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Corrugating medium — Determination of the flat crush resistance after laboratory fluting —

Part 1: A-flute

Papier cannelure — Détermination de la résistance à la compression à plat après cannelage en laboratoire —

Partie 1: Cannelure A

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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.

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 of 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 www.iso.org/iso/foreword.html.

This document 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 document cancels and replaces ISO 7263:2011, which has been technically revised.

The main changes compared with ISO 7263:2011 are as follows:

— ISO 7263 has been divided into two parts due to technical developments to allow both A-flute (Part 1) and B-flute (Part 2) performance to be tested;

— Clause 1: editorial changes have been made to the scope;

— Clause 2: normative references have been updated;

— Clause 7: this document requires conditioning of samples where testing will be carried out immediately after fluting, not only where test pieces will be reconditioned before testing;

— 9.2: for testing immediately after fluting the time between fluted test piece discharge and initial application of force has been increased to a more realistic level;

— Clause 11: precision with more detailed description of precision data according to ISO/TR 24498 and TAPPI T 1200 has been moved to informative Annex B;

— Test report is now Clause 11 and has been updated;

— Annex B: precision data according to ISO/TR 24498 and TAPPI T 1200 has been added.

A list of all parts in the ISO 7263 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The flat crush resistance of laboratory-fluted corrugating medium is regarded as a property indicating the potential flat crush resistance of corrugated fibreboard made from that medium. The corrugated medium is fluted by passing it between heated rollers. Two different test procedures are used:

a) the fluted corrugating medium is compressed immediately after fluting (i.e. 15 s to 25 s after fluting);

b) the fluted corrugating medium is conditioned for 30 min to 35 min under standard laboratory test conditions before being compressed.

Since considerable advantages are claimed for both procedures and both are widely used, the ISO 7263 series describes both procedures. Procedure a) generally gives considerably higher results than those obtained with procedure b). The differences in results are claimed to be caused by the lower moisture content (and thus higher stiffness) of the unconditioned fluted corrugating medium, and/or the change in flute profile which occurs during the conditioning period.

This document describes the testing method for the A-flute geometry.

ISO 7263-2[6] describes the testing method for the B-flute geometry.

The option of using an A- or B-flute geometry is determined by the producer and/or the end-use customer; it is not required for any particular flute structure.

A method for determining the flat crush resistance of manufactured corrugated fibreboard is given in ISO 3035[3].

Corrugating medium — Determination of the flat crush resistance after laboratory fluting —

Part 1:
A-flute

1 Scope

This document describes a method for the determination of the flat crush resistance of a corrugating medium after laboratory fluting using an A-flute geometry.

The procedure is applicable to any corrugating medium intended to be used, after fluting, in the manufacture of corrugated board.

NOTE ISO 7263-2 describes a method to determine the flat crush resistance using a B-flute geometry.

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

ISO 13820, *Paper, board and corrugated fibreboard — Description and calibration of compression-testing equipment*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
flat crush resistance
maximum force that a corrugated test piece will withstand before the flutes collapse under an increasing force applied perpendicular to its surface

Note 1 to entry: The flat crush resistance is expressed in newtons (N).

3.2
flat crush resistance index
flat crush resistance (3.1) divided by the grammage of the paper

Note 1 to entry: The result is expressed in newton square metres per gram (Nm^2/g).

4 Principle

Fluting of the corrugating medium by passing it between heated rollers, and its formation into single-faced corrugated board using pressure-sensitive adhesive tape as the facing. Application of a crushing force, in the direction perpendicular to the plane of the flutes, and determination of the flat crush resistance.

For details regarding the test method precision, see Annex B.

5 Apparatus

5.1 Cutting device, for cutting the test pieces to the dimensions required.

5.2 Fluter, consisting of a pair of matched rotating steel corrugating rolls, a means of heating the rolls and a chute for feeding test pieces squarely between the rolls.

The roll temperature shall be maintained at 175 °C ± 8 °C. The temperature can be controlled by any suitable method. Check the temperature when the rolls are in motion.

