INTERNATIONAL STANDARD

ISO 20344

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Personal protective equipment — Test methods for footwear

Équipement de protection individuelle — Méthodes d'essais pour les chaussures

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 20344 was prepared by the European Committee for Standardization (CEN) in collaboration with Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 3, *Foot protection*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this document, read "...this European Standard..." to mean "...this International Standard...".

This first edition of ISO 20344 cancels and replaces ISO 8782-1:1998, which has been technically revised.

For the purposes of this International Standard the CEN annex regarding fulfilment of European Council Directives has been removed.

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Foreword

This document (EN ISO 20344:2004) has been prepared by CEN /TC 161, "Foot and leg protectors", the secretariat of which is held by BSI in collaboration with ISO/TC 94 "Personal safety - Protective clothing and equipment".

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2005, and conflicting national standards shall be withdrawn at the latest by August 2005.

This document supersedes EN 344:1992 and EN 344-2: 1996.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom

1. Scope

This Standard specifies methods for testing footwear designed as personal protective equipment.

2. Normative references

The following referenced documents are indispensable for the application 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.

EN 388:1994, Protective gloves against mechanical risks

EN 12568:1998, Foot and leg protectors — Requirements and test methods for toecaps and metal penetration resistant inserts

EN 50321:1999, Electrically insulating footwear for working on low voltage installations

EN ISO 868, Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness) (ISO 868:2003)

EN ISO 3696, Water for analytical laboratory use – Specification and test methods (ISO 3696:1987)

EN ISO 3376:2002, Leather — Physical and mechanical tests - Determination of tensile strength and percentage extension (ISO 3376:2002)

EN ISO 3377-2, Leather - Physical and mechanical tests - Determination of tear load (ISO 3377-2: 2002)

EN ISO 4044, Leather — Preparation of chemical test samples (ISO 4044:1977)

EN ISO 4045, Leather — determination of pH (ISO 4045:1977)

EN ISO 4674-1:2003, Rubber- or plastics-coated fabrics - Determination of tear resistance - Part 1: Constant rate of tear methods (ISO 4674-1:2003)

EN ISO 17249:2004, Safety footwear with resistance to chain saw cutting (ISO 17249: 2004)

EN ISO 20345, Personal protective equipment - Safety footwear (ISO 20345:2004)

EN ISO 20346, Personal protective equipment - Protective footwear (ISO 20346:2004)

EN ISO 20347, Personal protective equimpent - Occupational footwear (ISO 20347:2004)

ISO 34-1:1994, Rubber, vulcanised or thermoplastic — Determination of tear strength — Part 1 : Trouser, angle and crescent test pieces

ISO 1817:1999, Rubber, vulcanised — Determination of the effect of liquids

ISO 2023:1994, Rubber footwear - Lined industrial vulcanized rubber boots - Specification

ISO 3290, Rolling bearings — Balls — Dimensions and tolerances

ISO 4643:1992, Moulded plastic footwear — Lined or unlined poly(vinyl chloride) boots for general industrial use — Specification

ISO 4648:1991, Rubber, vulcanized or thermoplastic — Determination of dimensions of test pieces and products for test purposes

ISO 4649:2002, Rubber, vulcanized or thermoplastic — Determination of abrasion resistance using a rotating cylindrical drum device

ISO 5423:1992, Moulded plastic footwear — Lined or unlined polyurethane boots for general industrial use — Specification

3. Terms and definitions

For the purposes of this standard, the terms and definitions given in EN ISO 20345, EN ISO 20346 and EN ISO 20347 shall apply.

4. Sampling and conditioning

The minimum numbers of samples to be tested in order to check compliance with the requirements specified in EN ISO 20345, EN ISO 20346, EN ISO 20347 and any specific job related footwear standards (e.g. EN ISO 17249 footwear with resistance to chain saw cutting), together with the minimum number of test pieces taken from each sample, shall be in accordance with Table 1.

