TECHNICAL REPORT

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Textiles — Three-dimensional measuring apparatus for fabric appearance

Textiles — Dispositif de mesure tridimensionnelle pour évaluer l'aspect des étoffes

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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.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

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.

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Introduction

This Technical Report introduces two approaches, one by Japan and one by Korea, to three-dimensional seam pucker measurements. Other systems are emerging in the area but are not yet widely available. The two approaches were presented for consideration as ISO methodology to TC38/SC2/WG4 (Appearance Retention) in Gothenberg, Sweden on August 2nd-3rd, 2001 and will be processed jointly as a technical report to TC38/SC2. As the systems are further developed, resolution of measurements may improve. Contact the manufacturer for the most recent information on system capabilities.

Background

The American Association of Textile Chemists and Colorists (AATCC) provides a standard method of grading seam puckering based on samples rated on a scale of 1-5, where 1 is the most heavily puckered and 5 is the smoothest (Figure 1). The scale for wrinkles in fabric is comparable, although for this the AATCC provides replicas as samples (Figure 2). Typically, both seam and wrinkle grading is performed by human graders, a subjective assessment prone to both inter- and intra-grader variability.

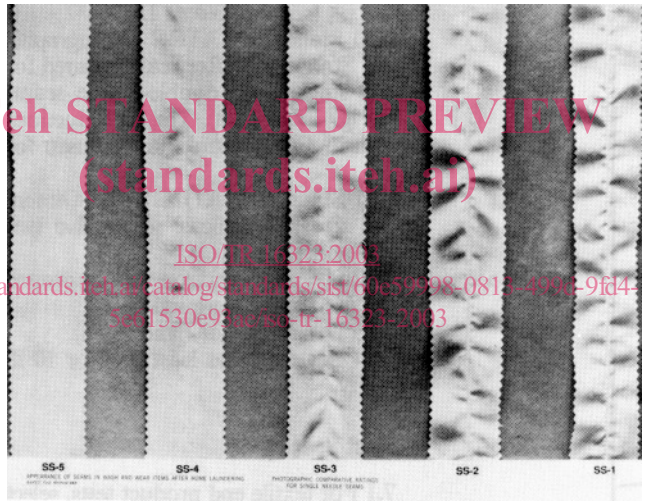

Figure 1 — AATCC sample for single-seam gradings 5 down to 1
(Similar double-seam samples exist)

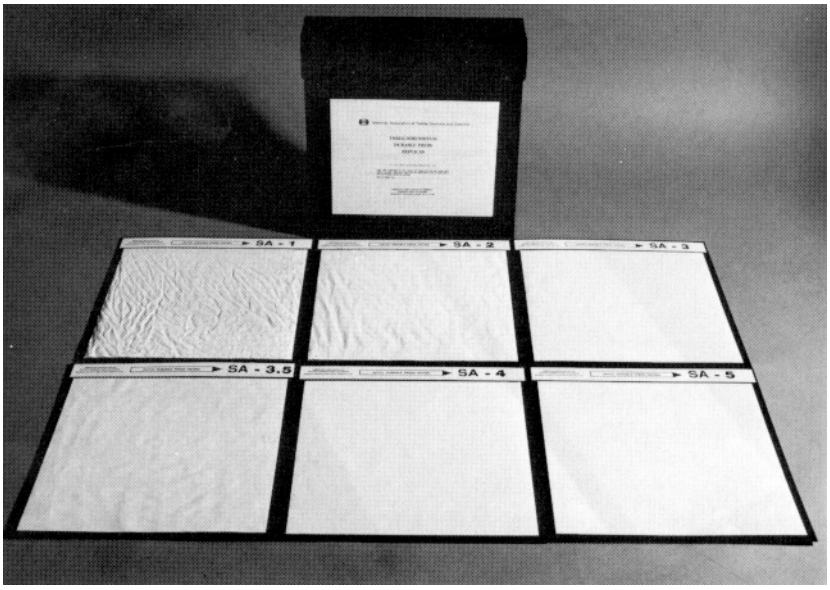

Figure 2 — AATCC wrinkle replicas for gradings (left to right, top to bottom) 1, 2, 3, 3,5, 4 and 5

Comparison

These Japanese (Method 1) and Korean (Method 2) systems are intended to supplement the subjective visual grading of the appearance of seams with a reliable and reproducible instrumental method.

Method 1, detailed in Annex A, is image-analysis-based. Light is projected through a parallel grid (forming a striped pattern) on to a 250 mm × 250 mm area of the seam. The grid pattern appears warped on the surface, forming a topographical map. A CCD camera is then used to capture four images of the striped pattern on the fabric, each from slightly different positions. The images are then analysed in three dimensions. The software compares the analysis to the analysis of the five-grade seam puckering replicas used by human graders and produces a numerical rating for the seam's appearance.

