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Footwear — Resistance to crack initiation and growth — Belt flex method

Chaussures — Résistance à la fissuration et à sa croissance — Méthode de flexion de la ceinture

Reference number
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Foreword

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Footwear — Resistance to crack initiation and growth — Belt flex method

1 Scope

This International Standard specifies a test method for determining the resistance of a component or material to crack initiation and growth due to repeated flexing. The method is mainly applicable to outsoles of footwear but may also be used with certain other flexible components.

2 Apparatus and materials

2.1 Flexing machine with:

2.1.1 Free wheeling, slightly crowned flexing roller, with a width of (170 ± 20) mm and

— for high performance soles,

diameter at its centre (60,0 ± 0,5) mm,

diameter at its ends (57 ± 1) mm;

NOTE This roller will normally only be used for footwear which is expected to be subjected to abnormally high flexing demands.

— for typical sole units,

diameter at its centre (90,0 ± 0,5) mm,

diameter at its ends (87 ± 1) mm;

— for soles with a thickness greater than 15 mm,

diameter at its centre (120,0 ± 0,5) mm,

diameter at its ends (117 ± 1) mm.

2.1.2 Driven, slightly crowned roller, with a diameter of (225 ± 5) mm and a width of (170 ± 20) mm.

2.1.3 Flexible continuous belt of cotton canvas of length (1 930 ± 50) mm and width (140 ± 5) mm which passes over the two rollers (2.1.1) and (2.1.2). The cotton canvas is 2-ply 100 % cotton belting having a mass per unit area of (500 ± 25) g/m^2 and an extension at break along the belt of (14 ± 2) % at a breaking force of (2 000 ± 200) N. The corresponding across-the-belt values are (14 ± 2) % and (750 ± 50) N.

2.1.4 Means of driving the larger roller (2.1.2) at a speed of (247 ± 20) r/min so that the belt (2.1.3) completes (90 ± 8) flexing cycles per minute.

2.1.5 Method of counting the number of cycles completed by the belt (2.1.3).

2.2 Polyurethane adhesive system to bond the test specimen to the surface of the belt (2.1.3), consisting of:

2.2.1 Pre-reacted PU adhesive.

2.2.2 Single-component PU adhesive.

2.3 Cutting device, such as a sharp knife or scalpel, capable of cutting test specimens.

2.4 Smooth-surfaced hand tool for the application of localized pressure by a rubbing action.

NOTE A rapid acting platen press with the capability of applying a pressure of (500 ± 50) kPa over the whole area of the test specimen may be suitable for some types of sole specimen.

2.5 Means of heating adhesive film, for activating adhesive film or removing samples from the belt. This can be achieved by using a hot air gun or an oven set at 50 °C. Heat should be applied in short bursts to prevent partial melting of soles.

NOTE Commercial equipment for heat reactivating outsoles and uppers in production is suitable.

2.6 Method of checking that the temperature of the adhesive film is within the range between 80 °C and 90 °C. Heat sensitive crayons, such as Tempilstik[1)], are suitable, preferably with a melting temperature of 83 °C.

2.7 Primers.

2.7.1 Vulcanized and thermoplastic rubber test specimens. A halogenation primer for rubber will be necessary for producing satisfactory bonds.

2.7.2 EVA test specimens. An EVA primer will be necessary for producing satisfactory bonds.

2.8 Device, such as a T square, with an internal angle of (90 ± 1)°.

2.9 Device for checking whether the depth of a crack is greater than 1,5 mm. A thin strip of metal with a length scale or stepped thickness is suitable.

3 Principle

A test specimen is bonded with a strong adhesive to a continuous belt, which is driven around two rollers. The spacing and radius of the rollers is such that the test specimen is repeatedly subjected to a short period of rapid flexing followed by a longer period unflexed as the belt passes around the rollers, which simulates the wear conditions of a footwear outsole. The specimen is flexed for a fixed number of cycles and the number of cracks that form and their severity is recorded.

