (*first revision*)
(Sec 2) : 2017	Martindale ball plate method
Part 3	Determination of soiling,
(Sec 1) : 2017	Rubbing (martindale) method
(Sec 2) : 2017	Tumbling method
(Part 4)	Determination of apparent density and mass per unit area (*under preparation*)
(Part 5)	Determination of tear load,
(Sec 1)	Single edge tear (*under preparation*)
(Sec 2)	Double edge tear (*under preparation*)

(*Continued on third cover*)

Contents

Page

Introduction

This document describes a widely-used method with a flexing apparatus for determining the dry or wet flex resistance of leather and finishes applied to leather. The number of flexing cycles chosen depends on the end use of the leather and the expected performance. The leather specification normally defines the number of flex cycles that the leather is required to achieve without damage. In addition, the flexing process can be used as a pre-treatment for other test procedures.

This type of flexing apparatus was developed in 1963 and the flexing equipment described in this document is available commercially from a range of manufacturers globally. The robust equipment is typically used by tanneries and test laboratories for many decades. Over the years, small differences in the geometry of the upper clamp (5.1.2) develop. In ISO 5402-1:2017 a modified upper clamp design was introduced. In this document the upper clamp differences have been grouped together into 2 categories: Specification 1 (as in ISO 5402-1:2017) and Specification 2 (as in ISO 5402-1:2011).

Indian Standard

METHODS OF PHYSICAL TESTING OF LEATHER

PART 6 DETERMINATION OF FLEX RESISTANCE

SECTION 1 FLEXOMETER METHOD

1 Scope

This document specifies a method for determining the dry or wet flex resistance of leather and finishes applied to leather. It is applicable to all types of flexible leather below 3,0 mm in thickness.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2418, *Leather — Chemical, physical and mechanical and fastness tests — Sampling location*

ISO 2419, *Leather — Physical and mechanical tests — Sample preparation and conditioning*

ISO 3696, *Water for analytical laboratory use — Specification and test methods*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Principle

A test piece is folded with the surface to be tested inwards and clamped in an upper movable clamp and with the surface to be tested outwards in a lower fixed clamp. Movement of the upper clamp causes a fold in the test piece to run along it. The test piece is examined periodically for damage.

5 Apparatus and reagents

5.1 Test machine

5.1.1 The test machine consists of a movable upper clamp, a fixed lower clamp and a counter as described in 5.1.2 to 5.1.4. Examples of suitable commercial suppliers of this machine are given in Annex A.

5.1.2 Upper clamp

5.1.2.1 The upper clamp comprises:

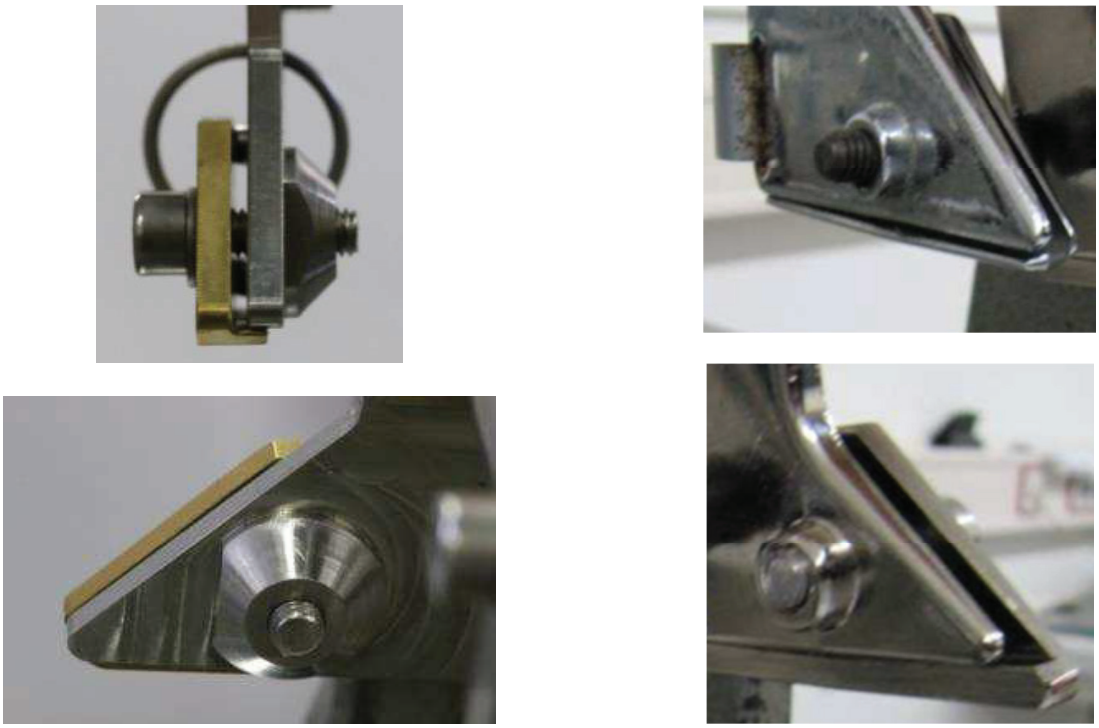
— a pivoting pair of plates (H and I) with flat mating faces, each of maximum 4 mm thickness, as in Figure 2 and Figure 3. The small plate (H) has the basic shape of a trapezium but with a radius of 2 mm at the acute corner. It has a ledge (G) to support the folded test piece. The larger plate (I) has a shape as shown in Figure 2 and Figure 3.