Method 2, detailed in Annex B, uses spot laser sensing or line laser scanning. Once the topographical data are obtained, the software associates each point with a vector of five numbers between 0 and 1. These numbers represent the likelihood that the point could be considered a member of each of five different sets. Each line is sampled at 9 points and the series of vectors for points on a line forms a frequency distribution. These distributions are then input into a classic fuzzy neural network, which produces output patterns corresponding to AATCC pucker grades.

Table 1 — Comparison of the methods

	Method 1	Method 2
Software basis	Image processing/analysis	Artificial intelligence (neurofuzzy)
Input/image capture device	External CCD camera, parallel grid, light source, controller, PC Result is a 3-D data set	Spot laser sensing system or laser line scanner (with CCD camera), PC Result is a 3D data set
System output	Rating 1-9, which can be mapped to AATCC pucker grade	AATCC pucker grade
Sample measurement	Sampling distance is 0,5 mm, points in 250 mm × 250 mm image are sampled at approximately 1 mm intervals	Height resolution is 0,05 mm, points in the image area are sampled every 2,5 mm in the width and 1 mm in the length directions

Information on the Japanese system can be obtained from Dr. Ryohei Komatsubara, TechnoArts Laboratory Co. Ltd., 3-10-7 Kotobuku-cho, Fuchu-shi, Tokyo, Japan 1830056 (Tel: +81-42-362-9201; Fax: +81-42-362-9261; ryohei@talab.co.jp)

Information on the Korean system can be obtained from Dr. Chang Kyu Park, Department of Textile Engineering, KONKUK University, 1 Hwa-Yong, Kwang-Jin, Seoul 143-701, Korea. (Tel: +82-2-457-8895; Fax: +82-62-530-1779; cezar@konkuk.ac.kr)

Textiles — Three-dimensional measuring apparatus for fabric appearance

1 Scope

This Technical Report specifies a test method for the objective evaluation of fabric appearance with a three-dimensional measuring apparatus.

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.

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

ISO 6330, *Textiles — Domestic washing and drying procedures for textile testing*

ISO 7770, *Textiles — Method for assessing the appearance of seams in durable press products after domestic washing and drying*

3 Terms and definitions

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

3.1
seam pucker
ridge, wrinkle or corrugation of the material or a number of small wrinkles running across and into one another, which appear on sewing together two pieces of fabric

4 Principle

4.1 Seamed fabric specimens are subjected to procedures simulating domestic laundering practices. One of the washing and drying procedures specified in ISO 6330 should be used, as agreed between the interested parties.

4.2 The seamed fabric specimens are instrumentally assessed using either Method 1 or Method 2.

4.3 These instrumental evaluation methods may not be suitable for all fabrics. Colours and patterns on fabrics may interfere with the accurate measurement of appearance. For information on whether a fabric is suitable for analysis, contact the manufacturer of the system.

4.4 For a detailed description of the theory behind the measurement apparatus and the assessment in Method 1, see Annex A. For a detailed description of the theory behind the measurement apparatus and the assessment in Method 2, see Annex B.

5 Apparatus

5.1 General

5.1.1 Washing and drying apparatus, as specified in ISO 6330.

5.1.2 Steam or dry iron, with appropriate fabric temperature settings.

5.1.3 Sewing machine, for fabric seaming.

5.2 Method 1

5.2.1 Lighting and evaluation area, as specified in ISO 7770 for measurement (see Figure 4).

5.2.2 Three-dimensional measuring apparatus, for evaluating seam appearance (single and double needle stitching) as shown in Figures 5 and 6. Its general principle and technological background are described in Annex A.

5.3 Method 2

5.3.1 3-dimensional measuring instrument, for fabric seam surface scanning.

5.3.1.1 Non-contact displacement meter, employing a spot laser sensor (or a CCD camera and a laser light source). It is not necessary that this be specified. See Figure 7 for examples. This instrument should have a resolution of the measured heights of 0,005 mm and in total 4 352 measuring points for each sample (17 lines with 2,5 mm intervals and 256 points with 1 mm intervals along each line) see Figure 3.

Dimensions in millimetres

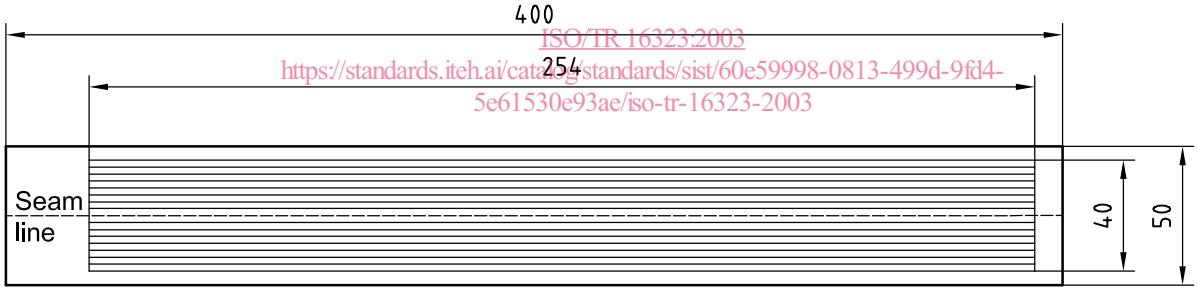

Figure 3 — Measuring area

5.3.1.2 One mounting frame and plate, for specimens (see Figure 8)

5.3.2 Objective five rating software, (see Annex B) capable of

a) calculation of: height data at the measuring points, frequency data between neighbouring measuring points, each average, each maximum and each variance along each measured line;