Table 1 — Minimum number of samples and test specimens or test pieces and their origin

	Property under test **B : basic requirement** **A : additional requirement**		**Clause reference**	**Number of samples**	**Number of test pieces from each sample**	**Test only on the final footwear**
5. Whole footwear	Specific ergonomic features	B	5.1	3 pairs from 3 different sizes	1 pair	yes
	Upper/outsole and sole interlayer bond strength	B	5.2	1 from each of 3 sizes	1	yes
	Internal toecap length	B	5.3	1 pair from each of 3 sizes	1 pair	yes
	Impact resistance	B	5.4	1 pair from each of 3 sizes	1 pair	yes
	Compression resistance	B	5.5	1 pair from each of 3 sizes	1 pair	yes
	Corrosion resistance of metallic toecaps or penetration-resistant metallic inserts	B	5.6	2 from different sizes	1	No for classification I Yes for classification II
	Leakproofness	B	5.7	2 from different sizes	1	yes
	Dimensional conformity and penetration resistance of inserts	A	5.8	1 pair from each of 3 sizes	1 pair	yes
	Flex resistance of penetration-resistant insert	A	5.9	1 pair from each of 3 sizes	1 pair	no
	Electrical resistance	A	5.10	1 pair from each of 3 sizes	1 pair	yes
	Electrical insulation	A	5.11	1 pair from each of 3 sizes	1 pair	yes
	Insulation against heat	A	5.12	2 from different sizes	1	yes
	Insulation against cold	A	5.13	2 from different sizes	1	yes
	Energy absorption of seat region	A	5.14	1 pair from each of 3 sizes	1 pair	yes
	Water resistance	A	5.15	3 pairs (minimum 2 different sizes)	1 pair	yes
	Impact resistance metatarsal protective device	A	5.16	1 pair from each of 3 sizes	1 pair	yes
	Ankle protection	A	5.17	1 pair from each of 3 sizes	1 pair	yes

Table 1 (continued)— Minimum number of samples and test specimens or test pieces and their origin

	Property under test B : basic requirement		Clause reference	Number of samples	Number of test pieces from each sample	Test only on the final footwear
6. Upper Lining And Tongue	Thickness	B	6.1	1 from each of 3 sizes	3	yes
	Height of the upper	B	6.2	1 from each of 3 sizes	3	yes
	Tear strength	B	6.3	1 from each of 3 sizes	3	yes
	Tensile properties	B	6.4	1 from each of 3 sizes	3	yes
	Flexing resistance	B	6.5	1 from each of 3 sizes	1	yes
	Water vapour permeability	B	6.6	1 from each of 3 sizes	1	yes
	Water vapour absorption	B	6.7	1 from each of 3 sizes	1	yes
	Water vapour coefficient	B	6.8	1 from each of 3 sizes	1	yes
	pH value	B	6.9	1	2	no
	Hydrolysis	B	6.10	1 from each of 3 sizes	1	yes
	Chromium VI content	B	6.11	1	2	no
	Abrasion resistance of lining	B	6.12	3	4	no
	Water penetration and water absorption	A	6.13	3	1	no
	Cut resistance	A	6.14	3	4	yes
7. Insole and Insock	Thickness of insole	B	7.1	3 [a]	1	no
	pH value	B	6.9	1	2	no
	Water absorption and desorption	B	7.2	3 [a]	1	no
	Abrasion resistance of insole	B	7.3	3 [a]	1	no
	Chromium VI content	B	6.11	1	2	no
	Abrasion resistance of insock	B	6.12	3	4	no
8. Outsole	Thickness	B	8.1	1 from each of 3 sizes	1	yes
	Tear strength	B	8.2	1 from each of 3 sizes	1	yes
	Abrasion resistance	B	8.3	1 from each of 3 sizes	1	yes
	Flexing resistance	B	8.4	1 from each of 3 sizes	1	yes
	Hydrolysis	B	8.5	1 from each of 3 sizes	1	yes
	Resistance to fuel oil	B	8.6	1 from each of 3 sizes	1	yes
	Resistance to hot contact	A	8.7	1 from each of 3 sizes	1	yes

[a] if the samples are taken from the footwear use 3 different sizes

Wherever possible and necessary to ensure the essential safety requirements, test pieces shall be taken from the whole footwear. This paragraph is applicable for all the table 1.