— a clamp tightening screw (F) to draw the two plates (H and I) together and also serve as a stop to correctly locate the test specimen;

— a mechanism that ensures that the mating faces of the plates remain parallel when clamping the test specimen while ensuring that the test specimen is securely clamped at the sloping edge and apex (nose) of the clamp.

— the upper clamp shall be reciprocated by a motor about a horizontal axis, descending through an angle of (22,5 ± 0,5)° at a frequency of (100 ± 5) cycles/min.

Two specifications for the upper clamp are permitted; Specification 1 as described in 5.1.2.2 and Figure 2, and Specification 2 as described in 5.1.2.3 and Figure 3. The type of upper clamp used and the manufacturer shall be reported in the test report.



a) Specification 1 (5.1.2.2) **b) Specification 2 (5.1.2.3)**

Figure 1 — Illustration of upper clamp Specifications 1 and 2

5.1.2.2 Specification 1

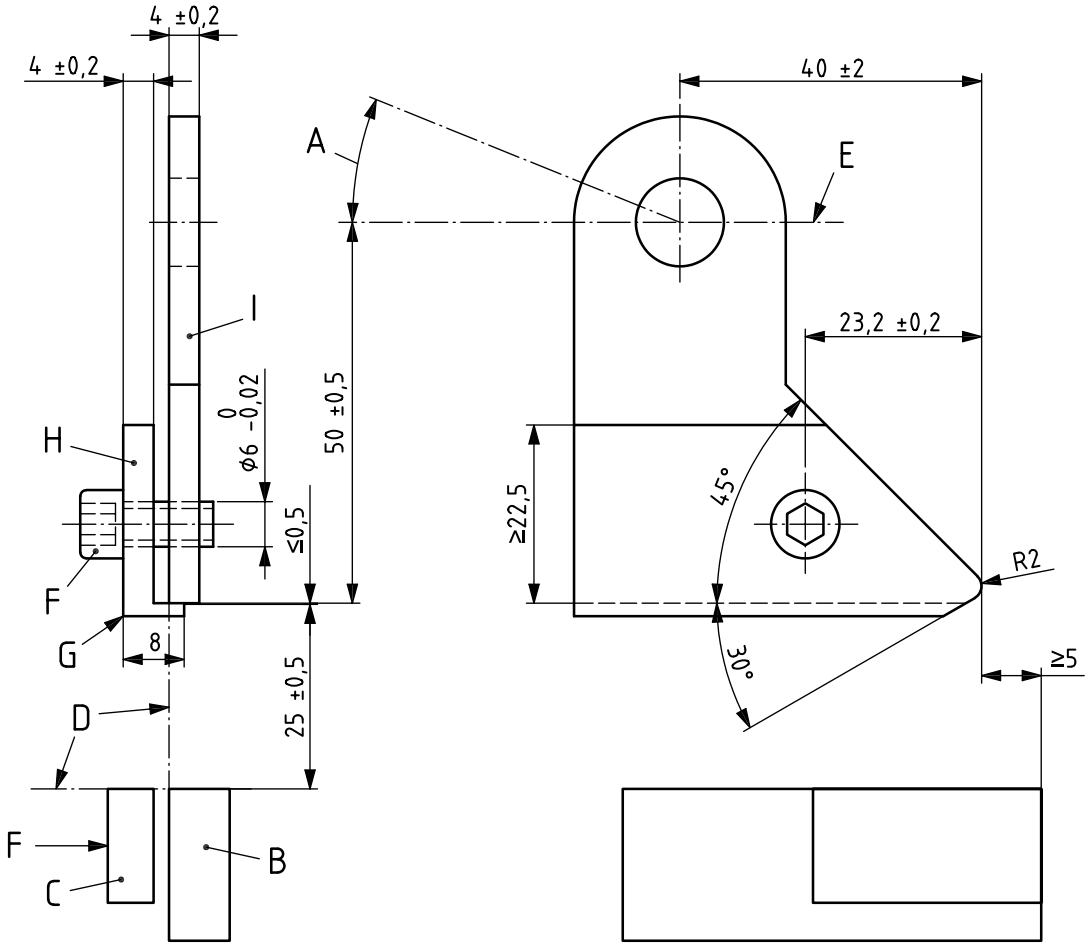
Specification 1 is illustrated in Figure 1 a) and described in Figure 2.

