INTERNATIONAL STANDARD

ISO 11378-1

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Textile floor coverings — Laboratory soiling tests —

Part 1: **Kappasoil test**

Revêtements de sol textiles — Essais d'encrassement en laboratoire —

Partie 1: Essai Kappasoil

Reference number
ISO 11378-1:2000(E)

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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 3.

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 part of ISO 11378 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 11378-1 was prepared by Technical Committee ISO/TC 38, *Textiles*, Subcommittee SC 12, *Textile floor coverings*.

ISO 11378 consists of the following parts, under the general title *Textile floor coverings — Laboratory soiling tests*:

— *Part 1: Kappasoil test*

— *Part 2: Drum test*

Annexes A, B and C of this part of ISO 11378 are for information only.

Textile floor coverings — Laboratory soiling tests —

Part 1:
Kappasoil test

1 Scope

This part of ISO 11378 specifies a method for assessing the propensity of textile floor coverings to soiling using an artificial soil composition.

The scope of this test method can be extended to assess the efficiency of cleaning chemicals, and cleaning equipment (see annex A).

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 11378. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 11378 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 105-A02:1993, *Textiles — Tests for colour fastness — Part A02: Grey scale for assessing change in colour.*

ISO 105-J01:1997, *Textiles — Tests for colour fastness — Part J01: General principles for measurement of surface colour.*

ISO 139:1973, *Textiles — Standard atmospheres for conditioning and testing.*

ISO 1957:—[1)], *Machine-made textile floor coverings — Selection and cutting specimens for physical tests.*

ISO 9405:—[2)], *Textile floor coverings — Assessment of changes in appearance.*

3 Principle

Carpet specimens are subjected to an accelerated soiling process. The degree of soiling is measured by comparing the change in colour between soiled and original specimens.

1) To be published. (Revision of ISO 1957:1986)

2) To be published. (Revision of ISO/TR 9405:1990)

4 Apparatus

4.1 Kappasoil machine, consisting of the following components.

4.1.1 Circular table, (600 ± 2) mm in diameter, rotating at a speed of (0,3 ± 0,016) s^{-1} [(18 ± 1) rpm] and reversing direction every 250 revolutions, to which the test specimens are attached.

4.1.2 Two cones, which rest radially on the table, one being free-running and the other driven in the same direction and with a cone surface speed (5 ± 1) % higher than the surface speed of the table, each cone assembly being adjusted to apply a load of (40 ± 2) N.

4.1.3 Soil dispenser, placed above the table, capable of dispensing soil uniformly and intermittently for distribution on the test specimens over a period of time during the machine cycle.

NOTE Typically (1,4 ± 0,01) g of soiling compound (4.2) is dispensed every 250 revolutions of the table and distributed evenly for one full revolution.

4.2 Standard soiling compound, compatible with the equipment.

NOTE Examples of such soiling compounds are listed in annex B.

4.3 Suction (vacuum) cleaner, with an airflow of (25 ± 5) $l \cdot s^{-1}$ through the suction-only nozzle with a suction surface of (125 ± 25) mm × (15 ± 2,5) mm.

4.4 Means of securing floor covering specimens to the horizontal table.

NOTE This can be double-sided, pressure-sensitive, adhesive tape or (aerosol) contact adhesive or a clamping system.

4.5 Colour measurement instrument, with a (50 ± 0,5) mm aperture, capable of measuring the colour of textile floor-coverings and expressing the results as ΔE or ΔL (CIELAB system) in accordance with ISO 105-J01.

4.6 Grey scales, in accordance with ISO 105-A02.

4.7 Template, to be used in conjunction with the colour measurement instrument and of the same size as the specimens with five holes of the same dimensions as the measuring head of the colour measurement equipment (see Figure 2).

4.8 Straight edged ruler, at least 200 mm long.

4.9 Illumination device, as described in ISO 9405.

5 Atmosphere for conditioning and testing

The standard atmospheres for conditioning and testing of textiles shall be one of those specified in ISO 139.

