INTERNATIONAL STANDARD

ISO 22653

First edition
2003-12-01

Footwear — Test methods for lining and insocks — Static friction

Chaussures — Méthodes d'essai pour la doublure et pour la première de propreté — Frottement statique

Reference number
ISO 22653:2003(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 22653 was prepared by CEN (as EN 12826:2000) and was adopted, under a special “fast-track procedure”, by Technical Committee ISO/TC 216, *Footwear*, in parallel with its approval by the ISO member bodies.

For the purposes of international standardization, a list of corresponding International and European Standards for which equivalents are not given in EN 12826 has been added as Annex ZZ.

Page 2
EN 12826:2000

Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 309 "Footwear", the secretariat of which is held by AENOR.

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of an identical text or by endorsement, at the latest by September 2000, and conflicting national standards shall be withdrawn at the latest by September 2000.

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

1 Scope

This European standard specifies two methods of assessing the frictional properties of lining and insocks, irrespective of the material.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 12222, *Footwear – Standard atmospheres for conditioning and testing of footwear and components for footwear.*

3 Definitions

For the purposes of this standard the following definitions apply:

3.1
coefficient of static friction (μ_s)
the ratio of the force necessary to cause the tangential separation of two stationary surfaces to the perpendicular force acting upon the two surfaces

3.2
coefficient of kinetic friction (μ_k)
the ratio of the force necessary to maintain a constant velocity between two surfaces in contact to the perpendicular force acting upon the two surfaces

3.3
kinetic angle of surface drag *(D_k)*
the angle of the inclined plane at which the test sled will slide down the inclined plane when sliding is initiated by a standard impulse

3.4
static angle of surface drag *(D_s)*
the angle of the inclined plane at which the test sled will slide down the inclined plane under its own mass and momentum

4 Apparatus and material

The following apparatus and material shall be used:

4.1 Method A

4.1.1 A sled, (150 mm ± 1 mm) long x (100 mm ± 1 mm) wide having a mass of 700 g ± 15 g to which a lining or insock test specimen is attached (see 5.1.1) and a test specimen support of cellular rubber, or plastics material, 3 mm thick and of medium apparent density. The surface of the sled is flat and smooth or polished. The edges of the sled do not contain any burrs or roughness.

When laid upon the horizontal bed of the test instrument the sliding surface of the sled is parallel with the horizontal bed, in full planar contact and without distortion.

4.1.2 A driving mechanism, to move the sled or horizontal bed in such a manner that the relative movement of one with the other can be maintained at a constant velocity of 800 mm/min ± 80 mm/min.

The drive mechanism is automatically disengaged or de-energized at the end of the test run (see 4.1.3).

4.1.3 A flat bed of rigid construction, having a smooth or polished surface to which the comparator material (see 5.1.2) is fixed in such a manner that the comparator material is not stretched more than a necessary minimum to remove wrinkles or other non-permanent distortions.

The flat bed is of a length to permit a relative surface travel during the test of approximately 400 mm and of a width to permit approximately 50 mm of clearance between the edge of the sled and any edge obstructions.

4.1.4 A measuring device, in the form of a strain gauge, with an associated autographic recording instrument to determine accurately the force necessary to initiate movement and the force necessary to maintain a constant velocity thereafter. The response time of the recording instrument is less than 0,25 s.

4.2 Method B

4.2.1 Instrument for the determination of static angle of surface drag (D_s)

4.2.1.1 Rigid platform, not less than 300 mm long and not less than 100 mm wide and hinged at one end to a baseboard provided with levelling screws. The rigid platform shall be provided with a spirit level and means for measuring the angle of inclination with an accuracy of ± 0,5°.

4.2.1.2 A piece of woollen melton cloth[1]), measuring approximately 250 mm long and 100 mm wide with its length in the cross direction and fixed under slight tension to the platform (see 4.2.1.1)

NOTE The melton cloth should be covered when the apparatus is not in use. It should be replaced at intervals, or if contaminated.