The clamp tightening screw (F) acts as a stop to prevent the test piece from being less than (15 ± 1) mm from the vertical through the pivot point (E).

NOTE The clamp tightening screw (F) is threaded and is used repeatedly. The threads will wear over time, which can result in the tolerance in Figure 2 being exceeded, so the dimensions given are nominal. This dimension is not critical to the test providing the material under test is securely clamped.

The fold of the test specimen (7.3) sits on the ledge (G) and the end of the test specimen butts up against the clamp tightening screw (F).

Dimensions in millimetres



Key

A flexing angle (22,5 ± 0,5)°
B fixed part of fixed lower clamp
C movable part of fixed lower clamp
D vertical positioning of fixed part of movable upper clamp and fixed part of fixed lower clamp
E horizontal axle (pivot point)
F clamp tightening screws (not shown in lower clamp)
NOTE Diameter is indicative as the threads will wear over time.
G ledge
H small plate of upper clamp with ledge (G)
I large plate of upper clamp

Figure 2 — Upper (moveable) clamp Specification 1 and lower (fixed) clamp

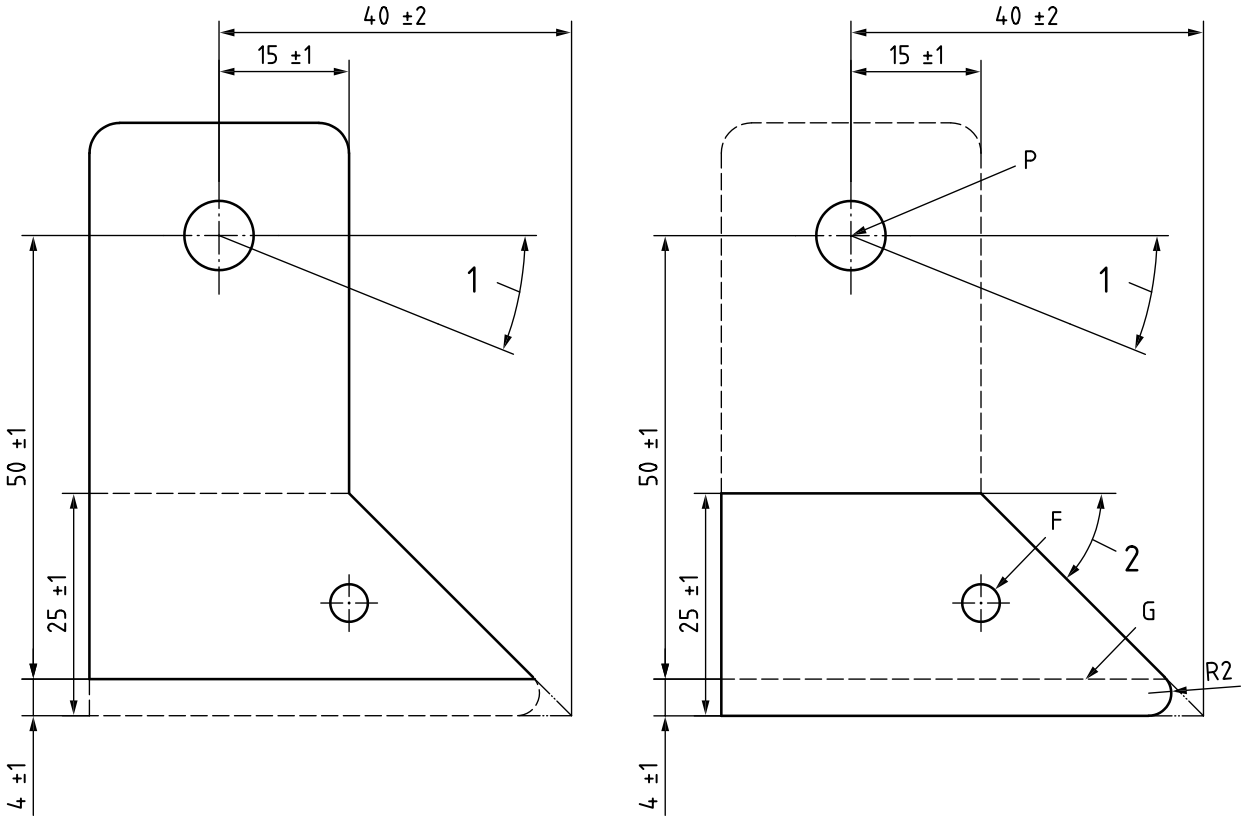
5.1.2.3 Specification 2

Specification 2 is illustrated in Figure 1 b) and described in Figure 3.

The clamp tightening screw (F) acts as a stop to prevent the test piece from being less than (15 ± 1) mm from the vertical through the pivot point (P).

The fold of the test specimen (7.3) sits on the ledge (G) and the end of the test specimen butts up against the clamp tightening screw (F).

Dimensions in millimetres



a) Large plate (I) **b) Small plate (H) with ledge (G)**

Key

1 flexing angle (22,5 ± 0,5)°
2 45°
P pivot point
F clamp tightening screw
G ledge
R2 radius approximately 2 mm
H small plate of upper clamp with ledge (G)
I large plate of upper clamp

Figure 3 — Upper clamp specification 2

5.1.3 Lower clamp, fixed and lying directly beneath (planar to) the upper clamp and consisting of a pair of flat plates (B and C in Figure 2) to hold the test piece with a clamp-tightening screw.