One roll is motor-driven at 4,5 r/min ± 1,0 r/min and the rolls are held in mesh by a force of 100 N ± 10 N exerted between the rolls and distributed evenly across the teeth, under test conditions. In some instruments, the force between the rolls is applied by a spring acting in a slide. In such instruments, friction in this device can result in the force which acts upon the test piece being considerably less than the force required to displace the rolls initially. When verifying that an instrument conforms to the requirements, it is therefore necessary to measure the force required to just prevent the stationary roll from moving towards the driven roll, from a position about 200 µm away.

The essential characteristics of each roll are shown in Table 1.

Table 1 — Measurements for A-flute

Description	A-profile
Roll diameter	(228,5 ± 0,5) mm
Roll face width	≥ 15 mm
Number of teeth for full roll	84
Radius of teeth at peak	(1,5 ± 0,1) mm
Radius of teeth at base	(2,0 ± 0,1) mm
Depth of teeth	(4,75 ± 0,05) mm
Distance between teeth (peak to peak around the arc)	(8,55 ± 0,05) mm

In order to optimize the matching of pairs of rolls, pairs of rolls should be selected in which the differences in dimensions between the two are substantially less than the tolerances shown. A difference of 0,1 mm or less for the pair of rolls is recommended. Prior to first use, the rolls should be run at the operating temperature for about 6 h with a mild abrasive on the teeth. The two rolls should then be marked in some way so that, after removal for cleaning or maintenance, they can be reassembled with exactly the same teeth in mesh.

NOTE In some fluters, a full roll is not used.

Partial roll fluters may be used, if they meet the geometry described in Table 1.

For maintenance of fluting rolls (horizontal type) see Annex A.

Dimensions in millimetres

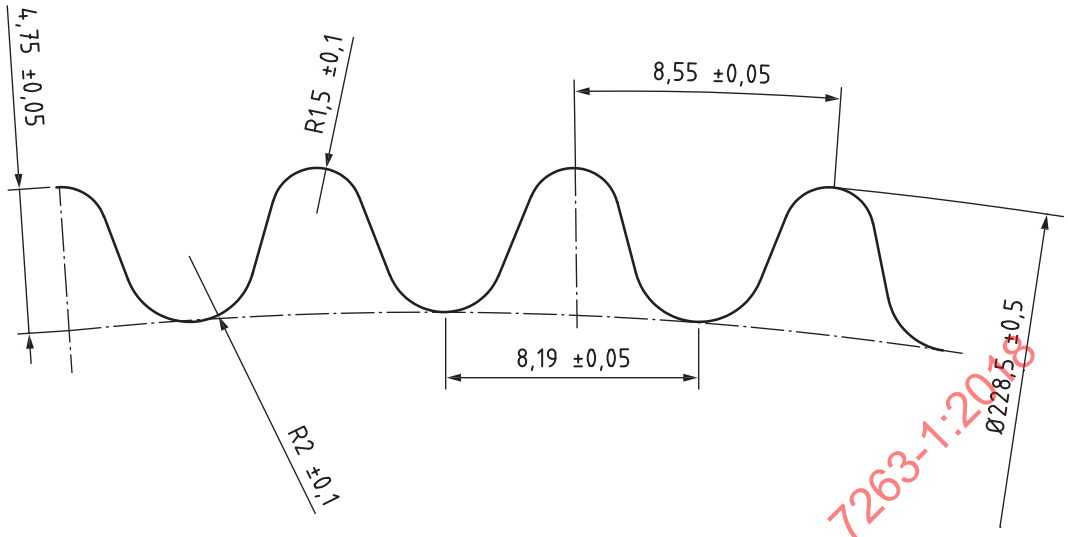


Figure 1 — A-profile of corrugating rolls

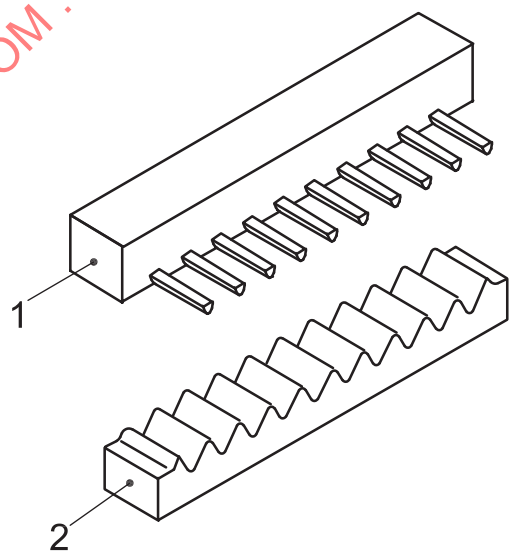
5.3 Rack and comb.