6 Sampling and preparation of test specimens

6.1 Sampling

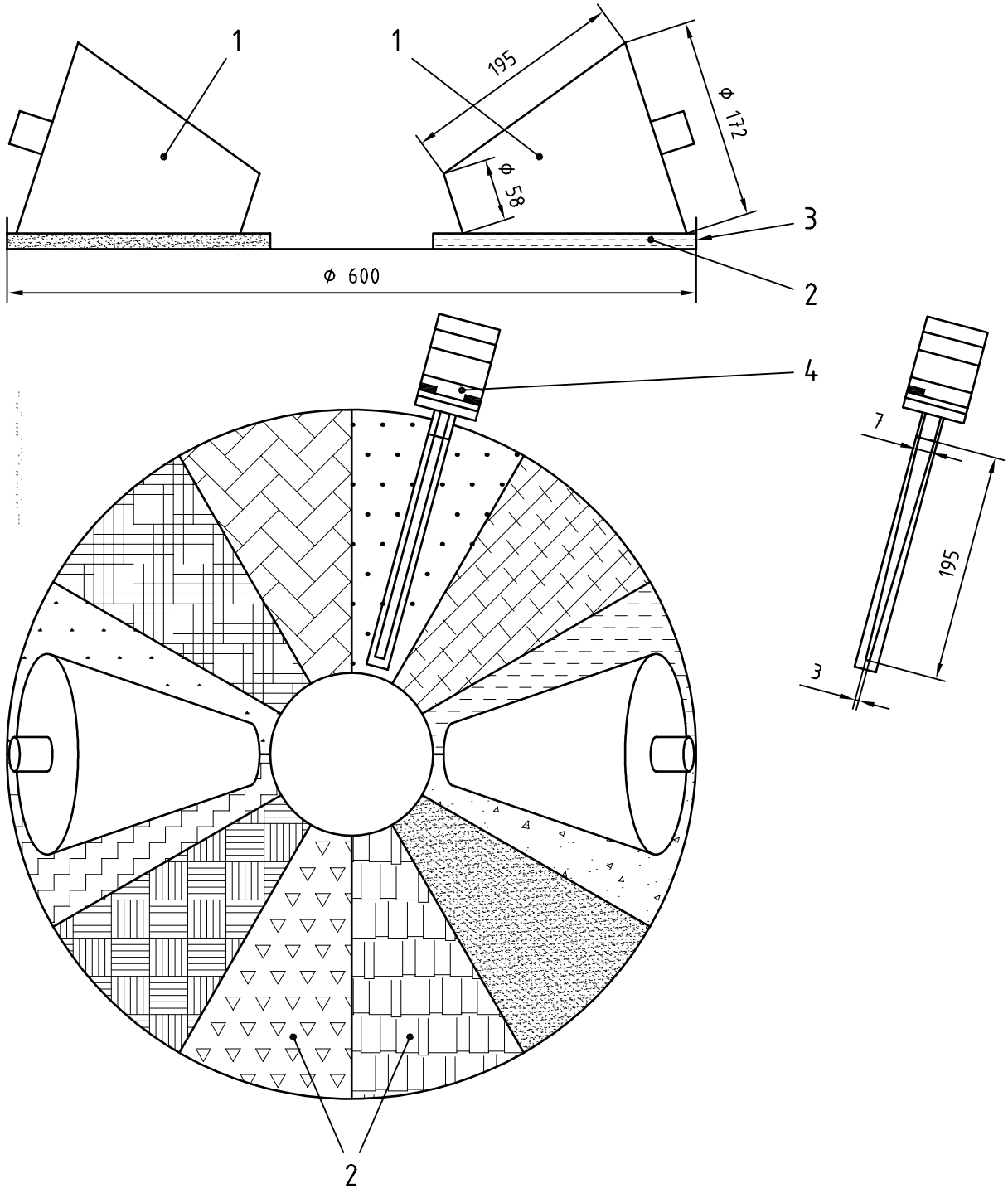
Select a minimum of two test specimens per textile floor covering being tested in accordance with ISO 1957. Cut each test specimen in such a way that in the case of those textile floor coverings with a “natural” pile lay, the direction of pile lay is at right angles to the direction of the rotational motion of the table. The specimens and soiling compound (4.2) shall be conditioned for a minimum of 24 h, and the test and assessment carried out in one of the standard atmospheres (clause 5).

6.2 Preparation of test specimens

A maximum of twelve test specimens (see Figure 1) from the same or different samples shall be exposed in each test run. Cut out the appropriate number of test specimens and allow to condition in the standard atmosphere (clause 5), flat, singly and use-surface uppermost, for at least 24 h.

