
**Silk — Electronic test method for
defects and evenness of raw silk**

*Soie — Méthode d'essai électronique pour les défauts et la régularité
de la soie brute*

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Foreword

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The committee responsible for this document is ISO/TC 38, *Textiles*, Subcommittee SC 23, *Fibres and yarns*.

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Introduction

Seriplane test is currently used to test defects and evenness of raw silk. The test is carried out in an inspection room with a special lighting system. Due to the difference of the coverage area of the threads on the board, and the penetration and reflection of the light, the evenness or stripes, cleanness, and neatness can be visually judged by comparing the Seriplane boards with the standard photos.

The capacitive tester for raw silk detects the electrical capacitance variation correlated with the mass variation of the silk thread when running through the sensor split having a certain length. The dimension and classification of defects are defined by setting the parameters of mass variation.

The optical tester detects the photometric variation of the shadow of silk thread correlated with the cross sectional area variation of the thread. The dimension and classification of defects are defined by setting the parameters of cross sectional area variation. The optical tester can detect the shape of defects that cannot be done by capacitive tester, but the later tester can detect the evenness of the raw silk precisely, thus the two kinds of tests give to some extent parallel information (defects are detected and counted with both sensors) but give also complementary information not available with a single sensor alone.

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Silk — Electronic test method for defects and evenness of raw silk

1 Scope

This International Standard specifies a test method for defects and evenness of raw silk by capacitive and optical electronic testers.

This International Standard is applicable to raw silk with the yarn size between 13,3 dtex and 76,7 dtex or 12 denier and 69 denier, whether in skein or on cone, soaked or unsoaked.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 2060, *Textiles — Yarn from packages — Determination of linear density (mass per unit length) by the skein method*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

raw silk

silk filament yarn formed by conglomerating a number of bombyx mori cocoon baves by reeling machine according to a certain reeling technique and quality requirement

3.2

soaked silk

raw silk soaked in a formulation of additives according to a technical requirement

3.3

electronic test method

method for evaluating the defects and evenness by using capacitive and optical testers

3.4

slub

for the capacitive method, the defect whose length is equal to or greater than 1 mm and whose mass surpasses 80 % of the average mass of the testing sample; for the optical method, the defect whose length is equal to or greater than 1 mm and whose cross-sectional area surpasses 80 % of the average cross-sectional area of the testing sample

Note 1 to entry: Slub can be classified into big slub and small slub, which can be referred to [A.1.1](#).

3.5

thick place

for the capacitive method, the defect whose length is equal to or greater than 10 mm and whose mass surpasses 35 % to 80 % of the average mass of the testing sample; for the optical method, the defect whose length is equal to or greater than 10 mm and whose cross-sectional area surpasses 30 % to 80 % of the average cross-sectional area of the testing sample

3.6

thin place

for the capacitive method, the defect whose length is equal to or higher than 10 mm and whose mass is over 40 % lower than the average mass of the testing sample; for the optical method, the defect whose length is equal to or higher than 10 mm and whose cross-sectional area is over 30 % lower than the average cross-sectional area of the testing sample

3.7

small imperfection element

SIE

defect whose length is no greater than 1 mm, and whose mass or cross-sectional area surpasses 80 % of the average mass or the average cross-sectional area of the testing sample

3.8

evenness

CV_{even} %, $CV_{5\text{m}}$ %, and $CV_{50\text{m}}$ %

variation in mass per unit length along the length of the yarn, expressed as coefficient of variation

Note 1 to entry: CV_{even} % is the coefficient of variation of the sample mass calculated from the masses of 1 cm yarn length segments.

Note 2 to entry: $CV_{5\text{m}}$ % is the coefficient of variation of the sample mass calculated from the masses of 5 m yarn length segments.

Note 3 to entry: $CV_{50\text{m}}$ % is the coefficient of variation of the sample mass calculated from the masses of 50 m yarn length segments.

3.9

CV_{between} %

coefficient of variation between the individual evenness values of the skeins or cones from one tested lot

Note 1 to entry: CV_{between} % represents an indication of the evenness homogeneity between skeins or cones of the tested lot.

