

Measurement of Set in Lasting with the Dome Plasticity Apparatus

1 Scope

This method is intended for use with any type of upper leather.

2 Principle of the method

The specimen, in the form of a circular disk, is cemented and clamped at the rim to a flat brass ring and is pressed into the form of a spherical cap whose area is approximately 115% of that of the free disk. The extended form is maintained for a measured period of time, after which the pressure on the cap is released, although the clamping at the rim is maintained. The area of the cap is estimated from measurements made after specified periods of time, and the remaining area increases at these times are expressed as percentages of the imposed area increase (see 10.1).

3 Definition of percentage set S

Let A_0 be the initial area of the flat leather disk within the brass ring. When the leather is maintained at a strained area A_1 of about 115% of A_0 , let the height of the circular cap so formed be h_1 and let the area and height be A_2 and h_2 when the specimen has been allowed to recover for a specified time.

The percentage set S at this recovery time is defined by the equation:

$$S = 100 \left(\frac{A_2 - A_0}{A_1 - A_0} \right)$$

In so far as the disk maintains the form of a spherical cap during recovery, this is equivalent to:

$$S = 100 \left(\frac{h_2}{h_1} \right)^2$$

and S is calculated from measurements of h_1 and h_2 .

4 Dome plasticity apparatus (see 10.2)

The apparatus consists of the following (see Fig 1):

- (1) A brass ring E, called the specimen ring, having a thickness 1.6 mm, external diameter 95.25 mm and internal diameter close to 69.8 mm (see below). The sample F is cemented to this ring before the test is made.
- (2) A piston G whose end is in the form of a circular cap. The diameter of the piston is 69.8 mm \pm 0.12 mm and the radius of curvature of the cap is 51.6 mm \pm 0.25 mm. The piston is made of a rigid material, which is heat resistant, of low thermal conductivity, and it has a rod H attached to the back (see 10.3).