If there are insufficient specimens available for testing, any vacant spaces on the circular table of the Kappasoil machine shall be filled with spare floor covering material of similar thickness.

Dimensions in millimetres



Key

1 Cones
2 Carpet specimens
3 Table
4 Soil dispenser

Figure 1 — Diagram of Kappasoil machine

7 Procedure

7.1 Clean the test specimens using the suction cleaner (4.3) to remove loose surface fibre using a total of four strokes, two against and two with the direction of pile lay. In the case of cut pile carpet, align the pile in the direction of natural pile lay by using a clean straight edged ruler (4.8). Move the ruler once across the carpet pile in the direction of pile lay, applying slight pressure.

If the assessment is made using grey scales, proceed to 7.3.

7.2 Locate the measuring template (4.7) on the test specimen and, using the colour measurement instrument (4.5), measure the colour of the test specimen in five places. Record these values.

7.3 Attach the test specimens securely on the table (4.1.1), ensuring that there are no gaps between the test specimens and that, when specimens of differing thickness are tested, the difference in thickness of adjacent test specimens is not more than 1 mm. Place the soiling compound mixture (4.2) in the soil dispenser.

NOTE When filling the soil dispenser, it is essential that the test specimens be protected from accidental soil spillage.

7.4 Start the machine and continue until 5 000 revolutions of the table have been completed.

If there is a build-up of loose fibre on the surface of the test specimens during the early part of the test, stop the machine and carefully remove the loose fibre by hand. Restart the machine and continue the test.

7.5 Remove the test specimens carefully and clean them by suction with the suction cleaner (4.3) to remove loose dirt and fibre, using a total of four strokes (two against the direction of the pile lay, and two with).

In the case of cut pile carpets, ensure that the last stroke of the suction nozzle is in the direction of the pile lay. Move the clean straight edged ruler (4.8) across the pile in the direction of pile lay, applying slight pressure.

8 Assessment

8.1 Colour measurement

Using the measuring template and the colour measurement instrument (4.5), measure the colour of the soiled test specimens in the same five places on each specimen (see Figure 2). Calculate the mean colour difference (ΔE) or mean lightness difference (ΔL) between original and soiled specimens according to the following formulae:

