INTERNATIONAL STANDARD

ISO 20754

First edition
2018-04

Textiles — Man-made fibres — Determination of shape factors in cross section

Textiles — Fibres fabriquées — Détermination des facteurs de forme dans la section

Reference number
ISO 20754:2018(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 38, *Textiles*, Subcommittee SC 23, *Fibres and yarns*.

Textiles — Man-made fibres — Determination of shape factors in cross section

1 Scope

This document specifies methods for the determination of shape factors in the cross-section of man-made fibres.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 2076, *Textiles — Man-made fibres — Generic names*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2076 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
shape factor
<radius> radius difference between the minimum circumscribed circle and the concentric circle internally tangent to the section

Note 1 to entry: It is expressed as a percentage of radius of the minimum circumscribed circle.

3.2
shape factor
<cross-section> area difference between the minimum circumscribed circle and the cross-section shape

Note 1 to entry: It is expressed as a percentage of area of the minimum circumscribed circle.

3.3
coefficient of perimeter
X_L
perimeter ratio between the cross-section shape and the circle shape in same area

3.4
degree of hollowness
area difference between the outer contour line of the cross-section and all hollow parts

Note 1 to entry: It is expressed as a percentage of area of outer contour line, used to express the shape factor of hollow fibres.

3.5
coefficient of perimeter of hollowness
C_{XL}
perimeter ratio between all the hollow parts and the outer contour line

Note 1 to entry: It is used to express the shape factor of hollow fibres.

4 Principle

This method provides techniques for the assessment of the cross-sectional shape of man-made fibres, based on contour lines, measured radii and perimeters, calculated area and other geometric quantities. Furthermore, the method provides techniques for the calculation of specified shape factors in the cross-sectional shape.

5 Apparatus

The usual laboratory apparatus and, in particular, the following.

5.1 Measuring microscope apparatus, which meets the following requirements:

a) stage mechanism moveable in two perpendicular directions;

b) magnification not less than 400x;

c) minimum resolvable distance of 1,5 µm;

d) digital measuring stage to measure the distance, area, perimeter, angles and other parameters.

5.2 Fibre microtome.

5.3 Sample plate, which meets the following requirements:

a) stainless metal plate;

b) 70 mm in length, 20 mm in width and 0,2 mm to 0,4 mm in thickness;

c) at least one hole passing all the way through the plate thickness.

5.4 Sharp blade.

5.5 Microscope stage micrometer, with divisions of 0,01 mm.

5.6 Auxiliary devices and materials, including:

a) glass slide;

b) cover glass;

c) anhydrous glycerol, liquid paraffin, or other mounting agents used for microscopy.

6 Testing conditions and specimen

6.1 Testing conditions

Specified atmospheric conditions are not required, it is sufficient to perform the tests under ambient room conditions.

6.2 Sampling

6.2.1 For filaments, randomly cut about 0,5 m in length from one package.

6.2.2 For staple fibres, randomly cut out a bundle of fibres weighing about 0,5 g from one package.

6.2.3 The quantity shall be suitable for the microtome (5.2) and the hole(s) in the sample plate (5.3).

6.3 Preparation of the test specimen

6.3.1 Microtome method

Arrange the fibres in parallel and place them into the notch on the microtome (5.2). Multiple fibres can be separated by other coloured fibres.

Cut away the fibre ends that stick out and turn the push rod adjustment screw to an appropriate level, so as to expose fibres at a height of 20 µm to 30 µm. Coat them with collodion or another coating used for microscopy cross-sections, and wait until solid.

Cut a slice of fibre using a sharp blade. Place it on the glass slide, into a drop of anhydrous glycerol or liquid paraffin, and place the cover glass on top.

6.3.2 Plate method

Arrange the fibres in parallel as a bundle.

Apply a manual twist at one end of the bundle to bring it to a point and feed this point through the hole in the sample plate. Gradually pull the fibre bundle through the hole, until it is centred and under sufficient tension to resist further movement but not so tightly filled as to create compression on the fibres.

Using a sharp blade, cut away the fibre ends that stick out on both sides of the plate so that both sides are smooth and no individual hairs protrude.

7 Testing procedure

7.1 Calibration of indicating value

Place the microscope stage micrometer (5.5) on the stage. Measure the distance observed between two scale lines at the far edges, under the objective lens.

Repeat the measurements with different magnifications.

Use known values as a benchmark and calibrate the indicating value of the measuring microscope apparatus (5.1).

7.2 Image capture of fibre cross-section

Take the slide or sample plate on the stage and align the objective lens with the sample.

Select different magnifications and adjust the distance between the lens and the sample, in order to capture clear images of the magnified fibre cross-section.

Avoid observing fibres at the edge of the prepared slide or sample plate as these may have been compressed during sample preparation.

Capture images sequentially in a fixed direction and prevent human error and repetition.

Exclude incomplete or severely damaged images.

7.3 Number of tests

Test at least 30 different cross-sections from each prepared slide or sample plate.

