

## Measurement of the Resistance to Bending of Heavy Leather

### 1 Scope

The method is intended for use with any heavy leather. It is not suitable for light leathers such as shoe upper and gloving leathers.

### 2 Principle of the method

A specimen of the leather is laid as a horizontal beam across a pair of rollers and the deflections are measured when loads are applied at its mid-point.

### 3 Apparatus

#### 3.1 Apparatus for conditioning specimens mechanically

3.1.1 Before measurements are made of the deflections produced by known loads, the specimens are conditioned mechanically by bending them several times to an extent somewhat greater than in the test itself. The auxiliary apparatus used for this mechanical conditioning consists of:

3.1.2 A pair of circular section, smooth surfaced steel pins of diameter  $7 \pm 1$  mm, mounted on a board so that their axes are normal to the board and 80 mm apart.

3.1.3 A piece of flat plate glass against which the flatness of the specimens can be tested.

#### 3.2 Apparatus for measurements of deflections

3.2.1 The apparatus has the following components (see Fig 1):

3.2.2 A pair of nylon rollers of diameter  $7 \pm 1$  mm and length  $20 \pm 1$  mm. They are mounted on a steel beam of width about 15 mm, thickness  $10 \pm 0.5$  mm and length  $130 \pm 5$  mm, the beam itself being supported horizontally in a rigid frame. The nylon rollers are equidistant from the marked centre part X of the beam, and are mounted with their axes parallel and  $60 \pm 0.2$  mm apart. The rollers rotate freely with little friction on their axles.

3.2.3 A yoke which carries a scale pan on which weights can be placed. During measurements, the cross piece at the top of the yoke rests across the middle of the specimen under test. The lower surface of the cross piece is rounded and has a radius of curvature of  $2.5 \pm 0.5$  mm. The upper surface of the cross piece carries a flat steel platform whose top surface is about 10 by 10 mm. The yoke and scale pan together weigh  $100 \pm 1$  gm.