4 Principle

Defects of raw silk, soaked or unsoaked, are evaluated, classified, and counted on the basis of variation of the electric capacity, in case of capacitive sensors, and of the photoelectric effect, in case of optical sensors, when passing through suitable sensors splits. The difference between optical and capacitive sensors in detecting defects of raw silk is shown in [Annex B](#).

The evenness of raw silk, soaked or unsoaked, is evaluated and counted on the basis of variation of electric capacity only in capacitive sensors.

The measurements are performed on individual yarn.

5 Apparatus

5.1 General

The electronic tester for raw silk can be single spindle or multi-spindle, and it comprises the measurement module consisting of capacitive and optical testers, signal processing module, and framework.

5.2 Measurement module.

5.2.1 Capacitive tester, used to test slub, thick place, thin place, SIE, and evenness of raw silk, with no more than 5 % of testing precision and 1 mm of minimum yarn advancement length.

5.2.2 Optical tester, used to test slub, thick place, thin place, and SIE, with no more than 5 % of testing precision, 1 mm of minimum yarn advancement length and at least two orthogonal rays.

5.3 Signal processing module, capable of

- a) controlling the testing procedure and processing the output signal,
- b) computing and classifying the defects according to their definition, and outputting the detailed testing data from each individual spindle and that from all the spindles of the tester using statistical charts and tables,
- c) calculating evenness indices at 1 cm, 5 m, and 50 m lengths as CV_{even} %, $CV_{5\text{m}}$ %, and $CV_{50\text{m}}$ %, and outputting the detailed testing data from each individual spindle and that from all the spindles of the tester using statistical charts and tables, and
- d) calculating CV_{between} %.

5.4 Framework.

5.4.1 Traction system, capable of carrying the yarn through the testing device at a constant speed without stretching or damaging it.

5.4.2 Winding device, equipped with a yarn-guiding device.

5.4.3 Yarn-guiding device, capable of ensuring the steady motion of the yarn with a fixed yarn traverse length.

The abnormal signal caused by the vibration or bump of the tested yarn shall not surpass 10 % of the average signal.

6 Atmospheres for conditioning and testing

Atmospheres used for conditioning and testing shall be in accordance with ISO 139. All the samples shall be conditioned for a minimum of 12 h before testing and remain conditioned during testing.

7 Lot formation and sampling

7.1 Lot formation

A lot consists of 600 kg of raw silk of the same nominal size from the same manufacturer. Each lot consists of 10 bales (about 60 kilograms per bale) or 20 cartons (about 30 kilograms per carton), reeled by the same reeling apparatus. In case of less than 10 bales or 20 cartons, regard them as one lot.

7.2 Sampling

7.2.1 Raw silk in skein

Randomly take 12 skeins from the side, 8 skeins from the centre, and 4 skeins from the corner of the silk bundles in one lot, i.e. 24 skeins in total. Take no more than 1 skein from each silk bundle.

7.2.2 Raw silk on cone

Take 12 cones randomly from one lot. Take no more than 1 cone from each carton.

8 Laboratory sample preparation

8.1 Raw silk in skein

8.1.1 Winding device

- a) winder, for winding silk samples;
- b) bobbins or cones, for collecting silk samples from the skeins.

8.1.2 Setting parameters

- a) winding speed: (140 to 200) m/min \pm 6 m/min;
- b) winding tension: (0,5 \pm 0,1) cN/dtex or (0,5 \pm 0,1) g/denier.

8.1.3 Number of samples

Prepare test samples from each of the 24 skeins sampled (see 7.2.1) by winding 7,5 km of yarn from each of two skeins onto 12 bobbins so that the total length of each bobbin is 15 km. Take the 7,5 km sample from each skein as specified in Table 1.

Table 1 — Rules for sampling

Number of skeins	Sampling position
10	Surface end
10	Inside end
2	Region representing the quarter closest to the surface end
2	Region representing the quarter closest to the inside end

8.2 Raw silk on cone

Test the 12 sampled cones (see 7.2.2) directly without further preparation.