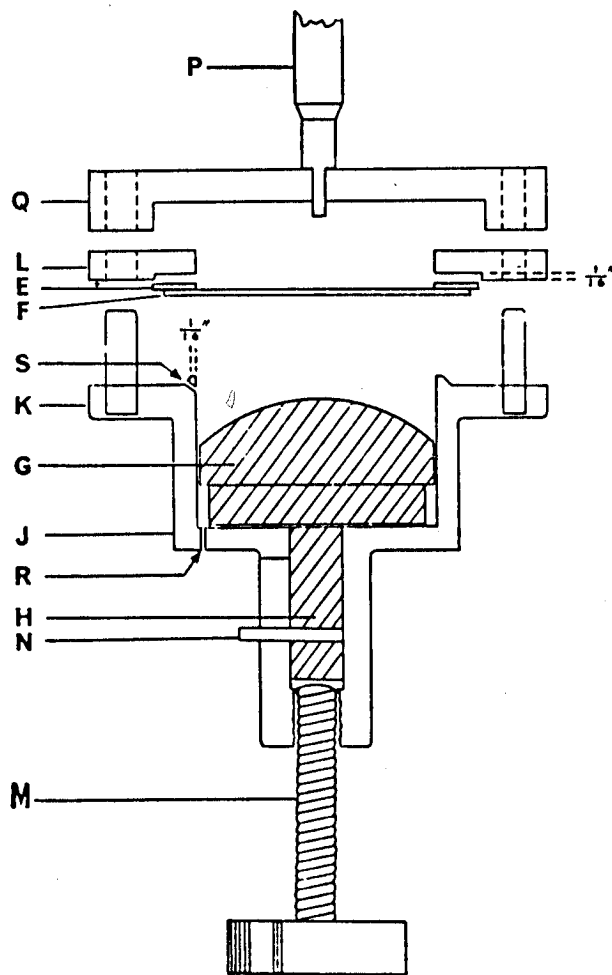


Fig 1 Dome plasticity apparatus

- (3) A metal cylinder J in which the piston and rod slide freely. Air can enter and leave J through the vent R. The cylinder has a pair of clamping rings K, L between which the specimen can be bolted with the aid of wing nuts. The lower clamping ring K is rigidly attached to the cylinder and has a raised internal edge of width 1.6 mm. Through this is a second air vent S. The upper clamping ring has a recess in which the specimen ring fits. When the specimen ring is clamped between the clamping rings, the axes of the cylinder and of the three rings are collinear and the piston is a sliding fit in them.
- (4) A loading screw M which bears against the rod of the piston and forces it upwards. The smaller rod N allows the piston to be drawn back when the loading screw is withdrawn.
- (5) A micrometer P reading directly to 0.02 mm and to 0.002 mm by estimation. The micrometer is attached to a rigid bridge Q which rests on the upper clamping rings and holds the micrometer directly

over the centre of the ring. When a locking nut has been loosened, the entire micrometer can be raised or lowered relative to the bridge for adjustment of the zero of the scale of heights (see 10.4).

In addition there is required:

(6) A flat brass disk of diameter 95.2 mm.

(7) An oven maintained at $80 \pm 2^\circ \text{C}$. The oven has no forced convection and only a small opening (eg, of area 1 cm^2) to the air outside.

5 Conditions of test

The percentage set of a leather depends upon various factors such as the moisture content of the leather when it is strained in the apparatus, the temperature during straining, the period for which it is strained, the period of recovery and the temperature and moisture content of the leather during the recovery period. Four sets of conditions for the straining are specified in this method of test, corresponding to different initial moisture contents and different temperatures during straining; for each of these sets of conditions, measurements are to be made after two periods of recovery. To make all these measurements four specimens are required.

For some purposes, tests may be made with conditions different from those specified here. If this is done the conditions of test shall be stated in detail when the results of the tests are reported (see 10.5).

6 Preparation of specimens

Cut four specimens as circles of diameter 88.9 mm. Mark them A, B, C and D respectively. Condition them in accordance with SLP 3 and weigh B and D. Condition B and D by suspending them for 48 hours over a saturated solution of sodium chloride in water in a closed vessel which is kept during this period at $20 \pm 2^\circ \text{C}$. Reweigh B and D and calculate their gains of weight as percentages of their initial conditioned weights (see 10.6).

7 Adjustment of the micrometer

7.1 Place the flat brass disk on the raised lip of the lower clamping ring. Place a specimen ring (without a specimen) in the recess of the upper clamping ring and place these two rings on the lower clamping ring, with the specimen ring in contact with the disk. Screw down the wing nuts to clamp the rings.

7.2 Place the bridge and micrometer in position. Loosen the locking nut so that the micrometer is free to slide upwards or downwards. Set the micrometer to zero and slide the entire micrometer down until it makes contact with the disk. Fasten the locking nut and remove the disk, which is merely used for this zero adjustment (see 10.7).

8 Procedure for test

8.1 Cold lasting; specimens A and B

(1) Lay specimen A on a flat surface, grain up.

- (2) Put a thin layer of adhesive on one side of a specimen ring (see 10.8). Put the specimen, with ring and specimen concentric, and press them together to make a joint with the aid of the adhesive. Care must be taken that no sliding occurs, causing adhesive to be smeared on the free surface of the specimen.
- (3) After the adhesive has set, transfer the specimen and ring to the dome plasticity apparatus, clamping them between the clamping rings and screwing the wing nuts down firmly by hand (see 10.9).
- (4) Place the bridge and micrometer in position and set the micrometer to 13.6 ± 0.02 mm.
- (5) Using the loading screw, raise the piston as rapidly as possible until the surface of the leather is seen just to make contact with the micrometer. In making this setting, keep the eyes at the level of the top of the domed leather and view the gap between micrometer and leather. Note the time when contact is made; this is the beginning of the period when the specimen is strained in the apparatus (see 10.10 and 10.11).
- (6) Unless otherwise specified, keep the specimen extended for 24 hours in the apparatus in the standard atmosphere for conditioning. At the end of this period, screw back the loading screw and withdraw the piston.
- (7) After a further period of 24 hours, measure the height h_2 of the dome, and use this with the initial height h_1 of 13.6 mm to calculate the percentage set after 24 hours recovery; viz $S = 100(h_2/13.6)^2$.
- (8) After a further period of six days, measure the height of the dome and calculate the percentage set after seven days recovery.
- (9) Test the specimen B as described for specimen A. Although B has been conditioned over sodium chloride solution and not in the standard atmosphere, it is to be kept in the standard atmosphere during straining in the apparatus and during recovery.