4 Preparation of test specimens

4.1 If the test specimen has been moulded, then the time between moulding and testing should be at least 48 h.

4.2 If the test specimen is an outsole attached to a made item of footwear:

— cut off the upper just above the level of the insole;

— remove the insole;

— scour or rough away the lasted margin of the upper, taking care not to damage the outsole;

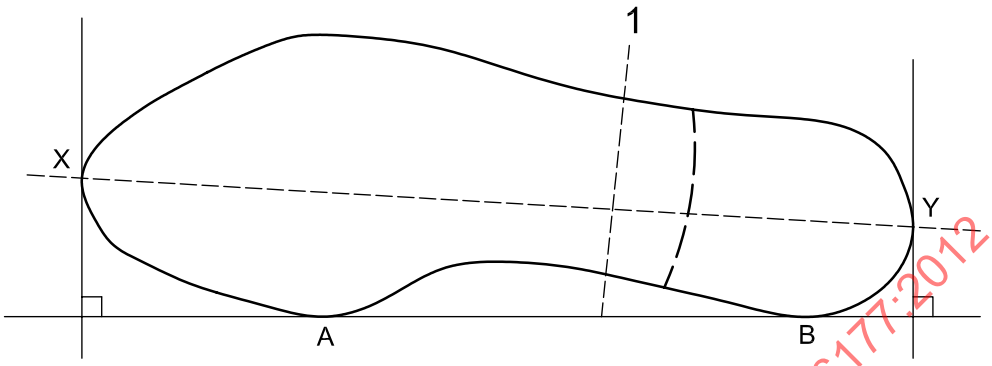
— check for the presence of a metallic penetration-resistant insert.

Do not use heat to soften the bond of the outsole to the upper as this may damage the outsole.

1) Tempilstik is an example of a suitable product available commercially. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of this product.

4.3 Mark the toe-heel centre line on the outer surface of the outsole as follows.

4.3.1 Place the points A and B (see Figure 1) on the inside edge of the outsole against the longer edge of the T square (2.8) and the toe against the shorter edge.



Key

1 cut as described in 4.4

Figure 1 — Marking and cutting of test specimen (see also Figure 42 of ISO 20344:2011)

4.3.2 Make a mark on the toe at the point that is in contact with the shorter edge of the T square.

4.3.3 Repeat the procedure described in 4.3.1 and 4.3.2 for the heel of the test specimen.

4.3.4 Mark a line between the point at the heel and the point at the toe, XY in Figure 1.

4.4 Cut off the heel and part of the waist portion so as to leave 10mm to 20 mm length of the waist on the forepart (see Figure 1).

4.5 If the edge of the forepart on the reverse side is cupped or includes any form of rand or imitation welt, scour this off until this surface is flat. Do not remove ribs in the central section of the outsole on the reverse side.

4.6 For outsoles which are thicker than 15 mm, reduce the thickness to 15 mm before preparation in order to ensure reasonable flexibility. In such cases, it will be necessary to use the 120 mm diameter flexing roller (2.1.1). Outsoles containing a metal insert are also tested using the 120 mm roller.

NOTE To help prevent thick soles peeling from the belt during the test, it is acceptable to taper the thickness at the extreme ends of the specimen (toe and waist) by scouring material away from the outside surface for a length of not more than 2,5 cm from each end, which will alleviate the flexing stress on the bond.

4.7 Prepare the reverse side of the forepart for bonding as follows.

4.7.1 Cellular polyurethane outsoles: lightly scour the whole of the surface.

4.7.2 Vulcanized and microcellular rubber: lightly scour the whole of the surface, then scrub it with a halogenation primer for rubber (2.7) using a stiff brush. Leave to dry for between 15 min and 8 h before applying any adhesive.

4.7.3 Thermoplastic rubber: lightly coat the whole of the reverse surface with a halogenation primer for rubber (2.7) using a soft brush. Leave to dry for between 30 min and 8 h before applying any adhesive.

4.7.4 Microcellular EVA: lightly scour the whole of the reverse surface, then coat it with an EVA primer (2.7) using a soft brush. Leave to dry for between 30 min and 8 h before applying any adhesive.