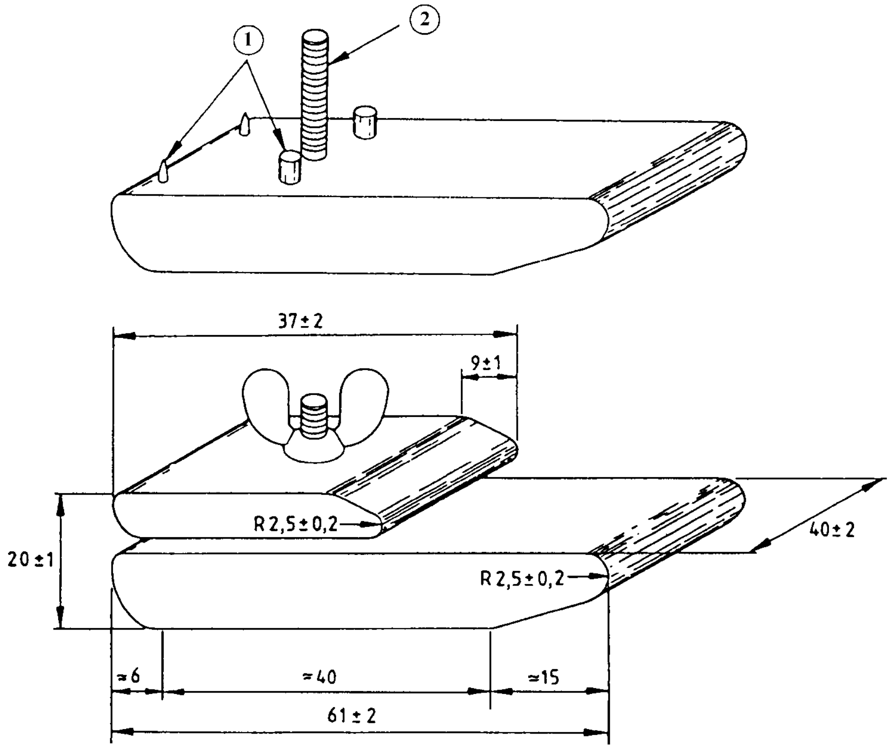
4.2.1.3 Specimen carrier, made of metal, with dimensions as illustrated in figure 1. The total mass of the carrier including the clamping screw shall be adjusted to 300 g by balanced boring out of the upper section of the carrier.

---

[1]) Recommended physical characteristics of woven fabrics:

Fibre content:	90 % Wool, 10 % Cotton
Weave:	3/1 broken
Finish and other details:	woollen spun
Mass per unit area:	min. 650 g/m^2
Threads per unit length:	warp: min. 14,6 per cm, weft: min. 11,0 per cm
Breaking strength:	warp: min. 355 N per 50 mm, weft: min. 325 N per 50 mm
Dimensional change:	max. 2,0

