INTERNATIONAL STANDARD

ISO 9895

Second edition
2008-10-15

Paper and board — Compressive strength — Short-span test

Papier et carton — Résistance à la compression — Essai à faible écartement

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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.

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 9895 was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*, Subcommittee SC 2, *Test methods and quality specifications for paper and board*.

This second edition cancels and replaces the first edition (ISO 9895:1989), which has been revised to insert a grammage range in the scope of this International Standard. Compared to the first edition, some editorial changes have also been made.

Introduction

This International Standard has been developed in order to specify the conditions for determining the compressive strength of paper and board used for the manufacture of containers and boxes.

In this International Standard, the same terminology and symbols are used as in general literature concerning materials physics and mechanics.

Paper and board — Compressive strength — Short-span test

1 Scope

This International Standard specifies a method for determining the compressive strength in the machine and cross-directions of paper and board using a short-span compressive tester. It is intended for papers and boards used for the manufacture of containers and boxes.

This International Standard is recommended for papers and boards with a grammage from 100 g/m^2 to 400 g/m^2.

NOTE 1 The procedure specified in this International Standard should not be used for the determination of strain at break (see Annex B).

NOTE 2 For the determination of compressive strength of laboratory sheets, see instructions in ISO 5270[1].

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 186, *Paper and board — Sampling to determine average quality*

ISO 187, *Paper, board and pulps — Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples*

ISO 536, *Paper and board — Determination of grammage*

3 Terms and definitions

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

3.1
compressive strength
maximum compressive force per unit width that a test piece of paper or board can withstand until the onset of failure

NOTE The compressive strength is expressed in kilonewtons per metre.

3.2
compressive index
compressive strength divided by the grammage

NOTE The compressive index is expressed in kilonewton metres per kilogram.

4 Principle

A test piece, 15 mm wide, is clamped between two clamps, spaced 0,70 mm apart, which are forced towards each other until a compressive failure occurs. The maximum force is measured and the compressive strength is calculated.

5 Apparatus

5.1 Compressive tester, with two clamps (see Figure 1), for holding a test piece 15 mm wide. Each clamp includes a stationary jaw (S_1, S_2) and a movable jaw (M_1, M_2). The clamps (C_1 and C_2) shall be 30 mm long and have a high-friction surface. The clamps shall be able to hold the test piece (T) in position with a constant clamping force of 2 300 $\pm$ 500 N. The clamps shall be designed so that they grip the test piece firmly over its full width (see also Annex A).

The stationary jaws shall be in the same plane and on the same side of the test piece. The clamping surfaces of the movable jaws shall be in the same plane and parallel to those of the stationary jaws. For specifications, see Annex A.

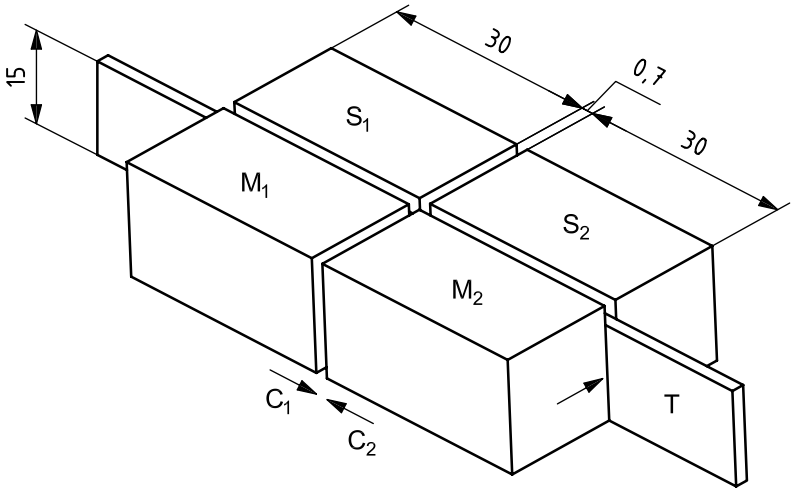
At the start of the test, the free span between the clamps shall be 0,70 mm $\pm$ 0,05 mm. Once the test is started, the clamps shall move towards each other at a speed of 3 mm/min $\pm$ 1 mm/min.

The tester shall have a measuring and display system so that the maximum compressive force can be determined with an error of less than $\pm$ 1 % of the reading when this is within 10 % to 100 % of the full-scale range.

The tester shall be designed so that a device for calibrating the load cell using weights of known mass can be attached. Alternatively, calibrated strain gauges can be used.

The tester shall have a device showing the clamping force exerted by the jaws, expressed in newtons.