$$\Delta E = \sqrt{(L_0 - L_S)^2 + (a_0 - a_S)^2 + (b_0 - b_S)^2}$$

or

$$\Delta L = L_0 - L_S$$

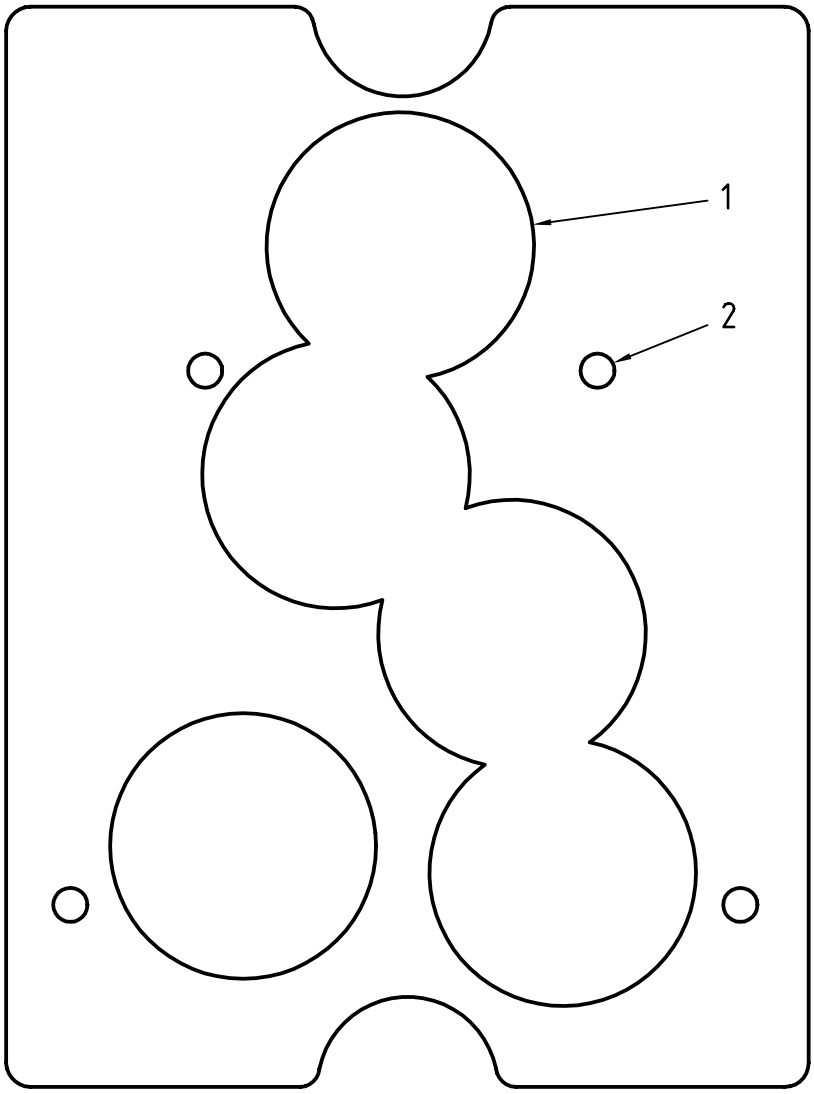
where

L_0, a_0 and b_0 are the mean CIE colour co-ordinates of the original specimen;

L_S, a_S and b_S are the mean CIE colour co-ordinates of the soiled specimen.

8.2 Grey scales

Three operators shall assess the colour difference between the soiled and original specimens in accordance with ISO 105-A02. Assessment shall be made using the large size grey scales and under the lighting conditions specified in ISO 9405.



Key

1 Coulour measuring aperture

2 Specimen locating peg

Figure 2 — Example of suitable template for colour measurement (actual size)

9 Accuracy and precision

Accuracy and precision data, obtained by means of interlaboratory trials, are given in annex C.

10 Test report

The test report shall include the following information:

a) all information necessary for complete identification of the sample;

b) reference to this part of ISO 11378, i.e. ISO 11378-1;

c) date of test;

d) conditioning and test atmosphere used;

e) details of the soiling compound used;

f) whether assessment was by colour measurement instrument or by grey scales assessment;

g) the test results;

h) any deviation to this part of ISO 11378 which could have affected the result.

Annex A
(informative)

Assessment of the efficiency of cleaning chemicals and cleaning equipment

A.1 General

The scope of this laboratory soiling test can be extended by either cleaning the soiled specimen(s) with different chemicals or by using different cleaning machines. Colour measurement or grey scale assessments can then be used to quantify the relative efficiencies of the cleaning products or processes being evaluated.

A.2 Assessment of further properties

A.2.1 The number of specimens per sample should be increased or decreased according to the number of chemicals and/or machines to be assessed.

A.2.2 Carry out each test in accordance with the procedure given in this part of ISO 13178, up to and including the assessment procedure (clause 7).

A.2.3 Clean the specimens in accordance with the method specified in ISO 11379. To assess cleaning chemical performance, use the same extraction cleaning machine for each chemical, and to assess cleaning machines use a standard cleaning chemical.

A.2.4 The efficiency of the cleaning is determined by comparison of the cleaned specimen(s) with the original, unsoiled, specimen(s) or with the soiled specimen(s), i.e. how well the cleaning process has restored the original appearance, or how much soil the cleaning process has removed, using one of the assessment methods given in clause 8 of this part of ISO 11378.

Annex B
(informative)

Standard artificial soiling compounds

A number of artificial soiling compounds, which can be used for laboratory soiling tests, have been available for many years. The composition of these compounds and their commercial suppliers are given in Table A.1. The quantity of soil used will depend on the composition of the soil and the textile floor covering characteristics evaluated.