Dimensions in millimetres



Key

1 Suggested arrangement only for locating pins and/or locating lugs

2 Thread locating and securing spindle for specimen carrier top part

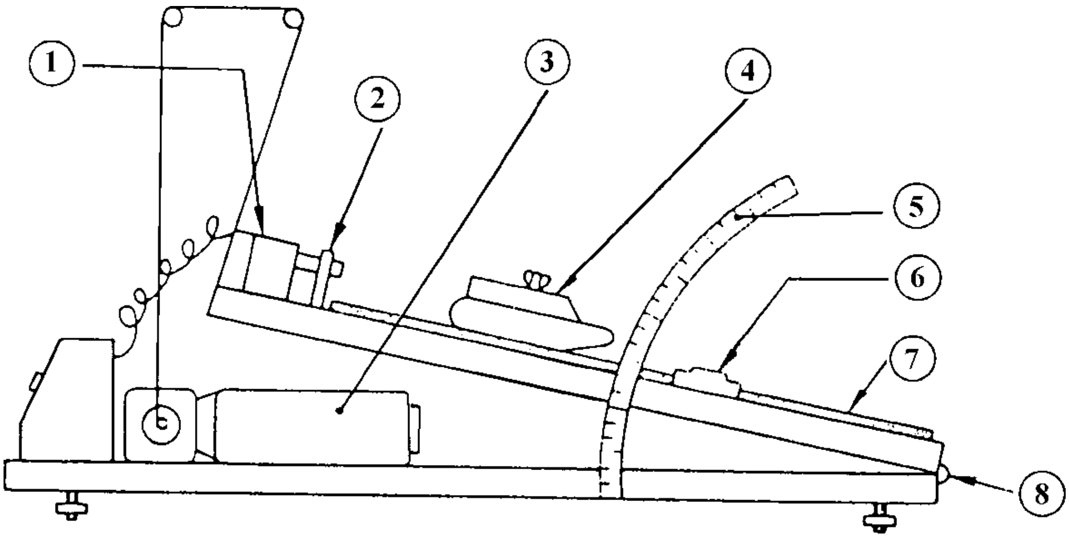
Figure 1 – Specimen holder for method B

4.2.1.4 Electric motor, suitably geared to tilt the plane of the platform mechanically at a rate of 15°/min ± 2°/min.

4.2.1.5 Microswitch included in the circuit in series with the electric motor (4.2.1.4) and is positioned at the top end of the platform (4.2.1.1) so that the actuating lever of the switch may be depressed by the back edge of the specimen carrier (4.2.1.3) resting on the melton cloth. A suitable stop shall be provided such that the distance of travel of the specimen carrier between the stop and the contact breaking position of the switch is 4,5 mm ± 0,5 mm.

The force required to depress the actuating lever of the microswitch shall be between 40 mN and 80 mN.

A suitable apparatus is shown schematically in figure 2.



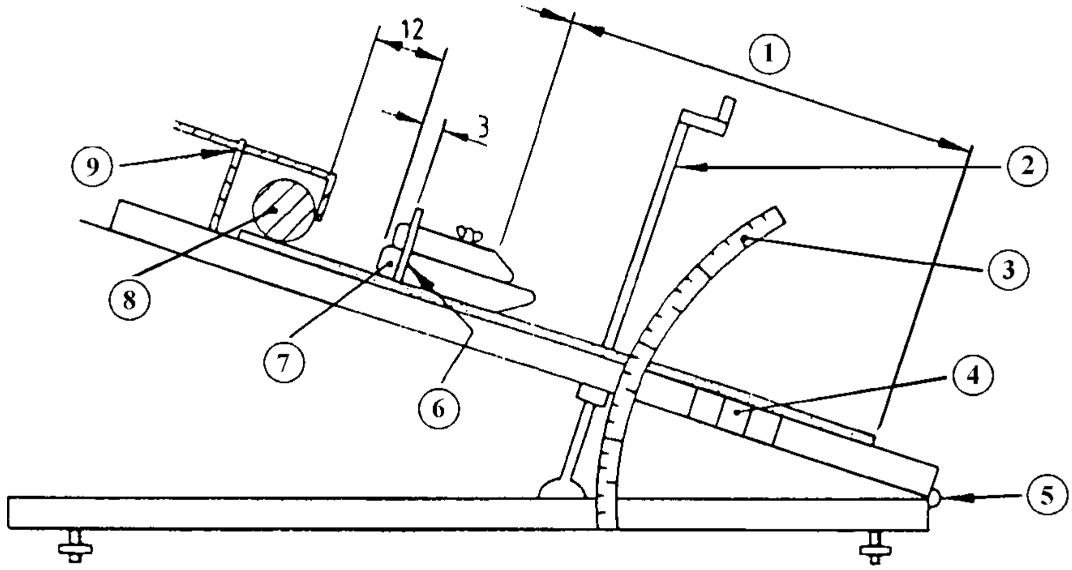
Key
1 Microswitch
2 Stop
3 Motor
4 Specimen carrier
5 Protractor
6 Spirit level
7 Melton cloth
8 Hinge

Figure 2 – Apparatus for method B – Mode 1

4.2.2 Instrument for the determination of the kinetic angle of surface drag (D_k)

A suitable apparatus is shown in figure 3.

Dimensions in millimetres



Key
1 Not less than 200
2 Inclination screw
3 Protractor
4 Spirit level
5 Hinge
6 Arresting bar
7 Specimen carrier
8 Metal roller
9 Pivot

Figure 3 – Apparatus for method B – Mode 2

The rigid platform (4.2.1.1) and the specimen carrier (4.2.1.3) shall be suitable. Means are provided for tilting the rigid platform so that it may be positioned accurately to within ± 0,5° of a required degree of inclination. Provision shall be made to impulse the back of the specimen carrier by a force of approximately 3 N in order to initiate sliding (see 6.2.2.2).

NOTE The impulse force of 3 N on the back of the specimen carrier can be achieved by a metal cylinder of appropriate dimensions and mass. This method is however subject to changes in resultant force at different inclinations of the platform.