The position of the lower clamp is such that the vertical distance (D) between the upper side of the ledge (G) of the upper clamp and the upper edge of the fixed lower clamp, when the upper clamp is horizontal, is (25,0 ± 0,5) mm.

5.1.4 Counter, to indicate the number of cycles.

5.2 Press knife, conforming to the requirements of ISO 2419, the inner wall of which is a rectangle (70 ± 1) mm × (45 ± 1) mm.

5.3 Magnifier, with a magnification of four to six times.

5.4 Desiccator, or other vessel that can be evacuated.

5.5 Vacuum pump, capable of reducing the pressure in the desiccator to less than 4 kPa.

5.6 Distilled or deionized water, conforming to the requirements of grade 3 of ISO 3696.

5.7 Glass dishes, minimum diameter 100 mm and minimum depth 25 mm.

5.8 Mandrel, diameter 10 mm and minimum length 70 mm.

5.9 Metal clip, 70 mm wide, capable of fixing a test piece bent around the mandrel (5.8) with slight stretch.

5.10 Stereo microscope, with a magnification of 25 times.

6 Sampling and sample preparation

6.1 Sample in accordance with ISO 2418. From the sample, cut a minimum of four pieces for dry test and/or four pieces for wet test by applying the press knife (5.2) to the surface to be tested. Cut a minimum of two test pieces with the long edge parallel to the backbone and two with the long edge perpendicular to the backbone.

If there is a requirement for more than two hides or skins to be tested in one batch, then only one test piece in each direction need be taken from each hide or skin, provided that the overall total is not less than three pieces in each direction.

6.2 For dry flex testing, condition the test pieces in accordance with ISO 2419 and test in the conditioned atmosphere.

6.3 For wet flex testing, place the test pieces in a glass dish (5.7), add sufficient distilled or deionized water (5.6) to give a minimum depth of 10 mm, put the dish in the desiccator and reduce the pressure to below 4 kPa for 2 min.

Restore to normal atmospheric pressure and repeat the pressure reduction/restoration twice. Remove the test piece and remove excess water using blotting paper. Carry out wet flexing without delay.