Table B.1 — Standard soiling compounds

Ref.	Composition	% by mass	Supplier [a]
B.1	Fine grained sand ($\leqslant$ 500 μ) Kaolin Calcium carbonate Calcium sulfate Slurried chalk Peat Portland cement Activated charcoal Bayferrox yellow 391 Mineral oil (Nujol 014) Bayferrox brown 686 Ferric oxide Soot (carbon black) Mixed metal oxides	83 7,3 1,95 1,95 1,95 1,57 0,74 0,57 0,37 0,26 0,23 0,11 0,11 0,01	Cleaning Research International 49, Boroughgate Otley LS21 1AG UK Ref: *ISO Artificial Soil*
B.2	Peat dust Portland cement Kaolin Quartz Mineral oil (Nujol 014) Dust Iron oxide Yellow pigment (Bayferrox yellow 930)	37,8 17,45 17,7 17,70 6,20 1,05 0,6 1,5	WFK Krefeld Postfach 130762 D-47759 Krefeld Germany Ref: *Teppichschmutz*
B.3	Peat moss Cement (vitreous or Portland) Kaolin Siliceous earth Mineral oil (Nujol 014) Carbon (lamp) black Iron oxide	38,4 18 18 18 6,25 1,05 0,3	Protective Chemical Products Div. 3M Center, Building 301-1 E-03 St. Paul MN 55144-1000 USA Ref: *3 M Carpet Soil*
B.4	Quartz silica Kaolin Yellow ferrous oxide Black ferrous oxide Paraffin oil	88,3 9,35 0,2 0,6 1,55	CTTN Av. Guy-de-Collongue BP 41 69131 Écully Cedex France Ref: *CEN Standard Soil*

[a] These trade names are examples of a suitable suppliers whose products are available commercially. This information is given for the convenience of users of this part of ISO 11378 and does not constitute an endorsement by ISO of these suppliers.

Annex C
(informative)

Accuracy and precision

C.1 General

Accuracy and precision are defined in ISO 5725-1 as follows.

accuracy
the closeness of agreement between a test result and the accepted reference value

NOTE 1 The term accuracy, when applied to a set of test results, involves a combination of random components and a common systematic error or bias component.

precision
the closeness of agreement between independent test results obtained under stipulated conditions

NOTE 2 Precision depends only on the distribution of random errors and does not relate to the true value or the specified value.

The level of precision of a test method is defined by two indicators, the repeatability and the reproducibility.

Repeatability is expressed as the standard deviation corresponding to the variability of the measurements made under conditions where test results are obtained with the same method on the same material by the same operator using the same equipment in the same laboratory within short intervals of time.

The difference between two test results obtained under repeatability conditions will exceed the repeatability limit (r) on average not more than once in twenty cases in the normal and correct operation of the method.

Reproducibility is expressed as a standard deviation taking into consideration the variability of the measurements made under conditions where test results are obtained with the same method on the same material by different operators on the same type of equipment located in different laboratories at different times.

Test results obtained under reproducibility conditions will exceed the reproducibility limit (R) on average not more than once in twenty cases in the normal and correct operation of the method.

C.2 Accuracy

Two international interlaboratory studies were conducted during 1991 to determine the correlation of results between the Kappasoil test using artificial soiling compound B.1 (see annex B) and in situ floor soiling trials of the type described in ISO 11377 (designated FST for the purposes of this annex).

In the first trial thirteen textile floor coverings having different constructions and colours and with different pile or use-layer fibres (see Table C.1) were used in order to ensure that a range of different soiling characteristics were evaluated. The in situ tests were conducted by six organisations, and laboratory soiling tests carried out by three organisations. The results, expressed as ΔE mean colour differences between unused and soiled floor covering specimens are shown in Table C.2 and show a good correlation between the results of the in situ tests (FST) and the laboratory tests using the Kappasoil machines.

The second trial involved five laboratories/test houses with a Kappasoil machine and the additional ability to carry out in situ floor soiling tests. 18 different textile floor coverings were used, details of which are given in Table C.3. Results expressed as ΔL mean lightness difference (to eliminate the effect of colour) between unused and soiled floor covering specimens are shown in Table C.4. Correlation coefficients (r^2) calculated using Spearman's rank correlation method show a good level of correlation between the in situ (FST) results and the Kappasoil results.

C.3 Precision

C.3.1 Repeatability

Table C.5 shows results obtained with the Kappasoil machine by two laboratories (II and III) over periods of 2–4 months.

Table C.6 illustrates the repeatability of the Kappasoil method when one laboratory (II) tested a range of very different textile floor covering specimens in duplicate. It should be borne in mind that these specimens included a significant number of patterned carpets which may have affected the repeatability of the test.

C.3.2 Reproducibility

Results obtained from Kappasoil machines operated by three different laboratories are shown in Table C.2 and further results from five laboratories are given in Table C.4.