5 Sampling and conditioning

5.1 Method A

5.1.1 Cut two lining or insock test pieces each measuring 250 mm x 100 mm, one in the longitudinal direction of the lining or insock material and one in the transversal direction.

5.1.2 Cut two comparator specimens, each not less than 550 mm long x 200 mm wide, from either the lining or insock material under test or from a woollen melton cloth.

Condition lining or insock pieces and comparator specimens according to EN 12222 for at least 24 h before testing, and carry out the test in this atmosphere.

5.2 Method B

Cut six test pieces each 50 mm wide x 120 mm long, with their length in the cross direction, from positions equally spaced across the width of the material but not within 50 mm of an edge.

Condition lining or insock test pieces according to EN 12222 for at least 24 h before testing and carry out the test in an atmosphere similar to that used for conditioning.

6 Test method

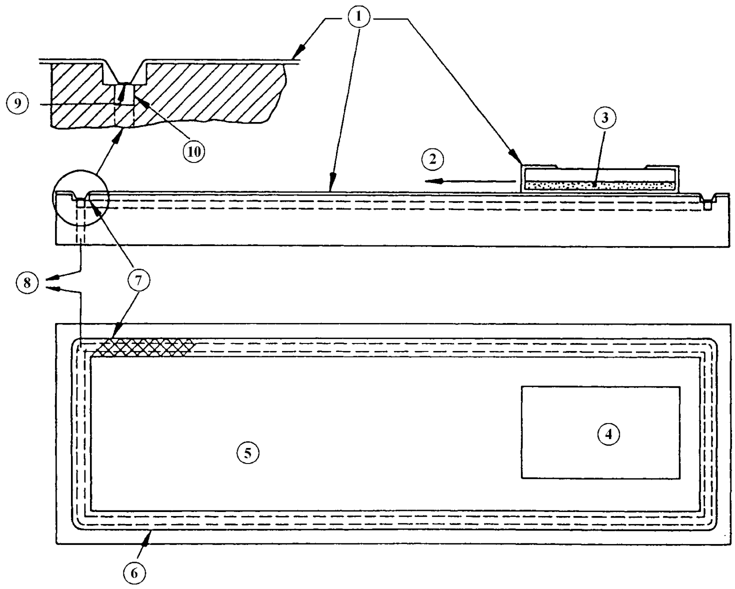
6.1 Method A. Flat bed method

6.1.1 Principle

A rectangular strip of the lining or insock is mounted with the coating outermost on a sled with a strain gauge attached to an autographic recording device. The sled is caused to move over a rigidly mounted horizontal bed to which the comparator material is fastened (either a melton cloth, lining, or insock itself). The force necessary to initiate movement of the sled and then maintain a constant velocity is measured.

6.1.2 Procedure

Determine the mass in grams of the lining or insock test piece (5.1.1). Mount the test piece on the sled (4.1.1) with the coated surface to be evaluated facing outwards (see figure 4).



Key

1 Coating under test
2 To force measuring device
3 Foam rubber
4 Sled
5 Bed
6 Vacuum clamp
7 Fine mesh wire gauze
8 To vacuum pump
9 Wire gauze
10 Evacuated channel

Figure 4 – Illustration of flat bed test apparatus

Ensure that the test specimen is not unduly stretched but is under sufficient tension to prevent the material from wrinkling or creasing during testing as this would affect the results.

Mount the comparator specimen (5.1.2) on the flat bed (4.1.3) in a similar manner.

Ensure that both surfaces are free of irregularities and foreign matter.

Without exerting any additional downward force, place the sled on the flat bed, ensure that the autographic recording device (4.1.4) is registering zero and that the chart speed is approximately 600 mm/min.

Measure and record the ambient relative humidity and temperature.

Engage or energize the driving mechanism (4.1.2).

NOTE It has been found to be convenient to overlap the comparator specimen over the edges of the flat bed and secure it underneath using adhesive tape. Alternatively the comparator may be taped securely within the vacuum channel, or, if the comparator is a thin single face coated fabric, it may be secured by vacuum suction as indicated in figure 4.

6.2 Method B. Inclined plane method

6.2.1 Principle

A sled on which a lining or insock test piece is mounted is placed on a bed of melton fabric that can be raised at an angle to the horizontal. The angle of the inclined plane is gradually increased until the sled slides down the inclined plane. The angle of inclination of the inclined plane is measured and reported as the angle of surface drag.