Dimensions in millimetres



Key

C_1 and C_2	clamps
M_1 and M_2	movable jaws
S_1 and S_2	stationary jaws
T	test piece

Figure 1 — Clamping arrangement

5.2 Cutting device, designed to produce test pieces of the required dimensions with clean and parallel edges.

6 Calibration

Check the calibration of the compressive tester regularly using calibrated weights or strain gauges. Select calibration weights or strain gauges so that the entire measuring range is covered with checks at evenly spaced points. The error at any point shall not exceed $\pm$ 1 % of the reading within 10 % to 100 % of the full-scale range.

If the instrument is out of calibration, make adjustments as instructed by the manufacturer.

7 Sampling

If the tests are being performed to evaluate a lot, select the sample in accordance with ISO 186. If the tests are made on another type of sample, make sure that the test pieces used are representative of the sample received.

8 Conditioning

Condition the sample in accordance with ISO 187.

9 Preparation of test pieces

Prepare the test pieces in the same atmospheric conditions as used to condition the sample. From undamaged areas of the sample, cut test pieces in the form of strips of at least 70 mm in length and with a width of 15 mm $\pm$ 0,1 mm. Cut test pieces with the longer side parallel to the machine direction in order to determine the compressive strength in the machine direction. Cut test pieces with the longer side parallel to the cross-direction in order to determine the compressive strength in the cross-direction.

Cut a sufficient number of test pieces to allow at least 20 determinations in each required direction.

This test, like all other tests depending on resistance to compression, is very sensitive to change in the moisture content of the test piece. Handle the test pieces carefully and never touch the compressive zone with bare hands. Keep the test pieces away from moisture, heat, direct illumination, expiration air and other conditions that may change their moisture content. Ensure that the clamps are not exposed to heat from lamps, motors, etc.

The compressive strength is measured on a small area of 0,7 mm $\times$ 15 mm. In order to minimize the influence of local variations in the paper, at least 20 determinations are prescribed.

10 Procedure

Clamp the test piece in position in the jaws. Set the jaws in motion and read the maximum compressive force indicated. Test at least 20 test pieces in each required direction (machine direction and/or cross-direction).

If multiple tests are to be made on a single test piece, ensure that the test area is not a part of the test piece that has been in the clamping area during the previous test.

If required, determine the grammage of the conditioned sample (see Clause 8) in accordance with ISO 536.

11 Calculation and expression of results

11.1 General

Calculate and report results separately for each required direction (machine direction and/or cross-direction).

11.2 Compressive strength

Calculate the mean maximum compressive force and then calculate the compressive strength from Equation (1):

$$\sigma_{\mathrm{C}}^{b} = \frac{\bar{F}_{\mathrm{C}}}{b} \tag{1}$$

where

$\bar{F}_C$ is the mean maximum compressive force, in newtons;

b is the initial width of the test piece, in millimetres (normally 15 mm);

σ_{C}^{b} is the compressive strength, in kilonewtons per metre.

Report the compressive strength, σ_{C}^{b}, to three significant figures. If required, also calculate the standard deviation of the compressive strength.

11.3 Compressive index

If required, calculate the compressive index from Equation (2):

$$\sigma_{\mathrm{C}}^{g} = \frac{1\,000 \times \sigma_{\mathrm{C}}^{b}}{g} \tag{2}$$

where

σ_{C}^{g} is the compressive index, in kilonewton metres per kilogram;

σ_{C}^{b} is the compressive strength, in kilonewtons per metre;

g is the grammage, in grams per square metre.

Report the compressive index, σ_{C}^{g}, to three significant figures.

12 Precision

12.1 General

The variation between single tests using the same paper depends mainly on the structure of the paper.

12.2 Repeatability

One laboratory tested flutings (grammage from 112 g/m^2 to 180 g/m^2) and kraft liners (grammage from 125 g/m^2 to 400 g/m^2) in four different apparatuses, side by side. The results (4 means of 20 determinations) normally had a coefficient of variation of less than 3 %.

12.3 Reproducibility

In an interlaboratory comparison trial, 10 laboratories tested the same flutings (grammage from 112 g/m^2 to 180 g/m^2) and kraft liners (grammage from 125 g/m^2 to 400 g/m^2). The coefficient of variation ranged between 3 % and 7 %.

13 Test report

The test report shall include the following information:

a) reference to this International Standard;

b) date and place of testing;

c) description and identification of the material tested;

d) conditioning atmosphere used;

e) grammage, if determined;

f) direction of the test;

g) number of replicates carried out, if not 20, in each tested direction;

h) for each direction tested, the compressive strength and, if required, the coefficient of variation;

i) if required, for each direction tested, the compressive index;

j) any departure from the procedure described in this International Standard or any other circumstances which may have affected the test results.