C.4 Laboratories/test houses

I British Carpet Technical Centre, UK
II International Wool Secretariat, UK
III Cleaning Research International, UK
IV Australian Wool Testing Authority, Australia
V Wool Testing Bureau, South Africa

Table C.1 — Textile floor coverings used in interlaboratory soiling studies — ISO studies

Floor covering code	Carpet construction	Pile fibre	Colour
A	tufted, loop pile	polyamide	grey
B	tufted, cut pile	polyamide	brown/beige
C	tufted, cut pile	polyamide (soil resist)	beige
D	tufted, cut pile	wool	beige
E	tufted, loop pile	polyamide	grey/blue
F	tufted, cut pile	polyamide	orange
G	tufted, cut pile	polyester (soil resist)	orange
H	tufted, loop pile	wool	beige
I	tufted, cut pile	wool	light beige
L	tufted, loop pile	wool	grey
M	woven, cut pile	cotton	grey
N	needlepunch, flat	polyamide	orange
O	needlepunch, textured	polyamide	beige/brown

Table C.2 — Accuracy and reproducibility between laboratories/test houses — ISO Interlaboratory study

Floor covering	FST (ΔE)	Level of soiling (ΔE)					
		I a	I b	II a	II b	III	Mean
A	3,15	4,1	3,4	2,7	2,1	2,8	2,9
B	3,4	3,6	3,4	3,3	2,4	2,4	2,9
C	4,82	5,6	5,8	4,3	2,4	2,2	3,9
D	5,07	8,9	9,3	4,4	3,7	5,3	6
E	5,1	6,3	6,8	5,2	5,9	6,1	5,8
F	5,53	5,5	5,8	4,6	4,3	4,6	4,7
G	8,32	9,8	9,8	9	7,4	7,6	8,1
H	8,92	8,7	14,9	9,9	9,8	10,9	10,2
I	10,47	16,6	15,9	12,7	12,7	11,5	12,9
L	2,37	4	3,8	2,5	2,5	1,9	2,8
M	8,27	14,9	7,8	13,2	11,7	8,1	10,7
N	5,65	6,2	6,3	4	4,2	5,8	5,7
O	3,32	1,6	1,4	0,5	1	2,5	2
Correlation with FST (r^2)		0,78	0,81	0,87	0,88	0,91	
Correlation with Mean (r^2)		0,90	0,83	0,93	0,96	0,93	

NOTES

I, II and III are the laboratories/test houses;

a, b are the duplicate tests;

FST is the floor soiling test;

Mean is the mean of laboratory tests.

Table C.3 — Textile floor coverings used in interlaboratory soiling studies — Kappasoil studies

Floor covering code	Carpet construction	Pile fibre	Colour
1	cut pile	polyamide (soil resist)	cream
2	cut pile	wool	cream
3	cut pile	polyamide (soil resist)	cream
4	cut pile	polyester	cream
5	cut pile	wool	cream
6	loop pile	wool	cream
7	loop pile	wool	cream
8	loop pile	wool	cream
9	loop pile	wool	yellow
10	loop pile	wool (soil resist)	yellow
11	loop pile	wool	cream
12	loop pile	wool	cream
13	cut pile	wool	cream/brown
14	cut/loop pile	wool	multicolour
15	cut pile	80 % wool/20 % polyamide	purple
16	cut pile	80 % wool/20 % polyamide	purple
17	cut pile	wool	purple
19	cut pile	wool	purple

Table C.4 — Accuracy and reproducibility between laboratories/test houses — Kappasoil interlaboratory study