6.2.2 Procedure

6.2.2.1 Mode 1. Determination of static angle of surface drag *(D_s)*

Set the platform to 0° on the protractor scale and level the platform using the levelling screws on the baseboard. Wrap a test specimen around the carrier and clamp it in position under slight tension. Place the test specimen carrier on the platform with the specimen in contact with the melton cloth and with the back of the carrier against the stop, thus actuating the microswitch. Switch on the motor. When the inclination of the platform is sufficient to cause the test specimen and carrier to slide over the melton cloth the microswitch actuating lever is released, stopping the motor. Record the angle of inclination of the platform to the nearest 0,5°

Repeat the procedure with two further test specimens.

6.2.2.2 Mode 2. Determination of kinetic angle of surface drag *(D_k)*

Wrap a test specimen of lining or insock material around the carrier and clamp it in position under slight tension. Place the specimen carrier on the platform with the specimen in contact with the melton cloth and with the back of the carrier against the stop. Raise the platform to an angle of 5° less than D_s. Propel the back of the carrier by a force of approximately 3 N. Note whether the carrier slides freely down the platform for a distance of 200 mm If the carrier does not slide freely, raise the angle of inclination by 1° and repeat the operation. Continue in this manner until the carrier slides freely down the platform for a distance of 200 mm.

Repeat the procedure with two further test specimens.

7 Expression of results

7.1 Method A

7.1.1 Coefficient of static friction (μ_s)

From the autographic record determine the maximum value necessary to initiate movement between the test surfaces.

Calculate the coefficient of static friction (μ_s) according to the following equation:

$$\mu_s = \frac{F}{W}$$

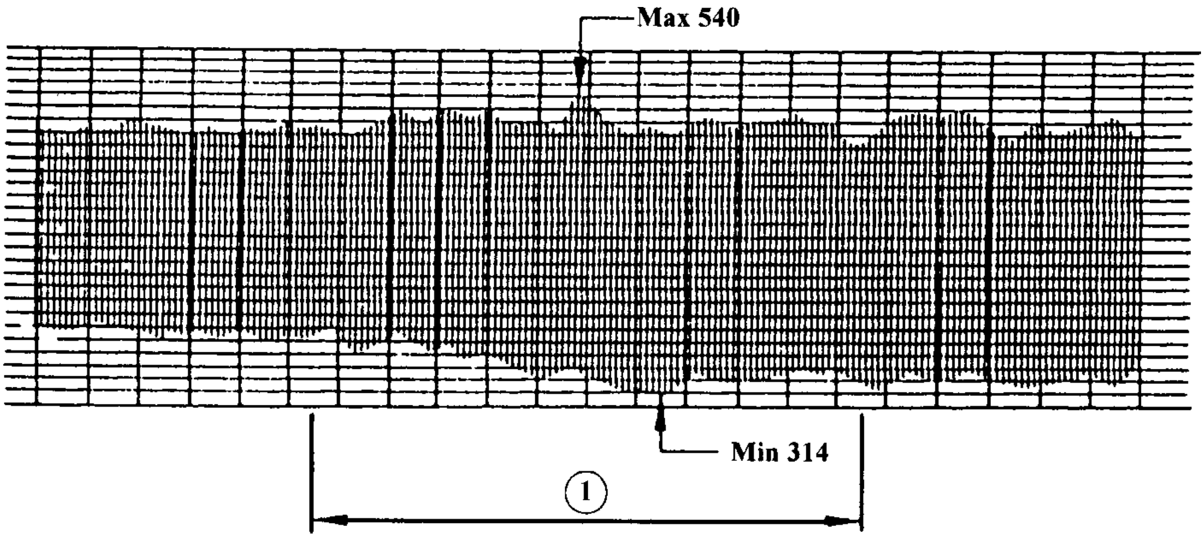
where

F is the maximum force necessary to initiate movement between the test surfaces (in newtons);

W is the weight of the sled and lining or insock test specimen (in newtons).

7.1.2 Coefficient of kinetic friction (μ_k)

From the autographic record determine from the central 50 % of the trace (i.e. the 2nd and 3rd quartiles), the maximum and minimum deflections of the trace and calculate their mean value *S* (in grams). (See figure 5).