4.7.5 PVC and solid (thermoplastic) PU: wipe the whole of the reverse surface with butan-2-one (methyl ethyl ketone, MEK). Leave to dry for between 15 min and 1 h before applying any adhesive.

5 Procedure

5.1 In order to prepare the belt for test, proceed as follows.

5.1.1 Cut a strip of cotton canvas fabric (140 ± 5) mm × (2 000 ± 20) mm, and mark its centre on both sides.

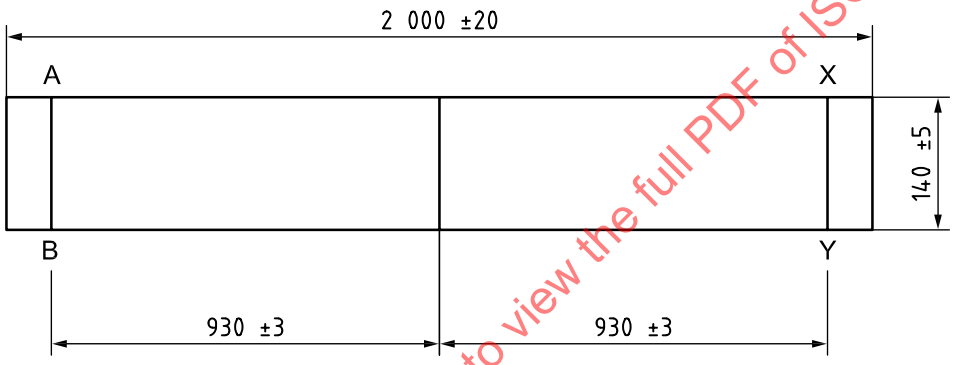
5.1.2 Draw two lines across the strip of fabric (see Figure 2):

— at 90° to the longer edges of the strip;

— one line (930 ± 3) mm on either side of the centre of the strip;

— one line on the upper surface and the other on the lower surface.

Dimensions in millimetres



NOTE Line AB should be drawn on the opposite surface to line XY.

Figure 2 — Diagram for marking lines on the belt

5.1.3 A belt used for previous tests can be reused provided that it is not excessively frayed and there is a sufficiently large unused area for the new test specimens.

5.2 Place the specimens to be tested (see Figure 3) onto the belt so that:

— their wearing surfaces are uppermost;

— they are evenly spaced between the two lines (5.1.2);

— they are no closer than 50 mm to each other or the lines (5.1.2);

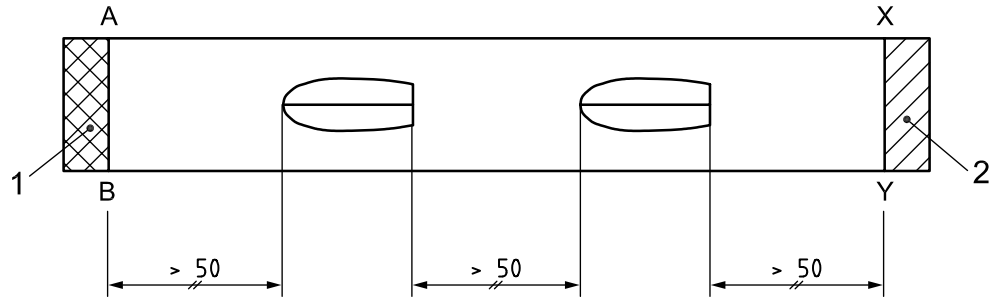
— they are centred across the width of the belt;

— their toes are pointing in the same direction;

— their centre line (4.3.4) is parallel to the longer edge of the belt;

— they do not cover any previously used areas of the belt.

Dimensions in millimetres



Key

1 adhesive applied to the same surface as line AB

2 adhesive applied to the same surface as line XY

NOTE AB and XY are on opposite surfaces.

Figure 3 — Diagram for placing the specimens on the belt

5.3 Mark the perimeter of each test specimen on the belt.

5.4 Apply the pre-reacted adhesive (2.2.1) to the surface of the belt over:

— the whole area of each of the marked specimen positions;

— the area between the lines (5.1.2) and the ends of the belt (on opposite surfaces at one end to the other).