5.3.1 Rack, at least 19 mm wide with a profile corresponding to the teeth of the corrugating rolls.

It has nine full teeth and one incomplete tooth at each end so as to form 10 valleys. The tooth spacing and the height of the teeth correspond to the data in Table 1, Figure 1 and Figure 3.

5.3.2 Comb, at least 19 mm wide with 10 prongs (see Figure 2 and Figure 3).

The rack (5.3.1) and comb may be replaced with an automatic device, provided it can be demonstrated that this device will produce the same results. For the comb, a trapezoidal profile is recommended.



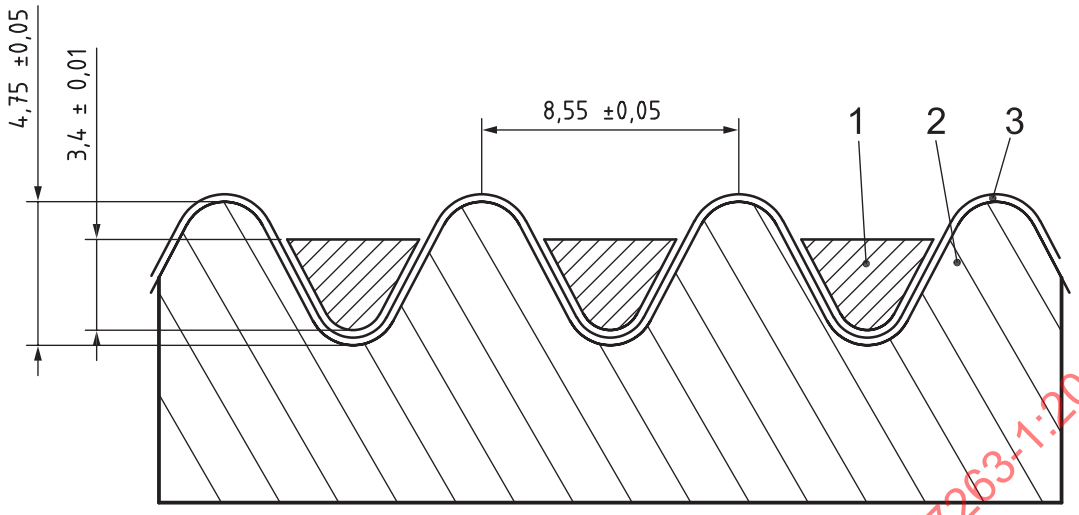
Key

1 comb

2 rack

Figure 2 — Profile of comb and rack

Dimensions in millimetres



Key

1 comb
2 rack
3 paper

Figure 3 — Dimensions of comb and rack

5.4 Pressure-sensitive adhesive tape, for example Tesafix 4961, Permacell P-50 and 3M grade 410 tape[1)] at least 15 mm wide.

The tape shall be of low stretch and have good adhesion properties; it shall not transfer moisture to the substrate during the test.

5.5 Flat crush tester, motor-driven, fixed-platen type in accordance with ISO 13820.

Test shall be conducted with sandpaper (400 grit, see the ISO 6344 series[5]) on the platens. The test appliance shall be operated with a compression rate of 12,5 mm/min. Any deviation from this shall be specified in the report.

6 Sampling

If the tests are being made to evaluate a lot, the sample shall be selected 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 sample in accordance with ISO 187.

8 Preparation of test pieces

If the determination of the flat crush resistance index is required, the grammage of the conditioned sample shall be tested according to ISO 536. Test pieces shall be free from wrinkles, creases and other visible defects.

1) Tesafix 4961, Permacell P-50 and 3M grade 410 tape are examples of suitable products available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of these products.

