INTERNATIONAL STANDARD

ISO 3034

Second edition
2011-06-01

Corrugated fibreboard — Determination of single sheet thickness

Carton ondulé — Détermination de l'épaisseur d'une feuille unique

Reference number
ISO 3034:2011(E)

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Published in Switzerland

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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 3034 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 3034:1975), which has been technically revised in compliance with ISO 534:2005[1]1). In addition, precision data have been inserted in Annex B.

1) ISO 534:2005 is currently being revised and this second edition of ISO 3034 is also in compliance with the forthcoming ISO 534:2011.

Corrugated fibreboard — Determination of single sheet thickness

1 Scope

This International Standard specifies a method for determining the single sheet thickness of corrugated fibreboard intended for use in the manufacture of packing cases.

This International Standard is applicable to all types of corrugated fibreboard.

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*

3 Terms and definitions

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

3.1
corrugated fibreboard
board consisting of one or more sheets of fluted paper glued to a flat sheet of board or between several sheets

[ISO 4046-4:2002, definition 4.49]

3.2
single sheet thickness corrugated fibreboard
distance between one surface of a corrugated fibreboard and the other, measured under an applied static load, using the test method specified in this International Standard

4 Principle

Measurement of thickness of corrugated board under a specific static load by means of a high-precision micrometer.

5 Apparatus

5.1 Dead-weight micrometer, provided with two plane, parallel, circular pressure faces, between which the corrugated board is placed for measurement.

The pressure exerted between the pressure faces during the thickness measurement shall be 20 kPa ± 0,5 kPa.

NOTE Other methods exist that use alternative pressures; however, different loading pressures might not give the same results.

The two pressure faces shall form an integral part of the micrometer, such that one face is fixed (the anvil) and the other is movable, in a direction perpendicular to the plane of the fixed face, smoothly at a speed of 2 mm/s to 3 mm/s. One face shall be 35,7 mm ± 0,3 mm in diameter and the second face shall be of such a size that it is in contact with the whole area of the other face when the micrometer reads zero. Thus, a circular region of a test piece, 1 000 mm^2 ± 20 mm^2 (10 cm^2 ± 0,2 cm^2) in area, is subjected during the thickness measurement to the pressure exerted between the faces.

The instrument shall be sufficiently accurate to permit measurements to be made to the nearest 0,05 mm (see Annex A).

The performance requirements of the micrometer shall be such that, when calibrated according to the method given in Annex A, the micrometer complies with the required pressure of 20 kPa ± 0,5 kPa and the performance requirements as shown in Table 1 (see also 9.2).

Table 1 — Micrometer performance requirements

Micrometer characteristics	Maximum permitted value
Indication error	±0,5 % of the reading
Error of parallelism between pressure faces	1 %
Repeatability of measurement (as standard deviation)	0,5 %

5.2 Thickness gauges (to be used in A.4), corresponding to approximately 10 %, 30 %, 50 %, 70 % and 90 % of the full-scale reading of the micrometer. The thickness of each gauge shall be known to an accuracy of 5 µm.

6 Sampling

If the tests are made 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 specimens taken are representative of the sample received.

7 Conditioning

Condition the specimens in accordance with ISO 187.

8 Preparation of test pieces

Prepare the test pieces in the same standard atmospheric conditions as used to condition the specimens.

The test pieces shall normally be free from any damage or other irregularities and, unless otherwise agreed between the interested parties, free from converting machine marks, printings, etc. that may affect the test results.

If the thickness of a printed sample is desired, all measurements should be performed in printed areas.

Testing can be done on a variety of samples in different states of quality to achieve various goals of process understanding and troubleshooting. Specimens should be representative of the materials being tested. If the test specimens are to be taken from corrugated shipping containers, they should be taken from areas away from scorelines, joints and closures. Unless otherwise agreed upon between interested parties, specimens should not be taken from obviously damaged areas and/or areas not representative of the container as a whole.

Select, at random, at least 5 specimens large enough to permit the cutting of at least 10 test pieces (two from each specimen). Cut from the specimens, test pieces each with an area of at least 10 000 mm^2 (100 cm^2), either square or circular (of diameter 112,9 mm). If only one test piece can be cut from each specimen, select 10 specimens and cut one test piece from each.

Ensure that the test piece dimensions are not so large that the micrometer reading is affected by the test piece mass that overhangs the lower pressure face while a measurement is being made.