Besides specified numbers, additional tests are necessary if, at a confidence level of 95 %, a half-length, *c,* of the confidence interval >10,0 % of the overall arithmetic mean. Calculate the number in accordance with Annex A.

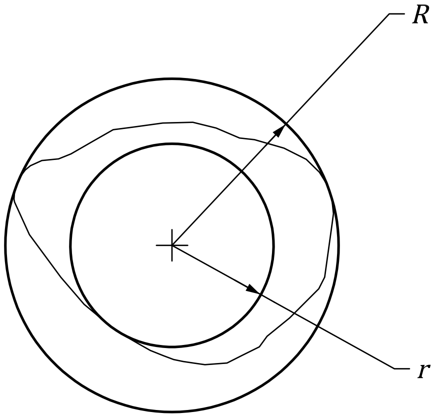
7.4 Shape factor in radius

7.4.1 Choose one shape in the image and draw a contour line.

7.4.2 Draw the minimum circumscribed circle, which contains the cross-section.

7.4.3 Draw the concentric circle internally tangent to the section.

7.4.4 Measure the radius of these two circles. See one example in Figure 1.



Key

R radius of the minimum circumscribed circle

r radius of the concentric circle internally tangent to the section

Figure 1 — Shape factor in radius

7.4.5 Calculate according to Formula (1).

$$D_R = \frac{R - r}{R} \times 100\,\% \qquad (1)$$

where

D_R is the shape factor in radius;

R is the radius of the minimum circumscribed circle, expressed in micrometres;

r is the radius of the concentric circle internally tangent to the section, expressed in micrometres.

7.5 Shape factor in cross-section

7.5.1 Choose one shape in the image, draw a contour line and measure the area.

7.5.2 Draw the minimum circumscribed circle, which contains the cross-section and measure the area.

7.5.3 Calculate according to Formula (2).

$$S_R = \left(1 - \frac{S_W}{S_Y}\right) \times 100\,\% \tag{2}$$

where

S_R is the shape factor in the cross-section;

S_W is the area of the enclosed contour shape, expressed in square micrometres;

S_Y is the area of the minimum circumscribed circle, expressed in square micrometres.

7.6 Coefficient of perimeter

7.6.1 Choose one shape in the image and draw a contour line.

7.6.2 Measure the perimeter and area of the enclosed contour shape.

7.6.3 Calculate according to Formula (3).

$$X_L = \frac{C}{2\sqrt{\pi S_W}} \tag{3}$$

where

X_L is the coefficient of perimeter, dimensionless value;

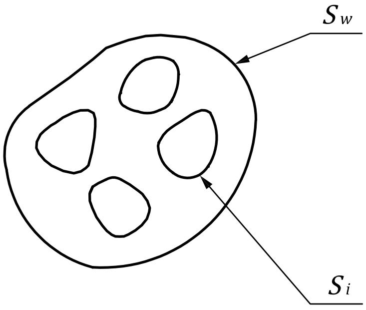
C is the perimeter of the enclosed contour shape, expressed in micrometres;

S_W is the area of the enclosed contour shape, expressed in square micrometres.

7.7 Degree of hollowness

7.7.1 Choose one shape in the image and draw the outer contour lines of the cross-section and of all the hollow parts.

7.7.2 Measure the area of the outer enclosed contour shape and of each hollow part. See one example in Figure 2.



Key

S_W area of the shape

S_i area of each hollow part

Figure 2 — Degree of hollowness

7.7.3 Calculate according to Formula (4).

$$C_S = \frac{\sum_{i=1}^{n} S_i}{S_W} \times 100\,\% \tag{4}$$

where

C_S is the degree of hollowness;

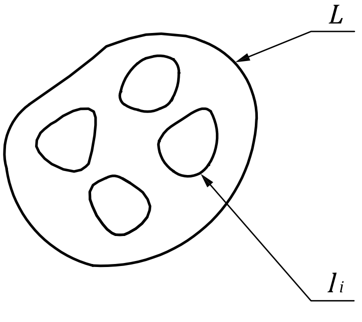
S_i is the area of each hollow part, expressed in square micrometres;

S_W is the area of the enclosed contour shape, expressed in square micrometres.

7.8 Coefficient of perimeters of hollowness

7.8.1 Choose one shape in the image and draw the outer contour lines of the cross-section and of all the hollow parts.

7.8.2 Measure the perimeter of the outer enclosed contour shape and of each hollow part. See one example in Figure 3.



Key

L perimeter of the shape

l_i perimeter of each hollow part

Figure 3 — Coefficient of perimeters of hollowness

7.8.3 Calculate according to Formula (5).

$$C_{XL} = \frac{\sum_{i=1}^{n} l_i}{L} \tag{5}$$

where

C_{XL} is the coefficient of perimeters of hollowness, dimensionless value;

l_i is the perimeter of each hollow part, expressed in micrometres;

L is the perimeter of the outer enclosed contour shape, expressed in micrometres.