5.5 Apply a coat of the PU adhesive (2.2.2) to:

— the prepared surface of each test specimen;

— the areas of the belt coated as described in 5.4;

and leave to dry for about 15 min.

5.6 Use the heater (2.5) to heat the adhesive on one of the test specimens to a temperature of between 80 °C and 85 °C, as indicated by the crayon (2.6). At the same time, heat the corresponding area of the belt to be bonded to the same temperature.

5.7 Immediately position the test specimen on the corresponding warmed area of the belt so that the specimen is aligned with its previously drawn outline (5.3). Apply enough pressure by hand to bond the specimen to the belt.

NOTE This can be achieved by turning the belt over and applying localized pressure to the back of the belt by rubbing into the inside surface of the sole. A hand tool with a smooth-faced surface can aid this process.

5.8 Repeat the procedure described in 5.6 to 5.7 for any remaining test specimens.

5.9 Fold the belt so that the two ends are together and use the heater (2.5) to simultaneously heat the adhesive on both ends of the belt to a temperature of between 80 °C and 85 °C, as indicated by the crayon (2.6).

5.10 Apply enough pressure by hand to bond the belt together and complete the bonding by applying localized pressure.

NOTE Rubbing using a hand tool with a smooth-faced surface can aid this process.

5.11 Store the prepared belt in a standard controlled environment of (23 ± 2) °C and (50 ± 2) % RH for at least 16 h to allow the adhesive to set.

5.12 If the test specimens are particularly hard or stiff, it may also be necessary to use an additional form of mechanical fastening between the specimen and belt at each end of the specimen. A row of stitching is convenient.

5.13 Fit the prepared belt over the two rollers of the machine (2.1) so that as the machine operates the toe of each specimen approaches the rollers and the flexing line runs from the toe to the heel.

5.14 Adjust the tension of the belt so that it is just taut.

5.15 Operate the machine (2.1) until the belt has completed the first test cycle (see 5.18).

5.16 Slowly move the belt round by hand and inspect the surface of each test specimen for signs of cracking as it passes over the flexing roller (2.1.1). If any cracks are found, record their position, their length to the nearest 1 mm and their depth as either:

— superficial (up to 0,5 mm);

— shallow (0,5 mm to 1,5 mm);

— moderate (1,5 mm to half the thickness of the test specimen);

— deep (greater than half the thickness of the test specimen).

Use the device (2.9) to quantitatively judge the transition between shallow and moderate depths. All other transitions can be subjectively judged visually. It may be convenient to record the position of any cracking by laying a piece of thin paper over the test specimen and tracing any surface pattern together with the cracks. Alternatively, digital photography can be employed to illustrate the crack positions by marking these onto a plan view image of the unflexed sole.

5.17 Check and, if necessary, adjust the tension of the belt. Also check the bond between the ends of each of the test specimens and the belt. If the length of separation between the toe and the belt is more than 10 mm, it is recommended that the test be interrupted while the affected area of the specimen is reattached.

5.18 Start the machine again and repeat the procedure described in 5.16 at intervals that are considered to give sufficient information about the rate of crack growth. It is recommended that the test specimen is inspected after a total of 2 500, 5 000, 10 000, 20 000, 30 000, 40 000 and 50 000 cycles.

5.19 After analysis is complete, and if the belt is required to be used again, remove the test specimens from the belt by heating the adhesive bond from the belt side with the heater (2.5) for approximately 40 s. The adhesive should then be soft enough for the specimens to be peeled off.

6 Test report

The test report should include, at least, the following:

a) reference to this International Standard, i.e. ISO 16177:2012;

b) complete description of the test specimen;

c) diameter of the flexing roller (2.1.1) used;

d) number of flexing cycles to which the specimens were subjected;

e) damage to the specimen at each inspection stage, as determined in 5.16;

f) temperature of the test (°C);

g) any deviations from this test method.