9 Procedure

9.1 General

Prior to the use of the micrometer (5.1) or when calibrating it (see Annex A), ensure that the anvil, pressure foot and thickness gauges (5.2) are clean. Check the zero point of the precision micrometer before and also during a series of measurements.

NOTE Particularly in the case of the anvil and pressure foot, small pieces of fibre can collect on these surfaces, causing erroneously high values.

With the pressure faces in contact with one another, set the micrometer reading to zero.

9.2 Verification and calibration of micrometer

At appropriate time intervals, calibrate the micrometer at the temperature of normal use, and verify its performance using the method given in Annex A.

9.3 Determination of single board thickness

Carry out the test in the standard atmospheric conditions at which the samples were conditioned.

Place the micrometer on a horizontal vibration-free surface, and place the test piece between the open pressure faces of the micrometer at a position at least 20 mm from any edge of the test piece. Permit the test piece to be held by the pressure face, by very carefully allowing the movable pressure face to move steadily and slowly, at a velocity of 2 mm/s to 3 mm/s, towards the anvil so that any punching effect is avoided.

Record the micrometer reading as soon as its value becomes steady, normally within 2 s to 5 s. If any “bedding down” of the corrugated board can occur, the reading shall be within 2 s to 3 s. Avoid imposing any manual stress on the test piece or micrometer while a reading is being made. Make only one measurement on the test piece.

Repeat the above procedure for the remaining test pieces.

10 Calculation and expression of results

Calculate the mean value and standard deviation of not less than ten readings made in accordance with 9.3. Express the single sheet thickness corrugated fibreboard, in millimetres, to three significant figures.

11 Test report

The test report shall include the following information:

a) a reference to this International Standard;

b) the date and place of testing;

c) a description and identification of the material tested;

d) the conditioning atmosphere used;

e) the arithmetic mean of the single sheet thickness corrugated fibreboard, as stated in Clause 10, and the standard deviation;

f) any deviation from this International Standard that may have affected the results;

g) any other information which may assist in the interpretation of the test results; in particular, whether any areas compressed by printing or other converting machines are involved.

Annex A
(normative)

Verification of micrometer performance and calibration

A.1 General

Verify the performance of the micrometer in the conditioned atmosphere, in which thickness measurements are to be made, using the following tests in the order given.

For micrometers in frequent use, determine the indication error and repeatability of measurement and determine the pressure exerted between the pressure faces and their error of parallelism according to the recommendation of the manufacturer.

If the micrometer performance is not within the tolerance appropriate to a particular measurement (see 5.1), make the necessary correction and recommence the series of tests.

To cover the range of corrugated fibreboards normally encountered, it is desirable that the measuring capacity of the dead-weight micrometer should be at least 20 mm.

Prior to the calibration, ensure that the anvil, pressure foot and thickness gauges (5.2) are clean. When thickness gauges are used, they should be gently wiped with alcohol using a non-linting absorbent material.

A.2 Pressure exerted between pressure faces

Use any suitable means (e.g. certified load cells or a laboratory balance with a through-spindle mounted above the micrometer with a cradle to suspend the pressure foot) of verifying the accuracy and uniformity of the pressure exerted between the pressure faces. This verification can also be performed during the calibration service by the manufacturer.

Use pressure-sensitive film to verify the evenness of pressure.

A.3 Indication error and repeatability of measurement

A.3.1 With the pressure faces in contact with one another, set the micrometer reading to zero. Do not reset the zero reading during the following procedure.

A.3.2 Open the gap between the pressure faces, allow it to close again so that the pressure faces make contact with one another, and note the micrometer reading. Repeat this procedure at least five times.

A.3.3 Take one of the thickness gauges specified in 5.2, open the gap between the pressure faces, interpose the gauge, allow the faces to close upon the gauge (see 9.1) and note the micrometer reading. Avoid direct handling of the thickness gauges when cleaning or positioning them. Repeat this procedure at least five times.

A.3.4 Repeat the procedure described in A.3.3, using, in turn, each of the remaining thickness gauges.

NOTE The thickness gauges are used singly, not in combination.

A.3.5 Repeat the procedure described in A.3.2.

A.3.6 For each gauge thickness at which micrometer readings are taken, calculate

a) the repeatability of measurement, that is, the standard deviation of the five (or more) readings taken, and

b) the indication error, i.e. the difference between the mean of the five (or more) readings taken and the gauge thickness.