Cut at least 10 test pieces with a width of 12,7 mm ± 0,1 mm and a length of 150 mm to 160 mm.

The length shall be cut in the machine direction. Care should be taken not to damage the edges of the test pieces and they should not be handled more than is necessary.

9 Procedure

9.1 General

The compression test shall be carried out immediately after fluting (see 9.2) or after reconditioning (see 9.3).

9.2 Testing immediately after fluting

If the test is to be carried out immediately after fluting, the total time between discharge of the fluted test piece from the fluting rolls and the initial application of the crushing force shall be 15 s to 25 s. Arrange all equipment to facilitate completing the operations in the specified time, including pre-cutting lengths of the adhesive tape (5.4) that is to serve as the facing to the prescribed length (at least 120 mm long) and adhering one end of each strip lightly to the workbench.

9.3 Testing after 30 min of reconditioning

If the test is to be carried out after reconditioning, the composite test piece (i.e. the fluted test piece attached to the adhesive tape) shall be reconditioned for 30 min to 35 min in the conditioning atmosphere used to condition the samples (see Clause 7). If the test is carried out on reconditioned samples, all of the composite test pieces may be formed prior to testing.

9.4 Fluting and testing

Start the motor and heat the corrugating rolls (5.2) to 175 °C ± 8 °C. Taking care that one edge is flat on the guide, feed a test piece into the corrugating rolls with its longer side perpendicular to the nip. When the corrugated test piece emerges from the fluting rolls, place it on the rack (5.3.1) so that approximately equal lengths rest on the flat surfaces at each end of the rack.

Place the comb (5.3.2) over the corrugated test piece and press down so that it is held firmly in the valleys of the rack, ensuring that the test piece is bottomed uniformly in each of the flutes.

NOTE A rolling motion of the comb as it is placed on the test piece aids in forming the composite test piece on the rack.

Flatten the ends of the corrugated test piece to facilitate subsequent removal of the test piece from the comb. Next place a strip of the adhesive tape (5.4), at least 120 mm long, adhesive side down, along the tips of the flutes and apply pressure (preferably by means of a flat rigid block) to the tape to adhere it to the tips of the flutes and the test piece ends. Carefully withdraw the comb from the flutes, without damaging the test piece, and lift the resulting 10-flute composite test piece out of the rack. If more than 10 flutes are formed, crush the extra flute(s) by hand prior to testing.

Care shall be taken to avoid distortion of the flutes caused by applying too great a pressure when adhering the tape to the tips of the flutes.

Perform the flat crush tests either immediately or after reconditioning (in the same conditioning atmosphere used to condition the samples).

Place the composite test piece centrally on the lower platen of the crush tester (5.5) with the uncovered flutes upwards. Start the crush tester and determine, to the nearest 1 N, the maximum force registered when completely crushing the flutes.

If the flutes have been pressed sideways during the compression or if they have come away from the tape at any point, reject the results.

Repeat the procedure for the remaining test pieces until a total of at least 10 valid results has been obtained.

10 Expression of results

10.1 Flat crush resistance

Calculate the mean flat crush resistance, to the nearest 1 N, from the valid results.

Calculate the standard deviation from the mean of the valid results.

To assist in the immediate identification of the results, for many purposes it may be most convenient to express the results in the form:

CMT_{A0} = 350 N

where

CMT is the corrugated medium test;

A0 is the flute geometry with A or B and the time, in minutes, for reconditioning.

If required, calculate the flat crush resistance index, in newton square meters per gram, using Formula (1):

$$X = \frac{\overline{F}}{g} \tag{1}$$

where

$\overline{F}$ is the mean flat crush resistance, in newtons;

g is the grammage, in grams per square metre, determined in accordance with ISO 536.

Report the flat crush resistance index to three significant figures.

11 Test report

The test report shall include the following information:

a) a reference to this document, i.e. ISO 7263-1;

b) the date and place of testing;

c) the rate of loading;

d) the flute geometry used;

e) the type of pressure-sensitive adhesive tape used (see 5.4);

f) a description and identification of the product tested;

g) the conditioning atmosphere used;

h) the time, to the nearest minute, between fluting and crushing (or reconditioning after fluting for CMT_{30});

i) the number of valid tests, and the arithmetic mean and standard deviation of all valid test results, to the nearest 1 N;

j) if required, the flat crush resistance index, in newton square metres per gram, to three significant figures;

k) details of any deviation from this document, including if a test width of 15 mm has been used;

l) any other information that may assist in the interpretation of the test results.