Annex A
(normative)

Specifications for the clamps

The four jaw edges in contact with the test piece in the 0,70 mm span shall not be blunted.

The difference in the free span measured at the top and bottom of the jaws shall be less than 0,03 mm.

Those parts of the two surfaces of the stationary jaws that grip the test piece in the area close to the free span shall lie between two parallel planes spaced 0,01 mm apart or less. Furthermore, all points of the two surfaces, extending 30 mm in each direction from the free span, shall lie between two parallel planes spaced 0,2 mm apart or less (see Figure A.1).

All points of the bottom surfaces of the jaws shall lie between two parallel planes spaced 0,1 mm apart or less (see Figure A.2).

Dimensions in millimetres

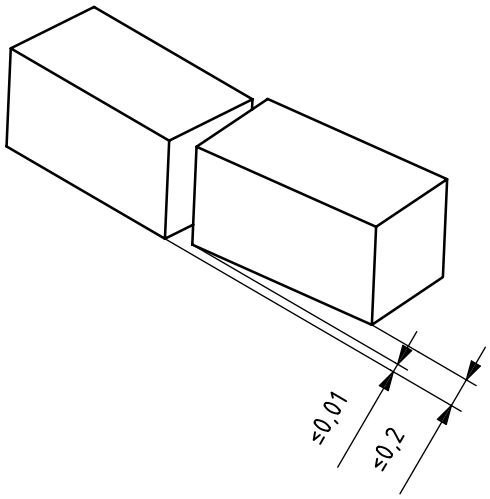


Figure A.1 — Specifications for the maximum permissible departure from parallelism of the clamping surfaces

Dimensions in millimetres

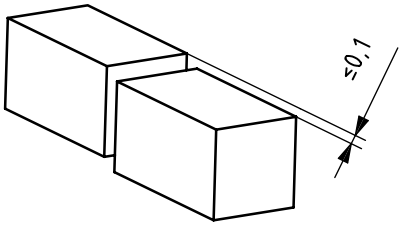


Figure A.2 — Specification for the maximum permissible departure from vertical alignment of the clamps

Annex B
(informative)

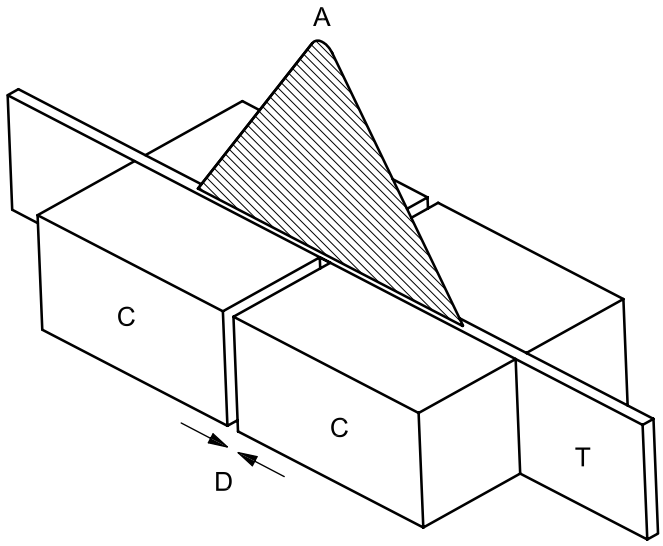
The reason for not measuring strain at break

The clamps of the compressive tester are constructed to clamp the test piece firmly without damaging it. The clamping force is therefore distributed over a large clamping area. This, however, has the consequence that the test piece slips or slides slightly during the test.

The strain in different parts of the test piece during a test is shown schematically in Figure B.1. It is highest in the free span section and gradually decreases in the clamped parts of the test piece.

The strain at break in compressive tests is of the order of 1 %, which means that the deformation to break in the 0,70 mm free span is only about 7 µm.

Because of the sliding of the test piece in the clamps, small variations in the free span and small movements of the clamps in the plane of the test piece do not affect the test result. However, the strain at break cannot be evaluated from the movement of the clamps and the method described in this International Standard shall not be used for that purpose.



Key

A strain distribution
C clamps
D direction of compression
T test piece

Figure B.1 — The strain in the test piece during a test

Bibliography

[1] ISO 5270, *Pulps — Laboratory sheets — Determination of physical properties*

[2] CAVLIN, S. and FELLERS, C. A new method for measuring the edgewise compression properties of paper, *Svensk Papperstidning*, **78** (9), pp. 329-32, 1975

[3] FELLERS, C. and DONNER, B.C. *Edgewise compression strength of paper*, pp. 481-525. In: *Handbook of Physical Testing of Paper*, **1**, Marcel Dekker, New York, 2002

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