NOTE If it is not possible to obtain a large enough test piece from the footwear, then a sample of the material from which the component has been manufactured may be used instead and this should be noted in the test report.

Where samples are required from each of three sizes, these shall comprise the largest, the smallest and a middle size of the footwear under test.

All test pieces shall be conditioned in a standard atmosphere of (23°± 2) °C and (50 ± 5)% r.h. for a minimum of 48 h before testing, unless otherwise stated in the test method.

The maximum time which shall elapse between removal from the conditioning atmosphere and the start of testing shall not be greater than 10 min, unless otherwise stated in the test method.

Each individual test piece shall satisfy the specified requirement, unless otherwise stated in the test method.

The uncertainty of measurement for each test method described in the present standard shall be assessed. One of the two following approaches shall be used:

— a statistical method, e.g. that given in ISO 5725-2;

— a mathematical method, e.g. that given in ENV 13005.

5. Test methods for whole footwear

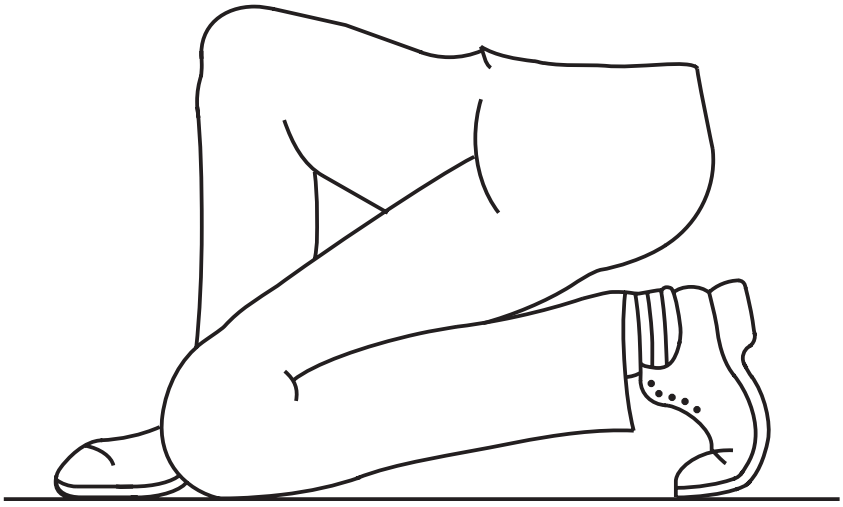
5.1 Specific ergonomic features

The specific ergonomic features of the footwear shall be assessed by examining the footwear using wear trials on 3 wearers with appropriate foot sizes.

During the trials the wearers wearing each pair of the correctly fitting footwear will simulate typical tasks likely to be undertaken in general use.

These tasks are :

- walk normally for 5 min at a speed of approx. 6 km/h.
- climb and descend (17 ± 3) stairs for 1 min
- kneel / crouch down, see figure 1



Note : This degree of shoe flexion will not be achieved for all types of footwear (for example footwear with a steel midsole)

Figure 1 - Position to adopt during the kneel / crouch down test

After having completed all tasks, each wearer shall fill in the questionnaire given in table 2.

Table 2 : Questionnaire for the assessment of ergonomic features

1.	Is the inside surface of the footwear free from rough, sharp or hard areas that caused you irritation or injury?	YES	NO
2	Are there no pinch points caused by the toecap or the edge covering of the toecap ?	YES	NO
3.	Is the footwear free of features that you consider to make wearing the footwear hazardous ?	YES	NO
4.	Can the fastening be adequately adjusted ? (if necessary)	YES	NO
5.	Can the following activities be performed without problems :		
	walking	YES	NO
	Climbing stairs	YES	NO
	Kneeling / crouching down	YES	NO

5.2 Determination of upper/outsole and sole interlayer bond strength

5.2.1 Principle

The force required to separate the upper from the outsole or to separate adjacent layers of the outsole or to cause tear failure of the upper or the sole is measured.