Floor covering	FST result	Level of soiling (ΔL)							
		I	II 1	II 2	III	IV	V	Mean	SD
1	14,3	13,6	21,3	18,8	23,4	16,5	13,1	16,7	4,5
2	12,1	19,3	21,4	20,4	22,9	18,8	17,7	19,4	2,3
3	10,9	13,6	19	16,4	22,2	13,7	12,9	15,3	3,9
4	10,6	11	17,5	15,2	17,2	11,5	12,2	13,3	3,1
5	9,5	16,6	19,8	19,8	20,8	17,8	15,6	17,7	2,5
6	8,9	12,1	14,1	13,4	15,3	13,3	11,8	13	1,4
7	7,7	12	15,3	14,2	15,7	15,1	13,0	13,9	1,5
8	6,8	15,4	16,6	16	17	15,3	15,7	15,6	1,2
9	6,1	8,2	9,2	9,1	11	8,4	7,7	8,7	1,2
10	5,9	7,2	9,6	8,9	11	8,3	7,4	8,5	1,4
11	5,2	15,4	16,3	16,1	16,7	15,6	15,5	15,5	1,1
12	4,4	11,3	13,3	12,4	13,8	11,3	11,1	11,8	1,5
13	2,2	10	10,9	10,7	10,8	8,9	7,9	9,3	1,8
14	– 0,3	4,1	5,9	6,1	5,9	4,4	4,1	4,6	1,4
15	– 1,8	3,4	5,5	4,3	5,9	3,2	2,5	3,8	1,4
16	– 2,8	3,4	6,6	6,3	6,5	1,7	3,8	4,2	2,2
17	– 3,1	2,6	4,3	3,8	4,5	2,7	2,1	3,1	1
18	– 3,9	2,9	4,7	3,6	5,3	2,1	2,8	3,3	1,2
Correlation with mean (r^2)		0,97	0,97	0,99	0,95	0,98	0,98	–	–
Correlation with FST (r^2)		0,73	0,87	0,83	0,90	0,81	0,74	–	–

NOTES

I, II, III, IV and V are the laboratories/test houses;

II 1 and II 2 are two Kappasoil machines at the same laboratory;

FST is the floor soiling test;

Mean is the mean of the laboratory soiling tests;

SD is the standard deviation.

Table C.5 — Repeatability of Kappasoil laboratory soiling test method — Replicate testing of single textile floor covering specimens test houses III and II

Test house III			Test house II	
Replicate	**Wool** [a]	**Nylon** [b]	**Replicate**	**Wool** [c]
1	14,4	22,2	1	10,1
2	14,8	20,5	2	10
3	14,8	21,2	3	10,2
4	15,8	21,6	4	9,6
5	17	22	5	10,9
6	16,2	21,9	6	11,5
7	15,9	21,6	7	10,7
8	15,7	22,2	8	10,4
9	15,9	19,8	9	12,1
10	14,4	18,3	10	11,3
11	15,2	21,7	11	11,7
12	15,1	19	12	11,6
13	14,9	19,9	13	11,6
14	15,4	22,1	14	11,9
15	15,5	20,4	15	11,1
16	15,6	19,6	16	11,6
17	15,5	20,7	17	10,9
18	15,7	21,5	18	10
			19	9,8
			20	10,1
Mean	15,4	20,9		10,9
SD	0,65	1,18		0,78
CV %	4,2	5,7		7,2
Period	1995-05-01 to 1995-06-30		1993-01-22 to 1995-04-26	

[a] 100 % wool, cut pile tufted carpet, cream.

[b] 100 % polyamide, cut pile tufted carpet, white.

[c] 100 % wool, loop pile tufted carpet, cream.

Table C.6 — Repeatability of Kappasoil laboratory soiling test method — Duplicate testing of different textile floor covering specimens

Specimen code	Day 1	Day 2
4298	10,5	10,4
5616	8	7,4
5617	7,6	7
5619	21,4	24
5636	10,7	9,6
5639	16,2	15,2
5642	8,9	10,8
5643	5,4	5
5645	17,3	17,9
5671	14,6	13,8
5672	2,7	2,5
5673	7,1	7,5
5674	6,6	7,2
5681	7,1	7,6
5685	10,8	10,4
5686	2,6	2,1
5689	8,9	9,6
5691	11,7	13,1
5694	4,3	3,6
5695	8,1	9,6
5701	0,5	0,6
5703	5,3	5,4
5705	11,3	9,9
5706	10,3	10,5
5708	11,1	11,1
5709	10,7	11,3
5710	9,5	10,5
5712	9,4	10,4
5713	8	9,3
5714	8,4	8,2
Correlation (r^2)	0,96	
Period	93-01-06 to 93-03-24	

Bibliography

[1] ISO 5725-1:1994, *Accuracy (trueness and precision) of measurement methods and results — Part 1: General principles and definitions*.

[2] ISO 5725-2:1994, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*.

[3] ISO 11377:1997, *Textile floor coverings — Floor soiling — Test site set-up and soiling evaluation*.

[4] ISO 11379: 1997, *Textile floor coverings — Laboratory cleaning procedure using spray extraction*.

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