8.3 Soaked silk

8.3.1 Prepare the laboratory samples of soaked silk according to Annex C.

8.3.2 Prepare the soaked silk samples as described in 8.1.

The soaked condition should be described in the test report.

NOTE Soaked silk samples can also be obtained from a supplier.

8.4 Sampling length

The total sampling length for a lot shall be no less than 150 km and that of the test sample on each bobbin or cone shall be no less than 12,5 km.

9 Setting

9.1 Setting of the apparatus

9.1.1 Set a constant winding speed at (600 ± 30) m/min for raw silk and $(1\ 000 \pm 50)$ m/min for soaked silk, and ensure the advancement of the yarn into the sensor split.

NOTE Other constant speeds can be used by agreement between the concerned parties, then record in the test report.

9.1.2 Set a pre-tension at $(0,20 \pm 0,05)$ cN/dtex or g/denier to minimize the vibration and jumping of the yarn, in order to maintain the steady motion.

9.1.3 Perform test for 150 km of yarn length for one lot, 12 bobbins or cones of 12,5 km sample yarn.

9.1.4 Set the nominal size. For example, the nominal size is set as 23,3 dtex (21 den) for the raw silk of 22,2/24,4 dtex (20/22 denier). When the nominal size is unknown, determine it according to ISO 2060.

9.2 Setting of the testing parameters of defects

Refer to [Annex A](#).

10 Test procedure

10.1 Clean all the detecting splits properly before starting a new test.

10.2 Switch on and warm up the tester normally about 30 min before starting the test.

10.3 Set the testing speed and testing tension according to [9.1.1](#) and [9.1.2](#).

10.4 Place the silk bobbins or cones one by one under the detecting position.

10.5 Pass through the silk yarn into the test region along the yarn-guiding pathway and then start the test.

10.6 Terminate the test when

- the length of the test sample is shorter than the designated test length in [9.1.3](#),
- frequent breaks of testing yarn occur, or
- the test sample is wound unevenly.

Then, repeat the sample preparation and setting of apparatus according to [Clause 8](#) and [Clause 9](#) from the beginning.

10.7 Collect all the data when the tests on all the sample packages are completed.

10.8 Label the samples from the soaked silk as “soaked”.

11 Calculation and expression of test results

11.1 Calculate the total numbers of big slubs, small slubs, thick places, thin places, and SIE for both capacitive and optical testers, by summing the individual result of each tested bobbin or cone and express the incidence of each type of defect as the number per 100 km.

11.2 Calculate the average evenness values CV_{even} %, $CV_{5\text{ m}}$ %, and $CV_{50\text{ m}}$ %, from the individual result of each tested bobbin or cone and the CV_{between} % from the individual result of CV_{even} % of each tested bobbin or cone.

11.3 Round off all numerical values to one decimal place.

11.4 An example of electronic testing result is given in [Annex D](#).

12 Precision

An international interlaboratory trial was organized to compare the repeatability and reproducibility of this method. The results are reported in [Annex E](#).

13 Test report

The test report shall contain at least the following information:

- a) a reference to this International Standard (i.e. ISO 15625);
- b) the details of the samples;
- c) the atmosphere condition for the conditioning and testing;
- d) the testing condition;
- e) the soaked condition, if used;
- f) the testing results;
- g) any deviation from this International Standard.

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Annex A (normative)

Defect counting and classification

A.1 Defect counting and classification

A.1.1 Slubs

The slubs detected by both capacitive and optical testers are classified into 25 classes (region SA, SB, SC, SD, and SE) as shown in [Figure A.1](#), and these slubs are divided into big slubs and small slubs. The big slubs include the classes from SA4 to SE4, SA3 to SE3, SC2 to SE2, and SD1 to SE1, and the small ones include the classes from SA2 to SB2, SA1 to SC1, and SA0 to SE0. The numbers of slubs classified according to [Figure A.1](#) are counted individually and not cumulative. For example, defects of class SA1 do not contribute to the number of defects counted in class SA0.