1 Central 50 % of trace

Figure 5 – Autographic trace illustrating the method of plotting values for μ_k

Calculate the mean coefficient of kinetic friction (μ_k) according to the following equation:

$$\mu_k = \frac{S}{W}$$

where

S is the mean force necessary to maintain a constant relative velocity between the test surfaces (in newtons);

W is the weight of the sled and lining or insock specimen (in newtons).

7.1.3 Percentage variability of kinetic friction *(V_k)* (See figures 6 and 7)

At 10 equally spaced positions along the length of the autographic trace, record the value (in grams) of the maximum and minimum deflections on the autographic trace and calculate the percentage variability of kinetic friction *(V_k)* according to the following equation:

$$V_k = \frac{\sqrt{\dfrac{[(M_n - S)^2 + (S - m_n)^2]}{20}}}{S} \times 100$$

where

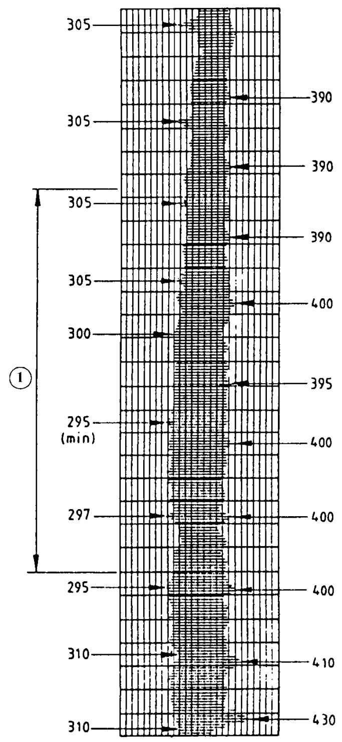
M_n are the maximum values of the kinetic frictional values at M_1, M_2, M_3, ... M_{10};

m_n are the minimum values of the kinetic frictional values at m_1, m_2, m_3, ... m_{10};

S is the mean value necessary to maintain a constant relative velocity between the test surfaces (in grams) (see 7.1.2)

The percentage value of V_k provides an indication of the amount by which the kinetic frictional value oscillates about the mean kinetic friction value.

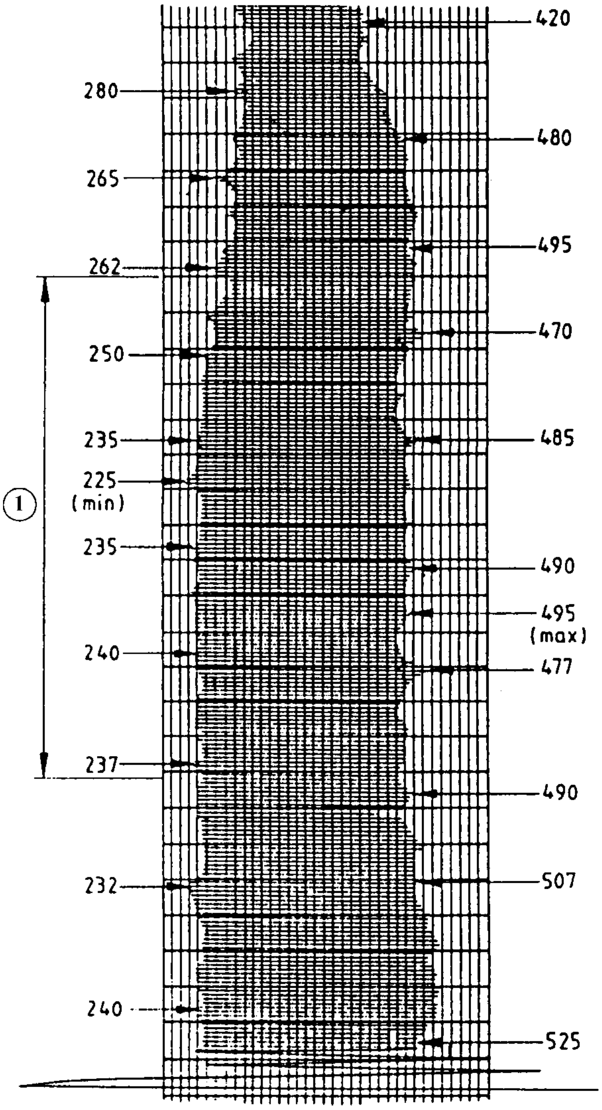
Examples of different values of V_k related to different autographic traces are given in annex A.