8.2 Hot lasting; specimens C and D

- (1) Clamp these specimens and strain them to the standard cap height of 13.6 ± 0.02 mm as described in 8.1 (1)-(5).
- (2) Immediately transfer each specimen and apparatus to the oven which is maintained at 80 °C. After the specimen has been strained for 60 minutes, remove the apparatus from the oven to the standard atmosphere (20 °C, 65% relative humidity).
- (3) After a further period of 120 minutes, screw back the loading screw and withdraw the piston (see 10.12).
- (4) Measure the dome heights 24 hours and seven days after screwing back the loading screw and calculate the percentage set after

24 hours and seven days recovery from these measurements.

9 Reporting results

- 9.1 Report the percentage gain of weight of specimens B and D caused by uptake of water during their conditioning over the salt solution.
- 9.2 For all four specimens, report the temperature and duration of straining, and the percentage sets and corresponding recovery times. If the temperatures, durations, or other conditions used differ from those laid down above, describe them in detail.

10 Notes

- 10.1 Percentage set is not much influenced by the amount of strain imposed initially, if other conditions are constant. The apparatus gives an initial area increase of 15% but the results are a good guide as to the percentage sets which would be obtained with larger or smaller initial strains.
- 10.2 The apparatus is designed by J Bunten. It can be purchased from Satra, Satra House, Rockingham Road, Kettering, Northamptonshire, England.
- 10.3 A suitable material is 'Tufnol' (Tufnol Limited, Birmingham).
- 10.4 Since the specimen is cemented to the specimen ring, these can be removed from the apparatus during the recovery periods (see 8.1 (7) and (8)) and subsequently replaced for the measurements of dome heights. The apparatus is thus freed for use meanwhile with other specimens and rings.
- 10.5 With the development of new lasting machines and methods, lasting of uppers at different moisture contents and different temperatures occurs. To simulate these lasting conditions it may be desirable to use other methods of conditioning or other temperatures of test than those specified in the method.
- 10.6 A saturated solution of sodium chloride gives a relative humidity of approximately 76%.
- 10.7 The zero adjustment need only be made once, if the locking screw is then tightened to prevent movement.
- 10.8 Nitrocellulose cement is suitable for most leathers. The layer of cement should be thin, to avoid pressing excess cement on to the free area of the specimen within the ring.
- 10.9 Each nut is first to be screwed down to make loose contact with the top clamping ring. To avoid tilting and bending the ring, the nuts are then screwed down by turning each in succession by a small amount and repeating this until they are tight.

- 10.10 The piston is raised as rapidly as possible because the leather is, in any case, stretched more slowly than during lasting in a shoe factory. Care must be taken not to overshoot; it is not permissible to raise the piston above the 13.6 mm mark and then return to it.
- 10.11 Because the leather is nipped between the raised lip of the lower clamping ring and the specimen ring, the height of the centre of the specimen is not usually zero before the piston is raised, but this is to be ignored for test purposes.
- 10.12 This further period of 120 minutes allows the specimen to cool in the strained state on the apparatus. After hot lasting in shoe factories there is often a corresponding delay before the shoes are removed from the lasts.