7.9 Specific factors

7.9.1 Length of contour line

7.9.1.1 Choose one shape in the image and draw its contour line.

7.9.1.2 Measure the length of the contour line, expressed in micrometres.

7.9.2 Arc radius

7.9.2.1 Choose one shape in the image and mark three points on the arc.

7.9.2.2 Connect adjacent points and form two straights. Draw the perpendicular bisectors.

7.9.2.3 Extend the two perpendicular bisectors until they intersect. The intersection is the centre of arc.

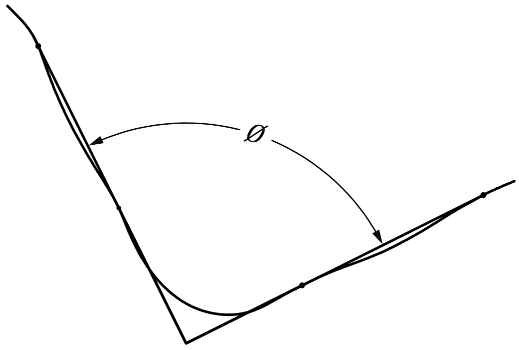
7.9.2.4 Measure the arc radius, expressed in micrometres.

7.9.3 Angle

7.9.3.1 Choose one shape in the image. Select a point on either side of the angle and draw the tangent lines. Alternatively, select two points on each side of the angle and connect them on either side of the angle to form two straight lines.

7.9.3.2 Extend the two tangent lines (or straight lines) until they intersect.

7.9.3.3 Measure the angle at intersection, expressed in degrees. See one example in Figure 4.



Key

θ angle at intersection

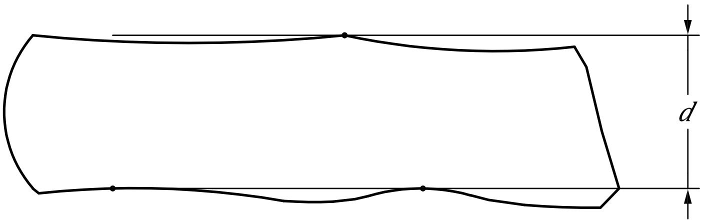
Figure 4 — Angle at intersection

7.9.4 Distance between two lines

7.9.4.1 Choose one shape in the image. Select a point on the contour line and draw its tangent line. Alternatively, select two points on the contour line and connect them to form one straight line.

7.9.4.2 Choose another point on the contour line and draw the parallel to the tangent line (or straight line).

7.9.4.3 Measure the vertical distance between the two parallel lines, expressed in micrometres. See one example in Figure 5.



Key

d distance between two lines

Figure 5 — Distance between two lines

8 Result

Calculate the mean value, standard deviation and coefficient of variation for each individual shape factor.

Take these three values as the reported results.

The mean value is calculated according to Formula (6).

$$\bar{x} = \frac{x_1 + x_2 + \ldots + x_n}{n} = \frac{\sum_{i=1}^{n} x_i}{n} \tag{6}$$

The standard deviation is calculated according to Formula (7).

$$S = \sqrt{\frac{\sum_{i=1}^{n} \left(x_i - \bar{x}\right)^2}{n-1}} \tag{7}$$

The coefficient of variation of each shape factor, C_V, is calculated according to Formula (8).

$$C_V = \frac{S}{\bar{x}} \times 100\,\% \tag{8}$$

where

$\bar{x}$ is the mean value of each shape factor;

x_i is the value of each shape factor;

n is the number of tests, $n = 30$;

S is the standard deviation of each shape factor.

For coefficient of perimeter (7.6) and coefficient of perimeters of hollowness (7.8), the results are rounded to the second decimal place.

For other shape factors, the results are rounded to the first decimal place.

9 Test report

The test report shall include the following information:

a) a reference to this document (including its year of publication);

b) all the details necessary for the identification of the sample tested (including the method of preparation, if applicable);

c) the test conditions;

d) the test results (mean value and coefficient of variation of shape factors);

e) any deviation, by agreement or otherwise, from the procedure specified;

f) any unusual features observed;

g) the date of the test;

h) any information that needs to be indicated.

Annex A
(normative)

Number of additional tests

The half-length of the confidence interval, c, is calculated according to Formula (A.1).

$$c = t \times \frac{S}{\sqrt{n}} \quad \text{(A.1)}$$

where

t is the Student's t-value (given in Table A.1);

n is the number of tests;

S is the standard deviation of each shape factor.

The number of additional tests, m, is calculated according to Formula (A.2).

$$m = t^2 \times \frac{S^2}{c^2} - n \quad \text{(A.2)}$$

where

t is the Student's t-value (given in Table A.1);

S is the standard deviation of each shape factor;

c is the half-length of the confidence interval;

n is the number of tests.

In such cases, calculate the mean value and the confidence interval from the results of all tests ($m + n$). Verify that the new confidence interval is satisfactory.

If additional tests are necessary, take samples from the unused reserve. Test them by using the same procedures as used for the original samples.

Table A.1 — the Student's *t*-value at confidence level of 95 %

n	t
30	2,04
31 to 40	2,03
41 to 60	2,01
61 to 120	1,99
121 to 230	1,97
>230	1,96

ICS 59.060.20

Price based on 10 pages