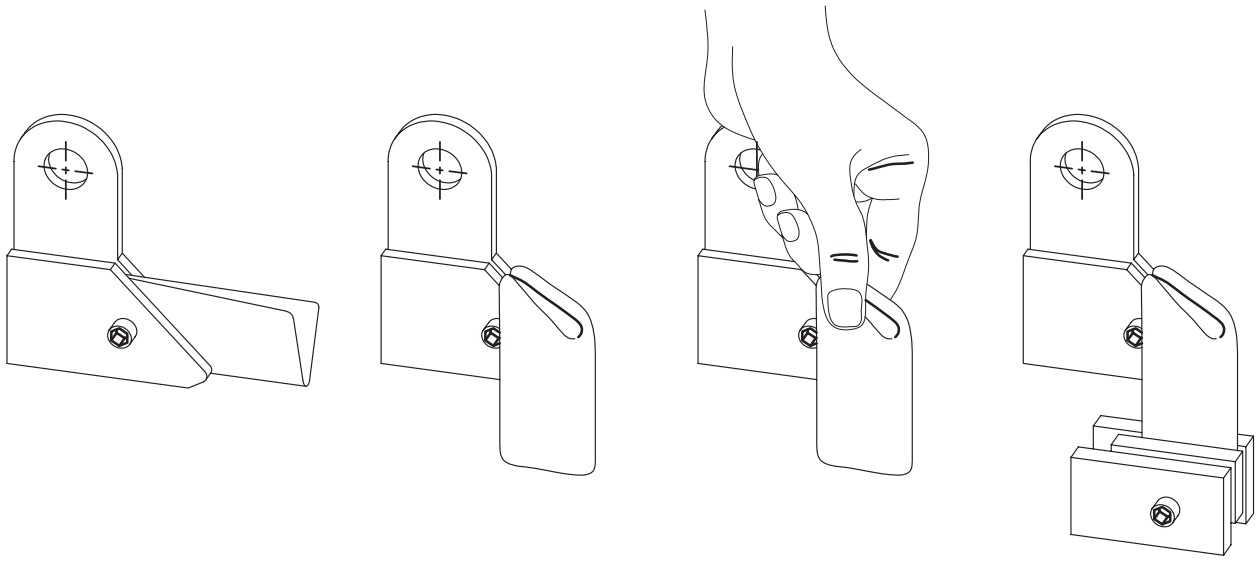
6.4 It is not possible to clamp thick leathers in the upper clamp. In such cases, the thickness of the test piece is reduced for a maximum length of 15 mm from one end only and this end inserted in the upper clamp. Even so, the leather can be too stiff to be tested by this method.

7 Procedure

7.1 Open the upper and lower clamps (5.1.2 and 5.1.3) so that the gap is at least twice the thickness of the test piece.

7.2 Turn the motor until the lower edge of the upper clamp (5.1.2) is parallel to the upper edge of the fixed lower clamp (5.1.3) as shown in Figure 4 d) (the point at which the direction of rotation of the horizontal axle changes).

7.3 Fold the test piece in half lengthwise, such that the two long edges are brought together exactly and the grain surface meets face to face. Clamp the folded test piece as shown in Figure 4 a) with the folded edge parallel to, and positioned against, the ledge and with the end of the test piece against the stop formed by the clamping screw. Ensure that the corners of the test piece within the upper clamp are securely fixed and cannot slip during the test.



a) Sample in upper clamp **b) Sample folded back** **c) Sample fixed with two fingers on upper clamp** **d) Sample fully clamped**

Figure 4 — Loading of the test piece

7.4 Draw the free corners of the test piece outward and downward around the clamp as shown in Figure 4 b). Bring the inner surfaces together and place the free end in the opened lower clamp.

7.5 Press the test piece against the outer surfaces of the upper clamp as shown in Figure 4 c). It is important to ensure that the test piece is in contact with the 45° sloping face of the clamp. This ensures that the lower part of the test piece is perpendicular to the lower clamp. Fix the test piece in this position in the lower clamp [see Figure 4 d)].

NOTE 1 The procedure ensures that no elongation is applied to the test piece by clamping.

NOTE 2 Flexible (soft) materials will show a direct contact of their backing on the outer face of the upper clamp. For stiffer materials, ballooning of the materials in this area is unavoidable.

7.6 Inspect the vertical orientation of the test piece (rear edge). If the rear edge is not perpendicular to the lower clamp, repeat 7.4 and 7.5.

7.7 Run the machine for the required number of flex cycles selected from the following list:

— dry flex: 500; 1 000; 5 000; 10 000; 20 000; 25 000; 50 000; 100 000; 150 000; 200 000; 250 000 cycles;

— wet flex: 500; 1 000; 2 500; 10 000; 20 000; 25 000; 50 000 cycles.

In addition to the above inspection points, remove the wet test pieces from the machine every 25 000 cycles and examine them for spue before re-wetting (6.3) and replacing in the test machine.

Other inspection points can be considered if required.