1 Central 50 %

$$\text{Mean} = \frac{400 + 295}{2} = 347{,}5 \text{ g}$$

Figure 6 – Autographic trace illustrating a coated fabric to melton friction test and the method of plotting values for V_k



1 Central 50 %

$$\text{Mean} = \frac{495 + 225}{2} = 360 \text{ g}$$

Figure 7 – Autographic trace illustrating a coated surface to coated surface friction test and the method of plotting values for V_k

7.2 Method B

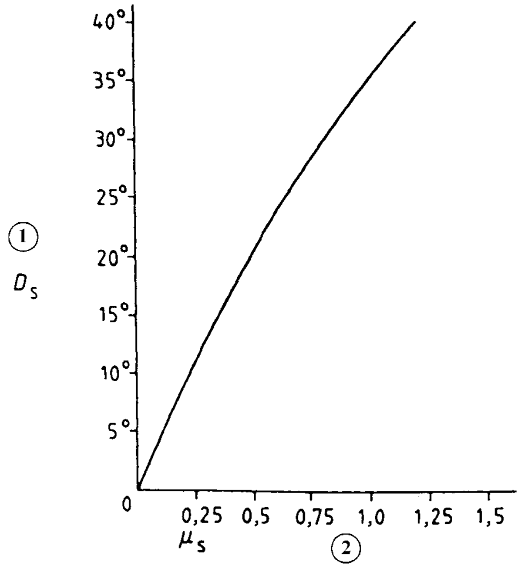
7.2.1 Static angle of surface drag

Calculate the mean value of the angle of inclination determined at 6.2.2.1 and report this as the static angle of surface drag *(D_s)*.

7.2.2 Kinetic angle of surface drag

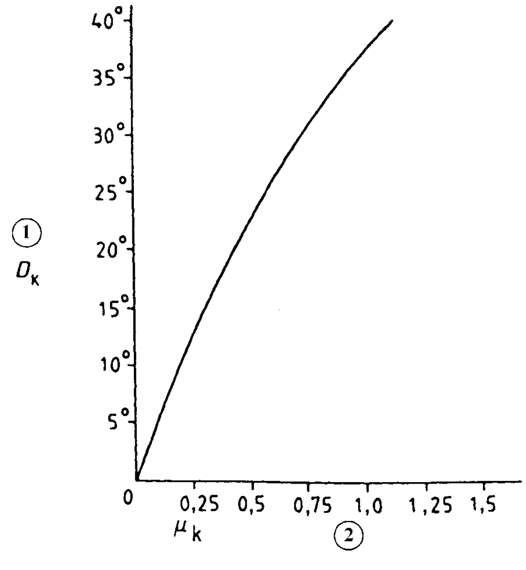
Calculate the mean value of the angle of inclination determined at 6.2.2.2 and report this as the kinetic angle of surface drag *(D_k)*.

The results given by method B are not expressed in absolute coefficients of friction but in degrees of inclination of the inclined plane. Interlaboratory trials have indicated that an angle of surface drag of 30° equates very approximately with a coefficient of friction of 0,9. See figures 8 and 9.



1 Method B, mode 1
2 (Coated surface to Melton) Method A

Figure 8 – Graphical representation of friction test results on identical materials using method A and method B, mode 1



1 Method B, mode 2
2 (Coated surface to Melton) Method A

Figure 9 – Graphical representation of friction test results on identical materials using method A and method B, mode 2

8 Test report

The test report shall include the following information:

a) the result, expressed in accordance with clause 7;

b) full description of the samples tested including commercial styles codes, colours, nature, etc.;

c) description of sampling procedure, where relevant;

d) reference to the test method;

e) details of any deviation from the standard test method;

f) date of testing.

Annex A

(informative)

Examples of autographic traces of friction tests on coated fabrics and determination of the variability of kinetic friction

A.1 Coated fabric to melton

In interlaboratory tests the mass of the sled was 682,7 g and the mass of the coated fabric test specimen was 2,4 g.

From the autographic trace the maximum and minimum values of the frictional force are 400 g and 295 g respectively.

The mean kinetic frictional value *(S)* is therefore 347,5 g.

