British Standard Methods of test for

Footwear and footwear materials

Part 4. Other components

Section 4.18 Longitudinal stiffness of steel shanks

Méthodes d'essai des chaussures et des matériaux entrant dans leur confection
Partie 4. Autre composants
Section 4.18 Rigidité longitudinale des tiges de renforcement en acier

Prüfverfahren für Fussbekleidung und Fussbekleidungswerkstoffe
Teil 4. Sonstige Bestandteile
Abschnitt 4.18 Längssteifigkeit von Gelenkeinlagen aus Stahl

NOTE. It is recommended that this Section should be read in conjunction with the information in the General introduction to BS 5131, published separately.

1 Scope

This Section of BS 5131 : Part 4 describes a method for measurement of the stiffness in the longitudinal direction of steel shanks used for the reinforcement of the waist region of women's, and some men's and children's shoes.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

2 Principle

The shank is clamped at its heel end and bent as a cantilever beam by masses added to its forward end. The amount of bending is measured and used to calculate the flexural rigidity of the shank, a quantity which is a measure of stiffness and which is dependent on the metal of the shank and its cross section, but not on its length.

3 Apparatus

The general layout of a suitable apparatus is shown in figure 4.18/1*. It consists of an adjustable heel end clamp A, a loading clamp B plus weights, and a dial gauge C to measure the deflection.

The clamp at the heel end of the shank is shown in more detail in figure 4.18/2.

It consists of two jaws each measuring 32 mm from front to back. Each jaw has two bars or flat ridges across it which grip the shank. All four ridges are 6 mm from front to back. The front ridge of the upper jaw has a groove cut in it across the centre of the ridge which is 6 mm wide and 4 mm deep.

NOTE. This groove is to accommodate the fluting on the shank, as it has been found that more consistent results are obtained if the shank is not clamped on top of the fluting but immediately on each side of it. Should a shank be of unusual design so that this size of groove will not accommodate the fluting, a new grooved upper clamp should be made which will accommodate it. The lower front ridge is bevelled, as shown in figure 4.18/2, so that shanks with curved rear ends cannot rest on its rear edge.

The heel-end clamp is adjustable by rotation about a transverse axis D (see figure 4.18/1) so that the clamped shank E can be made to lie horizontal. In order to achieve this for shanks for high heeled shoes it is necessary that the maximum angle of rotation of the clamp from the horizontal shall be at least 30 ° when the back of the clamp is raised.

*For information on the availability of a metal shank stiffness tester apply to Enquiry Section (London), British Standards Institution, enclosing a stamped addressed envelope for reply.