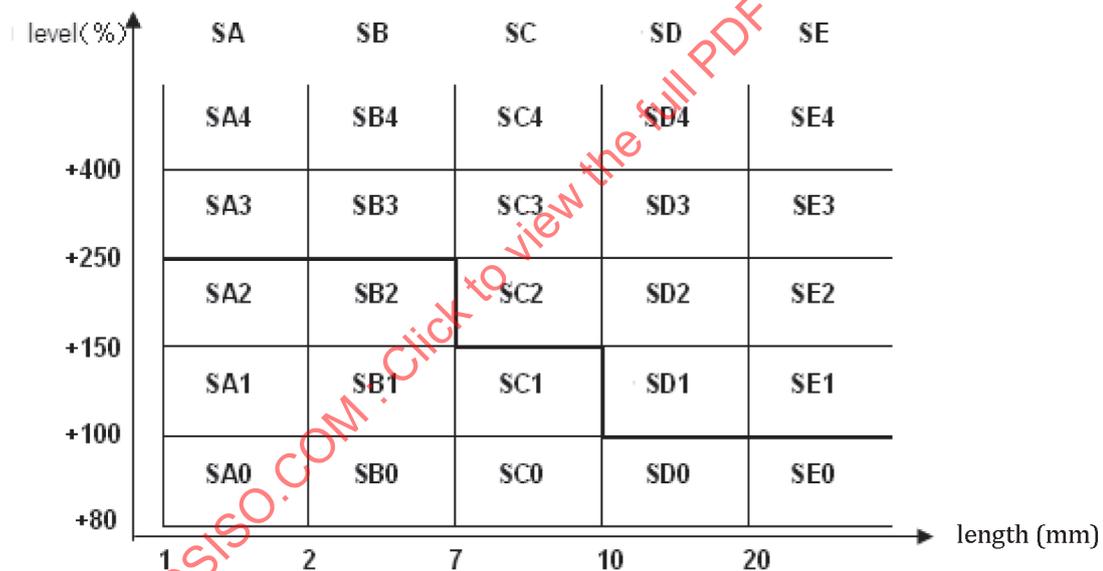


Figure A.1 — Classification of slubs (both capacitive and optical methods)

A.1.2 Thick places and thin places

The classification of thick places and thin places according to the capacitive and optical methods is shown in [Figures A.2](#) and [A.3](#), respectively. The thick places consist of 10 classes (region SF, SG, SH, SI, and SJ) including SF1 to SJ1 and SF2 to SJ2. Similarly, the thin places also consist of 10 classes (region SK, SL, SM, SN, and SO) including SK1 to SO1 and SK2 to SO2. The numbers of thick/thin places classified according to [Figures A.2](#) and [A.3](#) are counted individually, and not cumulative. For example, thin places of class SK2 do not contribute to the number of thin places counted in class SK1.