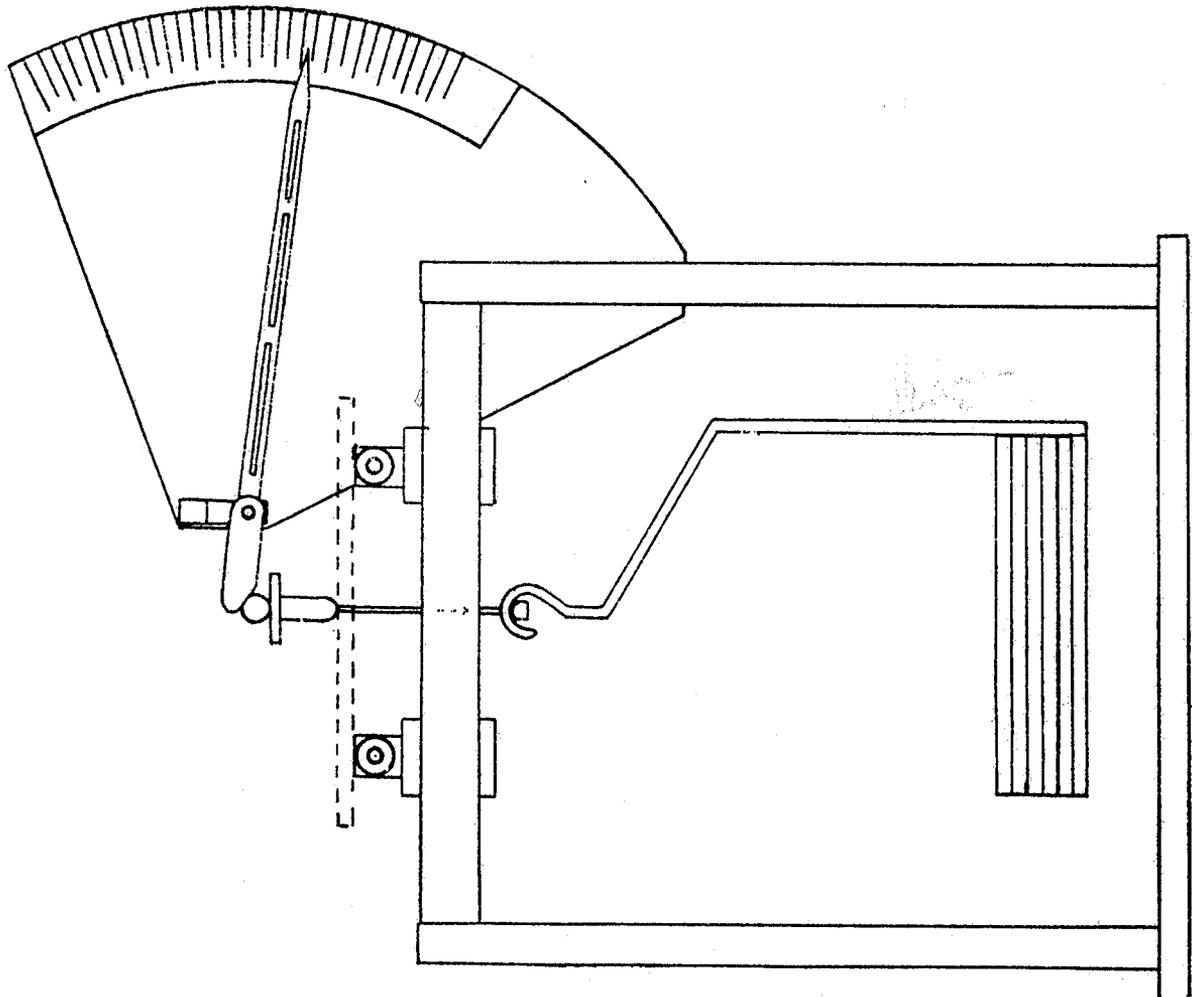


Fig 1

3.2.4 A pointer and a vertical metal plate carrying a scale. The pointer is carried by a horizontal axle in bearings that are rigidly attached to the metal plate, and turns with little friction. Its arms are approximately 20 and 100 mm long, and a steel bearing ball of diameter  $6.5 \pm 0.2$  mm is fixed to the lower side of the short arm at a distance of  $18 \pm 3$  mm from the axis of the pointer axle. When the pointer is near the middle of its scale, the bearing ball has its lowest point approximately on (within 0.5 mm of) the vertical line through the point X (see 3.2.2). The relative heights at which the ball and the

pointer axle are mounted are such that if a thin flat strip of metal is laid across the nylon rollers, the yoke is placed on the strip at X and the ball is lowered on to the platform of the yoke, the pointer points approximately to the middle of its scale. The masses of the pointer arms and bearing ball are such that the ball rests on the platform, applying to it a load of between 0.5 and 1.0 gm.

3.2.5 The scale is calibrated to read deflections of the mid-point of a beam laid across the nylon rollers. The calibration can be made by using as a beam a thin flat strip of steel with the yoke across it at X. The positions of the pointer are noted when various loads are added to the pan and the corresponding positions of a marked point on the yoke are measured with a travelling microscope. The zero of the scale is arbitrarily fixed, since the scale is only used to measure deflections and not actual positions. It is convenient to have a scale extending over 20 mm or more.

3.2.6 Twenty-five weights, each of  $100 \pm 0.1$  gm. They are in the form of flat discs so that a group weighing any integral number of hundreds of grams can be added simultaneously to the scale pan.

#### 4 Method of applying loads and taking readings

The loads applied must be put on gently, and without shock. Unless the apparatus used has an automatic device for doing this, the procedure recommended is as follows.

Put one hand beneath the scale pan and raise it so that the hook of the pan is not in contact with the yoke. Put the required weights on the scale pan, and lower it gently until the whole load has been transferred to the yoke. Read the pointer 10 seconds after the full load has been applied.

#### 5 Preparation of specimens

5.1 Using a sharp press knife, cut the specimens as rectangles 100 mm by 12.5 mm. To avoid cutting specimens whose cross section is a parallelogram rather than a rectangle, care is needed to ensure that the press knife is not tilted as pressure is applied to it.