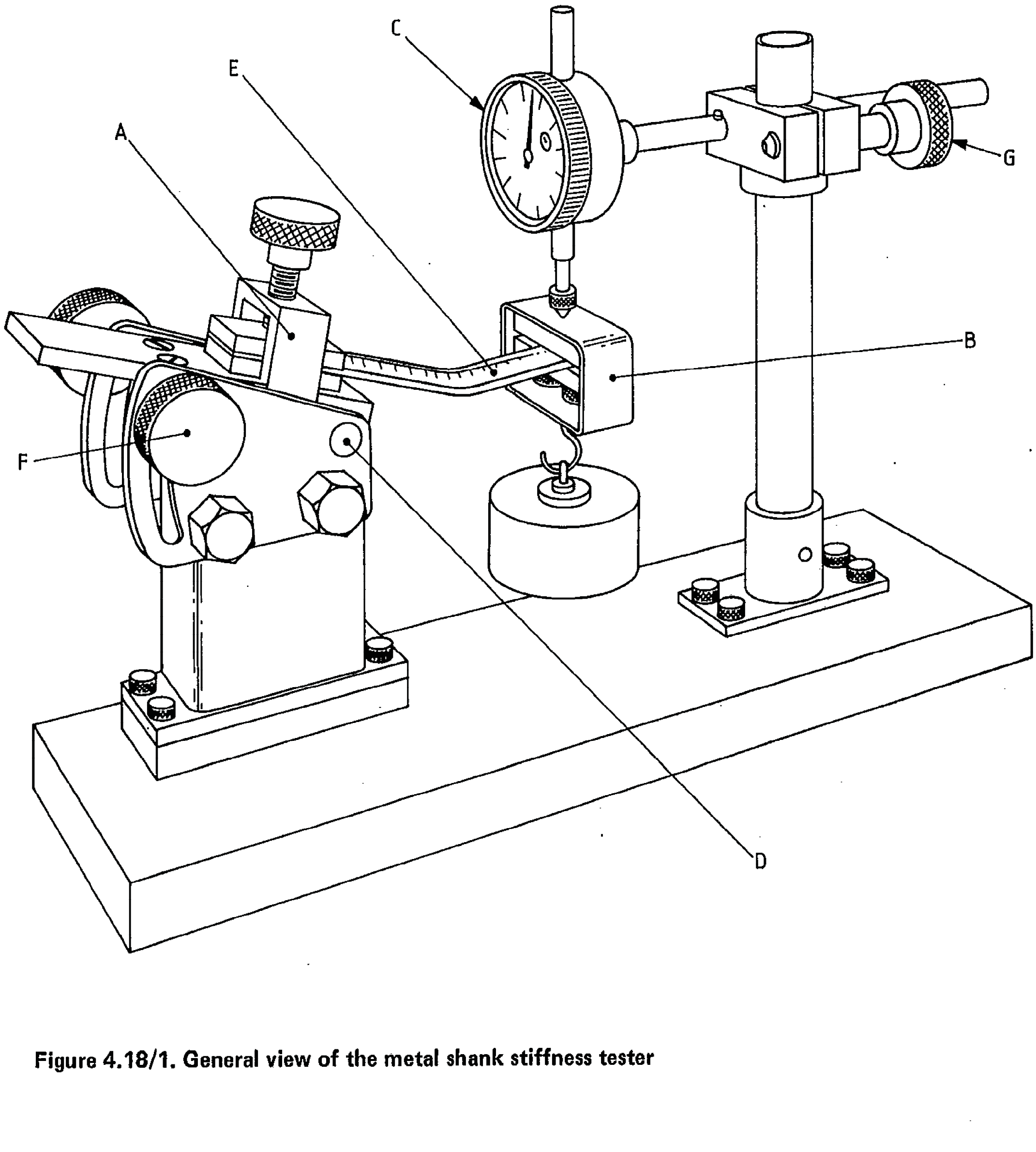
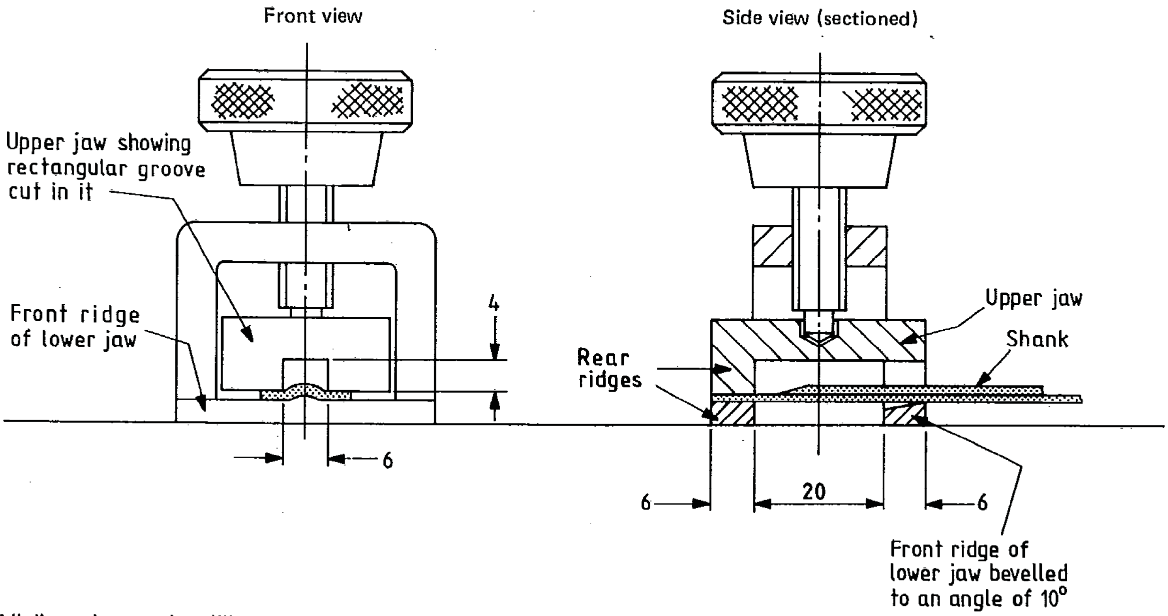


Figure 4.18/1. General view of the metal shank stiffness tester



All dimensions are in millimetres.