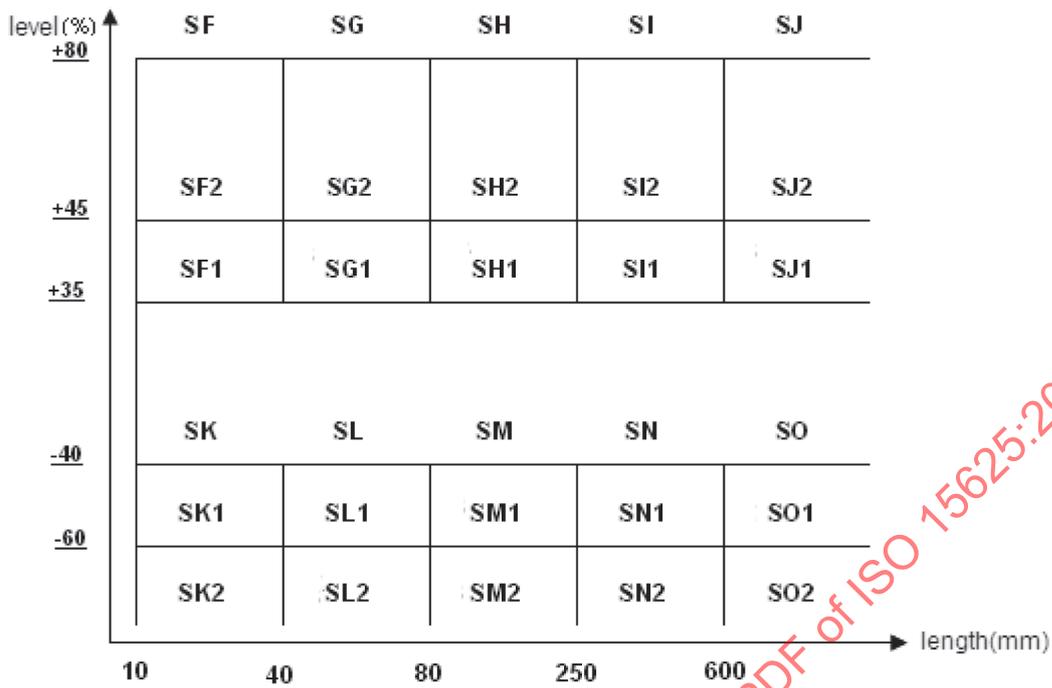


Figure A.2 — Classification of thick places and thin places (for the capacitive method)

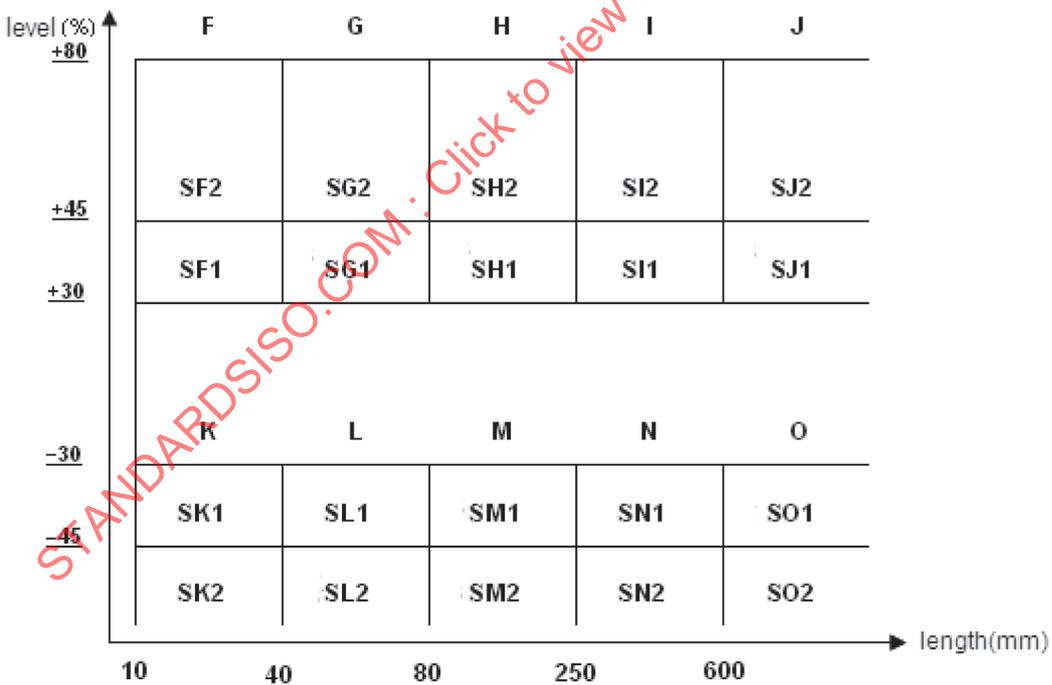


Figure A.3 — Classification of thick places and thin places (for the optical method)

A.1.3 SIE

SIE is the defect whose length is no greater than 1 mm and whose mass or cross-sectional area surpasses 80 % of the average mass or the average cross-sectional area of the testing sample.