5.2 Resistance to bending frequently depends considerably on the direction in which the specimens are cut, so the direction relative to the backbone of the long sides of the specimens must be noted during cutting and reported together with the location in the hide.

5.3 Condition the specimens for temperature and moisture in accordance with the Method SLP 3 (IUP/3).

Note: It is often informative to test leather in the wetted, as well as in the dry, conditioned state. If this is done, the manner of wetting the specimens must be stated when reporting the results.

5.4 Measure the thickness of each specimen in accordance with Method SLP 4 (IUP/4) at its mid-point to the nearest hundredth of a millimetre, and

at two points on its long axis and 10 mm from the mid-point. Take the mean value ( $t$  mm) of these measurements as the thickness of the specimen.

- 5.5 Using a pair of vernier callipers, measure the width of the specimen at its mid-point to the nearest tenth of a millimetre. Make similar measurements at positions 10 mm on each side of the mid-point, and take the mean of the three readings as the breadth ( $b$  mm) of the specimen.
- 5.6 Immediately before beginning to make deflection measurements on a specimen, condition it mechanically, as follows:
  - 5.6.1 Hold the specimen at the middle between thumb and forefinger and place it with its grain surface in contact with the pins of the pre-conditioning apparatus, with approximately equal lengths overlapping at each end. Apply at the mid-point of the specimen a force normal to the plane containing the axes of the pins, causing the specimen to bend until it passes between the pins.
  - 5.6.2 Turn the specimen over so that its flesh surface is in contact with the pins, and press the specimen through as before.
  - 5.6.3 Repeat 5.6.1 and 5.6.2 in turn four times more.
  - 5.6.4 Flatten the specimen carefully by bending it between the fingers. Test its flatness by laying the specimen grain down on the glass plate. Repeat until the specimen is as flat as it can be made.

## 6 Preliminary measurements

- 6.1 Lay the specimen, grain down across the nylon rollers and symmetrical with respect to them, and set the yoke at the mid-point  $X$  between the rollers. Hang the scale pan from the yoke so that a load of 100 gm is being applied to the leather, and after 10 seconds read the deflection scale.
- 6.2 Add weights gently to the scale pan, noting the readings of the deflection scale 10 seconds after their application. Continue to do this until the deflection (final scale reading minus reading of 6.1) first exceeds 10 mm. Note the total load of  $n$  hundreds of grams, made up of the weight of yoke and pan plus  $(n-1)$  added weights (see 10.1).
- 6.3 Recondition the specimen mechanically, and flatten it by repeating the procedure of 5.6 above.

## 7 Measurement of the deflection produced by a chosen load

- 7.1 Again lay the specimen across the rollers with the yoke and scale pan suspended from it as in 6.1 and after 10 seconds read the deflection scale.
- 7.2 Add gently, as a single set of weights,  $(n-2)$  hundreds of grams, and after 10 seconds read the deflection scale. Let the increase of

deflection (final scale reading minus reading of 7.1) be  $d$  mm.

## 8 Calculations

- 8.1 Calculate the force  $F$  required to give 10 mm deflection of a beam of the leather 10 mm wide, using the formula:

This force may be regarded as a measure of the resistance of the leather specimen to bending.

- 8.2 Calculate the apparent value of Young's modulus  $E$  for the leather, using the formula:

Young's modulus may be regarded as a measure of the stiffness of a beam of unit width and thickness. The formula is based on the assumption that the various layers of the leather have the same properties and this is not strictly true. Nevertheless, values of the apparent modulus are useful for comparing leathers of different thicknesses.

## 9 Reporting results

Report the thickness of the specimens, the directions in which they were cut, the force  $F$  required to give a deflection of 10 mm in specimens 10 mm wide, and the apparent Young's modulus. If specimens are tested in a wet state as well as in the dry conditioned state, report how these specimens were wetted as well as the other particulars.

## 10 Notes

- 10.1 Some leathers do not give approximately straight line graphs when deflection is plotted against load. For some purposes it is useful to plot graphs of the readings obtained by 6.1 and 6.2, and to note in the report any leathers whose graphs show substantial curvature.