b) fuzzification of averages, maxima and variances of height and frequency along each measured line;

c) making the input patterns for the six neurofuzzy engines;

d) objectively rating by six neurofuzzy engines through defuzzification;

e) final objective rating from the average of the six rating results;

f) reporting the results;

g) utilities including 3-dimensional image viewing, data filtering, statistics, frequency analysis, etc.

5.3.3 Six artificial neurofuzzy engines, as described in Annex B. Six artificial neurofuzzy engines evaluate seam appearance of test specimens with different-angled points of view. The first, second and third neurofuzzy engines are based on height information of the seam appearance and use average, maximum, and variance of heights along each measured line respectively. The fourth, fifth and sixth neurofuzzy engines are based on frequency information of the seam appearance and use average, maximum and variance of height differences between neighbouring measured points along each measured line, respectively.

5.3.4 Personal computer, for data filtering, calculation, image viewing, fuzzification, neurofuzzy engines, objective evaluating and reporting.

6 Specimen preparation

Prepare three specimens. For Method 1, each sample should measure 38 cm × 38 cm. For Method 2, each sample should measure 50 mm wide by 500 mm long. For both methods, each should be prepared in an identical manner with a seam inserted through the middle. If the fabric is wrinkled, it may be smoothed by appropriate ironing prior to testing. Care should be taken to avoid altering the quality of the seam itself. If excessive fraying is anticipated, specimens shall be stitched loosely 1 cm from the edges, using dimensionally-stable thread.

7 Testing procedure

7.1 Washing and drying procedures

Wash and dry each specimen according to one of the procedures specified in ISO 6330, as agreed upon by the interested parties. If required, repeat the selected washing and drying cycle four times, for a total of five cycles.

7.2 Conditioning

The standard atmosphere for conditioning and testing textiles as defined in ISO 139 shall be used (a temperature of (20 ± 2) °C and a relative humidity of (65 ± 2) % with the exception of tests intended to study the effects of specific temperatures and/or relative humidities on the appearance of the seam.

7.3 Evaluation

7.3.1 Method 1

7.3.1.1 Mount the test specimen on the viewing board as illustrated in Figure 4, with the seam in the vertical direction.

The overhead fluorescent light shall be the only light source for the viewing board, and all other lights in the room shall be turned off. It is recommended that the side walls be painted black or that blackout curtains be mounted on either side of the viewing board to eliminate any reflective interference.

7.3.1.2 Adjust the position of the three-dimensional measuring apparatus so that photo images of an appropriate area (17 cm × 17 cm) of the seam can be taken.

7.3.1.3 Start taking the measurement by projecting a stripe pattern on the surface of the specimen and taking the image in the computer through a CCD camera and recording the rating indicated.

7.3.1.4 Each of the other two test specimens shall be processed in the same manner.

7.3.2 Method 2

7.3.2.1 Mount the specimen on the test plate.

7.3.2.2 Insert the plate with the test specimen into the 3-dimensional measuring instrument.

7.3.2.3 Measure the surface of the test specimen in a darkroom using the 3-dimensional measuring instrument described in 5.3.1

7.3.2.4 Rate the test specimens objectively from 1 (severe pucker) to 5 (light pucker) using the software described in 5.3.2 to 5.3.4.

7.3.2.5 Repeat the procedure for the remainder of the samples

7.4 Expression of results

7.4.1 Method 1

Average the ratings on the set of three specimens. Report the average to the nearest half a rating.

Table 2 — Seam appearance ratings

Class	Seam appearance
5	Equivalent to Standard 5 of 3-dimensional replicas
4.5	In-between appearance of Standard 5 and Standard 4
4	Equivalent to Standard 4 of 3-dimensional replicas
3.5	In-between appearance of Standard 4 and Standard 3
3	Equivalent to Standard 3 of 3-dimensional replicas
2.5	In-between appearance of Standard 3 and Standard 2
2	Equivalent to Standard 2 of 3-dimensional replicas
1.5	In-between appearance of Standard 2 and Standard 1
1	Equivalent to Standard 1 of 3-dimensional replicas

7.4.2 Method 2

Average the 18 evaluations made by the six neurofuzzy engines on the set of three test specimens. Report the defuzzification value and the final rating to the second decimal place.

8 Test report

The test report shall include the following information:

a) reference to the testing method;

b) details of the washing and drying procedures used as specified in ISO 6330;

c) number of washing and drying cycles used;

d) sewing conditions (sewing thread used, stitch density, stitch type, needle used, etc.);

e) seam appearance rating as calculated above;

f) details of any deviation from the specified procedure.