Annex B (informative)

Difference between the optical and capacitive sensors in detecting defects of raw silk

B.1 Optical sensor

Optical sensor can measure the shape variation of the filament by detecting the shadow of the filament of a certain length. As the cross section of the filament is non-roundness, the optical sensor should have at least two orthogonal rays to test the cross-sectional variation of the filament. Therefore, the dimension and the class of the defects can be discerned by setting the limit of the variation extent of the cross section of the silk filament.

B.2 Capacitive sensor

Capacitive sensor can measure the mass variation of the filament of a certain length; the dimension and the class of the defects can be discerned by setting the limit of the mass variation extent of the silk filament.

B.3 Main difference between the two kinds of sensors

The optical sensor and the capacitive sensor can measure the defects and evenness of the silk filament. However, up to this day, the optical sensor cannot accurately measure the yarn evenness. The capacitive sensor can detect the mass variation of the silk filament, but have shortcomings in detecting the defects. For instance, for some defects with the same mass, they can have different shape. In such case, the difference of these defects can only be detected by the optical sensor. Thus, for the cohesion defects such as loose ends and loops, the capacitive sensor cannot discern, while the optical sensor is more sensitive to these defects. Thus, the optical sensor and capacitive sensor should work together to complement each other.

Annex C (normative)

Method for preparing soaked raw silk in lab

C.1 Apparatus

C.1.1 Maceration tank, with suitable capacity.

C.1.2 Dehydrator.

C.2 Soaking additives

The main chemical components of the soaking additives include anionic surfactants, natural waxes, emulsifiers, etc. Three recipes are given, and each of them can be used. The composition and percentages are obtained according to the dry chemical component. Prepare soaking solutions using grade 3 water that complies with ISO 3696.

C.2.1 Recipe I

a) Alkyl alcohol (C8-C18) ethoxylates (3-20 EO)	0 % – 10 %
b) Stearyl imidazoline	5 % – 15 %
c) Polyglycol (PEG 200-1000) stearates	2 % – 10 %
d) Polyglycol (PEG 200-1000) oleate ester	2 % – 10 %
e) Alkylamine ethoxylates (5-25 EO)	0 % – 10 %
f) Vegetal oil and refined white oil	20 % – 50 %

C.2.2 Recipe II

a) Stearic acid diethanolamide	0 % – 10 %
b) Stearyl imidazoline	0 % – 10 %
c) Alkyl alcohol (C11-C13) ethoxylates (3-8 EO)	5 % – 15 %
d) Polyglycols (P 400-4000)	5 % – 15 %
e) Sorbitan ethoxylates (20 EO) monostearate	5 % – 15 %
f) Polyglycol (P 400) laurate	30 % – 50 %
g) Polyglycol (P 400) cocoate	5 % – 15 %

C.2.3 Recipe III

a) Fatty acid (C11-20) triethanolamide	10 % – 30 %
b) Paraffin wax (Liquid)	40 % – 60 %
c) Fatty acid (C11-20), vegetable-oil, sulfated, sodium salts	10 % – 30 %

C.3 Soaking conditions

Use the following soaking conditions for most cases. If there are other soaking conditions, describe the details in the test report.

- a) Dosage of soaking additives shall be 2 % to 4 % of the weight of raw silk.
- b) Temperature shall be less than or equal to 40 °C.
- c) Treating time shall be less than or equal to 12h.
- d) Liquid ratio is 1:5.

C.4 Soaking procedure

C.4.1 Place the prepared soaking additives (C.2) in the maceration tank (C.1.1) filled with grade 3 water that complies with ISO 3696 to give a liquor ratio of 1:5 and stir to dilute. Submerge the 24 skeins (7.2.1) in the soaking solution for less than or equal to 12 h.

C.4.2 Pull out the soaked silk skeins and extract the liquid until moisture regain reaches 100 % to 105 %. Release the soaked skeins, and straighten out the skeins by loosing the silk yarns.

C.4.3 Cool or dry the straightened skeins by either at room temperature or at heated temperature of not exceeding 40 °C for 24 h as hanging them on a clean and smooth pole.

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