A.4 Parallelism of pressure faces

A.4.1 Take one of the thickness gauges specified in 5.2, open the gap between the pressure faces and interpose the gauge, as near as possible to one edge of the faces. Allow the pressure faces to close upon the gauge (see 9.1) and note the micrometer reading.

A.4.1.1 Open the gap between the pressure faces and interpose the thickness gauge as close as possible to the edge of the faces diametrically opposite the edge used in A.4.1. Allow the pressure faces to close upon the gauge (see 9.1) and again note the micrometer reading.

A.4.2 Repeat the procedure described in A.4.1, using positions as near as possible to the edge of the pressure faces and on a diameter perpendicular to that passing through the points referred to in A.4.1.

A.4.3 Repeat the procedure described in A.4.1, A.4.1.1 and A.4.2, using, in turn, each of the remaining thickness gauges.

NOTE The thickness gauges are used singly, not in combination.

A.4.4 For each gauge thickness at which micrometer readings are taken, calculate the error of parallelism, E, according to Equation (A.1):

$$E = 0{,}5\sqrt{d_1^2 + d_2^2} \tag{A.1}$$

where

d_1 is the difference between the readings corresponding to opposite ends of a diameter of the pressure faces;

d_2 is the difference between the readings corresponding to opposite ends of a diameter of the pressure faces perpendicular to that used to obtain d_1.

Annex B
(informative)

Precision

B.1 General

The following data were obtained by the CEPI Comparative Testing Service (CTS) round 2 in 2009. The participating laboratories (labs.) made ten measurements on each of the two samples.

The calculations have been made according to ISO/TR 24498:2006[4] and TAPPI Test method T 1200 sp-07[5].

When data from CEPI-CTS are used, there is a need to recalculate the data to present the repeatability limits and reproducibility limits:

The repeatability limit, r, can be calculated from: $r = 1{,}96 \times \sqrt{2} \times s_{\text{within lab.}}$

The reproducibility limit, R, can be calculated as: $R = 1{,}96 \times \sqrt{2} \times \sqrt{s^2_{\text{within lab.}} + s^2_{\text{between labs,}}}$

The repeatability standard deviation reported in Table B.1 is the “pooled” repeatability standard deviation, that is, the standard deviation calculated as the root-mean-square of the standard deviations of the participating laboratories. This differs from the conventional definition of repeatability in ISO 5725-1[3].

The repeatability and reproducibility limits reported are estimates of the maximum difference which should be expected in 19 of 20 instances, when comparing two test results for material similar to those described under similar test conditions. These estimates may not be valid for different materials or different test conditions.

Repeatability and reproducibility limits are calculated by multiplying the repeatability and reproducibility standard deviations by 2,77.

NOTE $2{,}77 = 1{,}96 \times \sqrt{2}$, provided that the test results have a normal distribution and that the standard deviation s is based on a large number of tests.

B.2 Repeatability

Table B.1 — Estimation of the repeatability of the test method for single sheet thickness for corrugated fibreboard

Sample	Number of labs	Mean thickness $\overline{X}$ mm	Standard deviation s_r mm	Coefficient of variation $C_{V,r}$ %	Repeatability limit r mm
Level 1	15	4,00	0,022	0,537	0,060
Level 2	13	6,96	0,035	0,508	0,098

B.3 Reproducibility

Table B.2 — Estimation of reproducibility of the test method for single sheet thickness for corrugated board

Sample	Number of labs	Mean thickness, $\bar{X}$ mm	Standard deviation s_R mm	Coefficient of variation $C_{V,r}$ %	Reproducibility limit R mm
Level 1	15	4,00	0,025	0,637	0,071
Level 2	13	6,96	0,047	0,676	0,130

Bibliography

[1] ISO 534:2005, *Paper and board — Determination of thickness, density and specific volume*

[2] ISO 4046-4:2002, *Paper, board, pulps and related terms — Vocabulary — Part 4: Paper and board grades and converted products*

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

[4] ISO/TR 24498:2006, *Paper, board and pulps — Estimation of uncertainty for test methods*

[5] TAPPI Test method T 1200 sp-07, *Interlaboratory evaluation of test methods to determine TAPPI repeatability and reproducibility*

ICS 85.060

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