NOTE In all cases the objective should be to test the bond strength nearest to the edge of the assembly. The test need not be carried out when the bond has been made by grindery (using, for example, nails or screws) or stitching.

5.2.2 Apparatus

Tensile machine, with a means of continuously recording load, with a jaw separation rate of (100 ± 20) mm/min and a force range of 0 N to 600 N. The machine shall be fitted with either pincers or flat jaws (depending on the construction of the test sample see 5.2.4), (27,5 ± 2,5) mm wide, capable of firmly gripping the test pieces.

5.2.3 Preparation of test pieces

5.2.3.1 Sole/upper bond strength: construction type a (see figure 2)

Take a test piece from either the inner or the outer joint region.

Make cuts at X-X and Y-Y at right angles to the edge of the sole, insole or outsole to produce a test piece about 25 mm wide. The length of the upper and sole shall be about 15 mm measured from the feather line (see figure 3). Remove the insole.

5.2.3.2 Sole/upper bond strength: construction types b, c, d and e (see figure 2)

Take a test piece from either the inner or outer joint region.

Cut the upper and sole at X-X and Y-Y to produce a test piece with a width of about 10 mm and a length of not less than 50 mm. Remove the insole.

Separate the upper from the sole for a length of about 10 mm by inserting a hot knife in the adhesive layer (see figure 4).

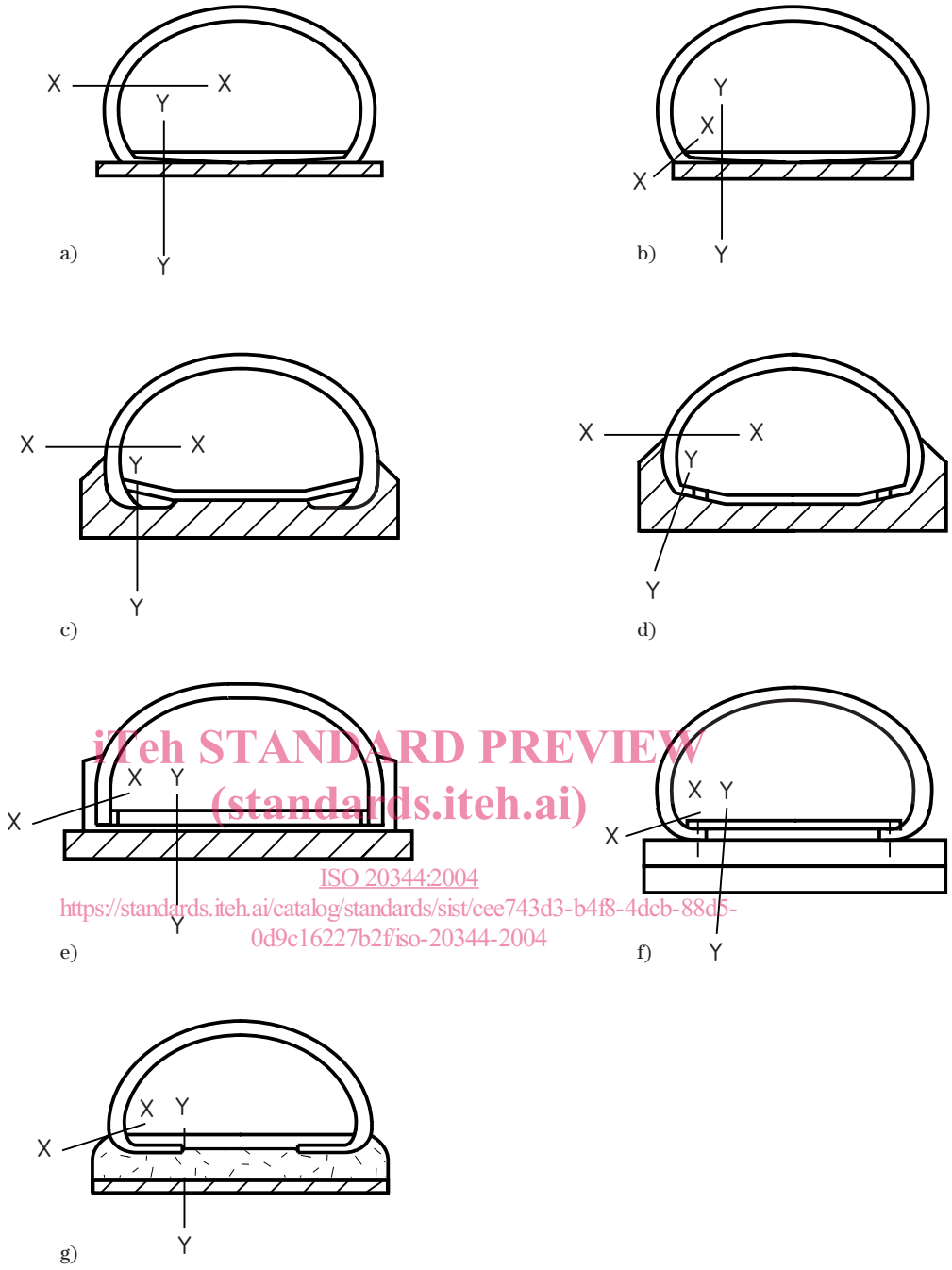
NOTE It is considered that a construction is c or d when the distance from X-X to the upper face of the insole is at least 8 mm.