The test pieces should flex without excessive bulging at the sides. If they do not flex in this mode, include this in the test report.

7.8 Stop the test machine and remove the test piece. Fold it along the longitudinal axis and examine visually in good light using the naked eye and with the magnifier (5.3). Assess and record any damage in the flexed area, ignoring damage in the clamped area.

If required to evaluate the intensity of cracks, bend the test piece along the longitudinal axis around the mandrel (5.8). Stretch the test piece slightly with the fingers or using a clip (5.9). Use the following wording to describe the cracks:

— cracks: visible with the naked eye;

— fine cracks: visible with a magnifier (5.3);

— micro cracks: visible with a microscope, 25 times magnification (5.10).

If required, cut through the flexed area to assist identification of loose leather structure; this will damage the test piece too severely to allow further testing and is only to be carried out after the final inspection.

Damage can include the following:

a) change of shade (greying) of the finish film without further damage;

b) cracking or crazing of the finish with the cracking extending through one or more finish layers; the number of cracks may be reported if it is feasible;

c) loss of adhesion of finish to the leather;

d) loss of adhesion between finish coats;

e) powdering or flaking of the finish coats;

f) colour contrasts shown by finish cracking, powdering or flaking.

7.9 If required, replace the test piece in the clamps using the marks produced by the clamps as a guide to ensure that the test piece is returned to its original position in the clamps.

7.10 Restart the machine and continue to the next required number of cycles. Repeat the inspection given in 7.8.

7.11 Repeat steps 7.9 and 7.10 if required for other numbers of flex cycles.

NOTE The actual number of cycles chosen will depend on the specification, the end use of the leather and the expected performance.

7.12 If only one test piece shows slight damage on final inspection, repeat the test with a new set of minimum four test pieces. In the case that all of the additional test pieces pass the test without any damage, report the final result as “no damage”, otherwise, report the evaluation of the worst test piece.

8 Test report

The test report shall include the following:

a) a reference to this document, i.e. ISO 5402-1:2022;

b) whether the leather was tested wet or dry;

c) the type and manufacturer of upper clamp used (5.1.2);

d) the number of flex cycles and damage reported for the worst test piece (7.8 and 7.12);

e) the standard atmosphere used for conditioning and testing as given in ISO 2419;

f) any deviations from the method specified in this document and any unusual features observed;

g) full details for identification of the sample and any deviation from ISO 2418 with respect to sampling;

h) the date of the test.

Annex A
(informative)

Sources of apparatus

Examples of sources of suitable apparatus available commercially are given below. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of these products.

The recommended apparatus is the flexometer manufactured, for example, by:

— Giuliani Tecnologie, via Centrallo 62/18, I-10156 Torino, Italy, www.giuliani.it;

— Muver-Francisco Muñoz Irles, Avda Hispanoamerica 42, E-03610 Petrer (Alicante), Spain, www.muver.com;

— PFI Test and Research Institute, Marie-Curie-Strasse 19, D-66953 Pirmasens, Germany, www.pfi-germany.de;

— SATRA Technology Centre, Wyndham Way, Kettering, Northants, NN16 8SD, England, www.satra.com;

— SODEMAT, 29 rue Jean Moulin, ZA Coulmet, F-10450 Breviandes, France.

(*Continued from second cover*)

Part 6	Determination of flex resistance,
Sec 2	Vamp flex method (*under preparation*)
Part 7	Determination of Resistance to Grain Cracking and Grain Crack Index (*under preparation*)

The text of ISO Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions and terminologies are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words `this document' appear referring to this standard, they should be read as `Indian Standard'; and

b) Comma (,) has been used as a decimal marker in the International Standard, while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

The technical committee has reviewed the provisions of the following International Standards referred in this standard and has decided that they are acceptable for use in conjugation with this standard:

International Standard	*Title*
ISO 2418	Leather — Chemical, physical and mechanical and fastness tests — Sampling location
ISO 2419	Leather — Physical and mechanical tests — Sample preparation and conditioning
ISO 3696	Water for analytical laboratory use — Specification and test methods

Conditioning and test atmospheres stipulated in this standard may not be applicable to tropical/subtropical countries like India. The applicable Standard Atmospheric Conditions (SAC) for Indian Conditions are (27 ± 2) ºC and (65 ± 5) percent relative humidity and may be observed while using this standard.

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 : 2022 'Rules for rounding off numerical values (*second revision*)'.

Bureau of Indian Standards

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website-www.bis.gov.in or www.standardsbis.in.

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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