The value of μ_k is then given by the following equation:

$$\mu_k = \frac{347,5}{(682,7 + 2,4)} = 0,507$$

The values of *M* are seen to be 430, 410, 400, 400, 400, 395, 400, 390, 390, 390.

The values of *m* are seen to be 310, 310, 295, 297, 295, 300, 305, 305, 305, 305.

The percentage value of V_k is therefore given by the following calculation:

$(M_n - S)^2$		$(S - m_n)^2$
$(430 – 347,5)^2$ = 6 806,25		1 406,25 = $(347,5 - 310)^2$
$(410 – 347,5)^2$ = 3 906,25		1 406,25 = $(347,5 - 310)^2$
$(400 – 347,5)^2$ = 2 756,25		2 756,25 = $(347,5 - 295)^2$
$(400 – 347,5)^2$ = 2 756,25		2 550,25 = $(347,5 - 297)^2$
$(400 – 347,5)^2$ = 2 756,25		2 756,25 = $(347,5 - 295)^2$
$(395 – 347,5)^2$ = 2 256,25		2 256,25 = $(347,5 - 300)^2$
$(400 – 347,5)^2$ = 2 756,25		1 806,25 = $(347,5 - 305)^2$
$(390 – 347,5)^2$ = 1 806,25		1 806,25 = $(347,5 - 305)^2$
$(390 – 347,5)^2$ = 1 806,25		1 806,25 = $(347,5 - 305)^2$
$(390 – 347,5)^2$ = <u>1 806,25</u>		<u>1 806,25</u> = $(347,5 - 305)^2$
(29 412,5)	+	(20 356,5)
	= 49 769	

Thus:

$$V_k = \frac{\sqrt{\frac{49\,769}{20}}}{347,5} \times 100 = 14,35\ \%$$

i.e. the kinetic frictional values differ from the mean on average by 14,35 % for this particular coated fabric.

A.2 Coated surface to coated surface

The same coated fabric as that used in example A.1 was tested for coated surfaces to coated surfaces. The autographic trace is illustrated in figure 7. The mass of the sled and coated fabric test specimen was the same, i.e. (682,7 + 2,4) = 685,1 g.

From the central 50 % of the autographic trace it is found that the maximum and minimum values of the trace are 495 g and 225 g respectively. The mean kinetic frictional value is therefore 360 g. μ_k is given by the following equation:

$$\mu_k = \frac{360}{685,1} = 0,525$$

The values of *M* are seen to be 525, 507, 490, 477, 490, 485, 470, 495, 480, 420.

The values of *m* are 240, 232, 237, 240, 235, 235, 250, 262, 265, 280.

The value of V_k is therefore given by the following calculation:

$(M_n - S)^2$		$(S - m_n)^2$
$(525 - 360)^2 = 27\ 225$		$14\ 400 = (360 - 240)^2$
$(507 - 360)^2 = 21\ 609$		$16\ 384 = (360 - 232)^2$
$(490 - 360)^2 = 16\ 900$		$15\ 129 = (360 - 237)^2$
$(477 - 360)^2 = 13\ 689$		$14\ 400 = (360 - 240)^2$
$(490 - 360)^2 = 16\ 900$		$15\ 625 = (360 - 235)^2$
$(485 - 360)^2 = 15\ 625$		$15\ 625 = (360 - 235)^2$
$(470 - 360)^2 = 12\ 100$		$12\ 100 = (360 - 250)^2$
$(495 - 360)^2 = 18\ 225$		$9\ 604 = (360 - 262)^2$
$(480 - 360)^2 = 14\ 400$		$9\ 025 = (360 - 265)^2$
$(420 - 360)^2 = \underline{3\ 600}$		$\underline{6\ 400} = (360 - 280)^2$
160 273	+	128 692
	= 288 965	

Thus:

$$V_k = \frac{\sqrt{\frac{288\ 965}{20}}}{360} \times 100 = 33\ \%$$

i.e the kinetic frictional values differ from the mean on average by 33%.

NOTE The coated fabrics used in A.1 and A.2 are the same.

Although the values of μ_k are similar, the values of V_k are widely different because of the different comparator.

Annex ZZ
(normative)

Corresponding International and European Standards for which equivalents are not given in the text

EN 12222:1997	ISO 18454:2001, *Footwear — Standard atmospheres for conditioning and testing of footwear and components for footwear*

ICS 61.060

Price based on 16 pages