5.2.3.3 Interlayer bond strength: construction types f and g (see figure 2)

Take a test piece from either the inner or the outer joint region.

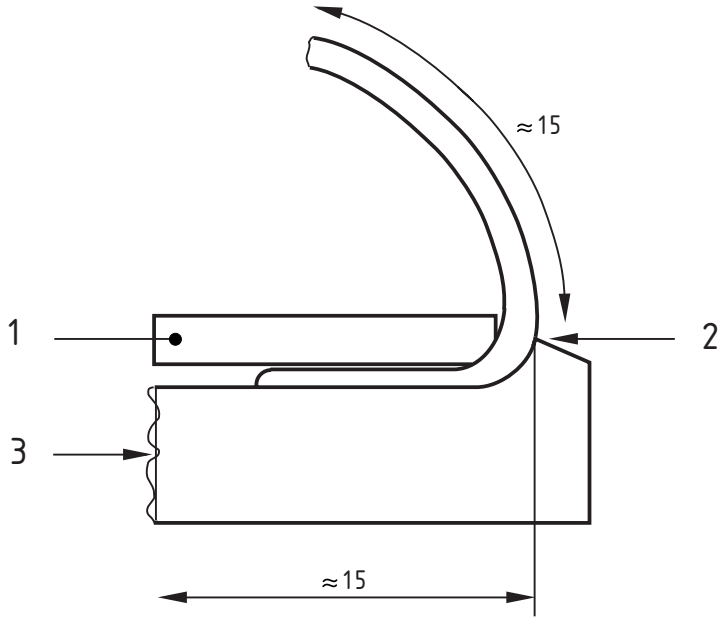
Remove the upper by cutting along the feather line at X-X. Remove the insole if present. Cut a strip parallel to and including the sole edge at Y-Y to produce a test piece about 15 mm wide and at least 50 mm long.

Separate the sole layers for a length of about 10 mm by inserting a hot knife into the adhesive layer (see figure 4).



Type a: Conventional lasting, Cemented or moulded outsole having an extended range
Type b: Conventional lasting, Close trimmed outsole
Type c: Conventional lasting, Direct injected or vulcanised outsole or cemented dished outsole
Type d: Strobel stitched, Cemented dished outsole or direct injected or vulcanised outsole
Type e: Conventional lasting or Strobel stitched with rubber mudguard and cemented outsole
Type f: Machine sewn or welted where the outsole is bonded to the throughsole
Type g: Multilayered sole, e.g. moulded-on sole, a moulded unit or a built unit

Figure 2 — Types of construction showing position for preparation of the test piece for bond strength