Figure 4.18/2. Details of clamp for the heel end of the shank

The clamp for the front end of the shank consists of two parts and is shown in figure 4.18/3. This clamp consists of two flat jaws of depth 12 mm. The lower jaw is about 6 mm wider on each side than the upper and has a V-shaped groove cut into its upper surface across its full width and centrally between its two edges. This jaw supports a stirrup from which the weights are hung which bend the shank in the test. The stirrup has two inward pointing horizontal co-axial pins fixed to the two sides, and these rest in the groove on the top surface of the lower jaw. The diameter of the pins and the size of the groove are so chosen that the axis of the pins is 0 mm to 1.0 mm above the top surface of the lower jaw.

A dial gauge reading in hundredths of a millimetre, to measure the deflection of the shank under load, is positioned so that its ball ended measuring foot rests on the centre of the top face of the loading stirrup. This measures the deflection of the shank under load.

The stirrup serves two purposes:

(a) it provides a surface for the measurement of deflection, which remains horizontal as the shank bends;

(b) it ensures that the line of action of the deforming force passes through the same point on the shank as it bends, in such a way that the moment length of the bending force is kept constant during the test.

4 Procedure

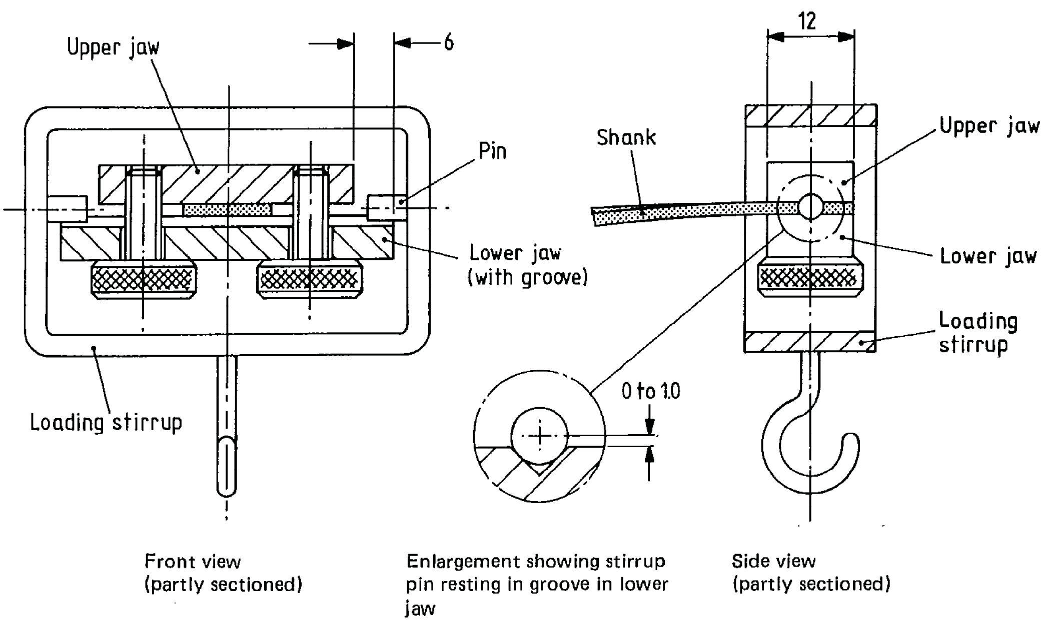
With the underside of the shank uppermost (which is normally the fluted side), insert the heel end centrally in its clamp so that the end of the shank is flush with the back of the clamp and the centreline of the shank is perpendicular to the clamp edge (see figure 4.18/2). Screw the clamp down firmly, to ensure that 32 mm of shank is clamped. For heels or shanks of unusual dimensions the length clamped may be changed to correspond to what is to be used in the shoe.

Fix the loading clamp firmly to the other end of the shank with the wider jaw (having the groove cut in it) on the under side. The loading clamp is normally positioned so that the end of the shank is flush with the edge of the clamp. However, in the case of shanks intended for high heeled footwear, it is often better if the shank end protrudes about 5 mm beyond the clamp.

NOTE. This protrusion may make it easier to clamp the shank firmly and brings the loading clamp nearer to the horizontal during the test, which is an advantage. It does not affect the value of flexural rigidity obtained.

Hang the loading stirrup from this clamp as shown in figure 4.18/3.

Adjust the angle of the rear clamp so that the part of the shank between the two clamps is horizontal, as judged by eye (see figure 4.18/1). Tighten the two finger knobs F



All dimensions are in millimetres.

Figure 4.18/3. Details of clamp for the front end of the shank

which hold the rear clamp in position. Position the dial gauge so that its shaft is vertical and in line with the centre of the top face of the loading stirrup. Lower the dial gauge until the large pointer has rotated at least twice, i.e. 2 mm of movement and clamp by tightening G.

Load the shank by hanging a 200 g mass on the hook on the loading stirrup. After 5 s take the dial reading, a_1, to the nearest hundredth of a millimetre, tapping the base of the instrument first to ensure that the gauge does not stick. Remove the mass and replace with one of 400 g mass so that the time interval between adding the first and second is 10 s. After 5 s take the second dial reading, a_2. Similarly take the dial readings a_3 and a_4 for masses of 600 g and 800 g respectively. Check the correctness of all these readings by checking that $a_4 - a_3$, $a_3 - a_2$ and $a_2 - a_1$ are approximately equal.

Remove the loading stirrup and measure in millimetres the distance between the front edge of the rear clamp and the rear edge of the loading clamp using internal callipers. Take one reading above the shank and one below, and calculate the average. To this value add half the depth of the loading clamp (that is, 6 mm), to obtain the moment length of the shank.

Test two other shanks in the same way.

5 Calculation and expression of results

The flexural rigidity S of a beam is given by the equation:

$$S = YAk^2$$

where

Y is Young's modulus for the material of the beam;

A is the cross-sectional area of the beam;

k is the radius of gyration of the beam cross section about its neutral axis.

For a cantilever beam the flexural rigidity S (in kN·mm^2) is given by the equation

$$S = \frac{9.81}{10^6} \times \frac{WL^3}{3a}$$

where

W is the load (in g);

a is the deflection produced (in mm);

L is the moment length (in mm).

The flexural rigidity of the shank is calculated from the experimentally obtained values of W, a and L by substitution in the above equation.

If W is taken as 200 g gravitational force, then the most accurate statistical estimate of the corresponding value of a is obtainable from the four readings of deflection as follows.

(a) Where the type of dial gauge used is one whose readings increase as the shank bends (that is, increase as the foot moves down) the deflection a (in mm) is given by the equation

$$a = \frac{1}{10}(3a_4 + a_3 - a_2 - 3a_1)$$

where

a is the deflection (in mm) produced per 200 g gravitational force;

a_4 is the dial reading (in mm) produced by hanging a 800 g mass on the loading stirrup;

a_3 is the dial reading (in mm) produced by hanging a 600 g mass on the loading stirrup;

a_2 is the dial reading (in mm) produced by hanging a 400 g mass on the loading stirrup;

a_1 is the dial reading (in mm) produced by hanging a 200 g mass on the loading stirrup.

(b) Where the type of dial gauge used is one whose readings decrease as the shank bends (that is, decrease as the foot moves down) the deflection a (in mm) is given by the equation

$$a = \frac{1}{10}(3a_1 + a_2 - a_3 - 3a_4)$$

where a, a_1, a_2, a_3 and a_4 are as defined in (a) above.

(c) Calculate the values of S (in $kN \cdot mm^2$) for the three shanks separately, and take the average. Record the result to two significant figures if the result is less than 1, or to three significant figures if greater than 1.

6 Test report

Include the following information in the test report:

(a) the shank reference;

(b) the longitudinal stiffness of the shank as determined in accordance with clause **5**;

(c) reference to the method of test, i.e. BS 5131 : Section 4.18;

(d) any deviations from the test procedure, in particular the length of shank which is clamped if this is not 32 mm.

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British Standards Institution · 2 Park Street London W1A 2BS · Telephone 01-629 9000 · Telex 266933

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