1 Insole (removed)
2 Feather line
3 Outsole

Dimensions are in mm

Figure 3 - Cross section of test piece

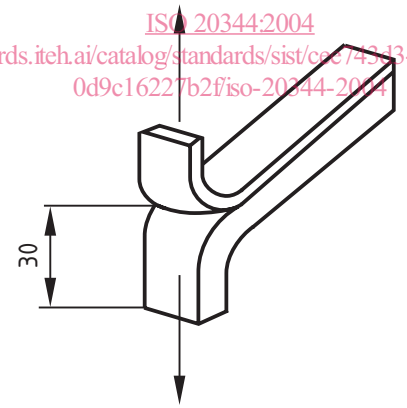


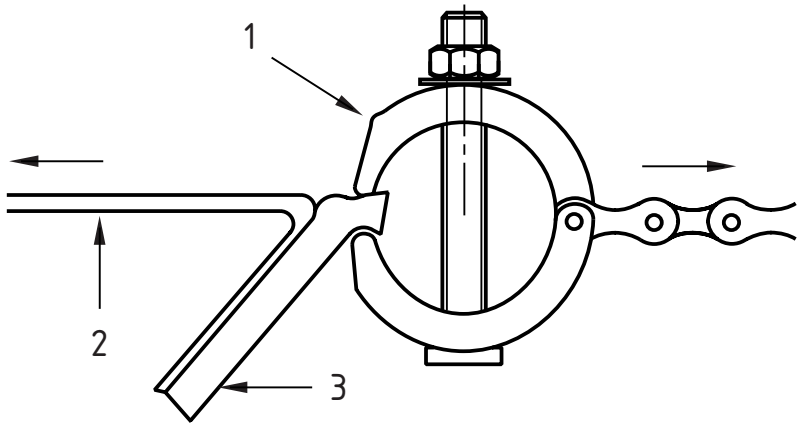
Figure 4 - Prepared test piece

5.2.4 Measurement of bond strength

Before carrying out the test, measure the width of the test piece to the nearest mm at several points using a calibrated steel rule and calculate the average value to the nearest mm. Then measure the bond strength on a minimum length of 30 mm in one of the following ways:

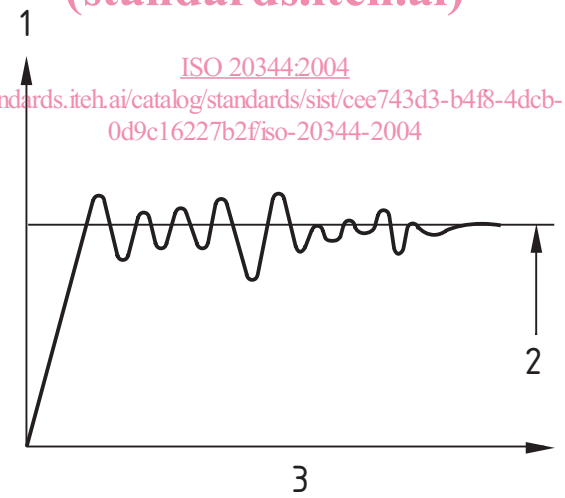
a) *For sole/upper bond strength: Construction type a.* Clamp the test piece into the jaws of the tensile machine, using a pincer jaw to grip the short edge of the sole (see figure 5), and record the load/deformation graph (see figure 6) at a separation speed of (100 ± 20) mm/min.

b) *For sole/upper bond strength: Construction types b, c, d and e and sole interlayer bond strength: construction types f and g:* Clamp the separated ends of the test piece in the flat jaws and record the load/deformation graph (see figure 6) at a jaw separation speed of (100 ± 20) mm/min.



1 Pincer jaw for sole edge
2 Upper
3 Sole

Figure 5 — Pincer jaw showing position of test piece



1 Peeling force in Newtons
2 Average
3 Deformation

Figure 6 — Example of load/deformation graph

5.2.5 Calculation and expression of results

Determine, from the load/deformation graph, the average peeling load in Newtons and divide by the average width (calculated in 5.2.4) to give the bond strength in N/mm.