Annex A
(informative)

Maintenance of fluting rolls (horizontal type)

Uniform meshing of fluting rolls can be checked by using, for example, national cash register tape[2)], (CB white national cash register paper and CR green tinted national cash register paper C2R).

Run a 12,7 mm-wide strip of each type of paper through the fluting rolls. The pressure pattern will appear on the green tinted strip. The pressure lines should be uniform and extend the full 12,7 mm width of the strip. If there is more impression at the top or bottom of the rolls, they are not in the same plane. This means that the heating plate has warped or is worn unevenly, or that the bearings are worn. In any case, the fluter should go back to the manufacturer for repair.

The rolls should ride flat on the heating plate. If the drive roll is not flat on the heating plate, loosen the collar directly above the bottom-bearing housing and tap the roll lightly until it is lying flat. It may also be necessary to loosen the bottom bearing. Make this adjustment only when the fluter is up to normal operating temperature. When the roll is flat, tighten all bolts and set screws. Remove the driven roll by taking out the centre bolt and lifting the roll up by the bolts inserted in the thread holes provided. Inspect the heating plate for wear of the chrome plating. If worn, a new heating plate should be installed by the manufacturer. The roll can also be inspected for smoothness and wear on the bottom. The spring-loaded post slide can be checked for freedom of movement and lubricated with powdered graphite, if necessary. When the roll is replaced, powdered graphite should be added to the lubricating hole while the roll is turning. Graphite should be added until the grooves under the roll are completely filled. The same holds true for the drive roll.

2) National cash register tape is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

Annex B
(informative)

Precision data

This method includes several approaches for measurement of CMT_A. The precision of the method will depend on both the time for reconditioning (CMT_{A0} and CMT_{A30}) and other factors. Thus, precision data from several different interlaboratory tests are included here.

The calculations are made according to ISO/TR 24498[7] and TAPPI T 1200[9].

The repeatability standard deviation is the "pooled" repeatability standard deviation. The standard deviation is 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[4].

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 might 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 1 The repeatability standard deviation and the within-laboratory standard deviation are identical. However, the reproducibility standard deviation is not the same as the between-laboratory standard deviation. The reproducibility standard deviation includes both the between-laboratory standard deviation and the standard deviation within a laboratory, viz.:

$$s^2_{\text{repeatability}} = s^2_{\text{within lab}} \quad \text{but} \quad s^2_{\text{reproducibility}} = s^2_{\text{within lab}} + s^2_{\text{between lab}}$$

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

Where a rigid platen tester is used and crushing commences 20 s to 25 s after the emergence from fluting, a repeatability of 5 % and a reproducibility of 11 % have been found for the test results, each of which is an average of 10 determinations. These data were obtained in an interlaboratory trial among 53 laboratories using rigid platen testers.

Where the test specimen is conditioned before fluting and reconditioned 30 min after fluting, a repeatability of 9 % and a reproducibility of 11 % have been found for test results, each of which is an average of 10 determinations. These data were obtained in an interlaboratory trial among 14 laboratories.

The TAPPI-CTS round-robin program examined semi chemical medium of about 127 g/m^2, where crushing commences 20 s to 25 s after the emergence from fluting (CMT_{A0}). The results were drawn from three different materials, in eight consecutive independent weekly trials. For example, the estimates presented are drawn from 19 laboratories performing eight trials over consecutive weeks. Each trial is 10 determinations, so the estimates are based on 1 520 independent determinations (19*8*10). Estimations of repeatability and reproducibility are presented in Table B.1 and Table B.2.

Table B.1 — Estimation of the repeatability CMT_{A0}

Number of laboratories/trials/ determinations	Mass per unit area	Property mean	Repeatability standard deviation	Repeatability	Repeatability in percent
			s_r	r	
	g/m²	N	N	N	%
19/8/10	~127	268	4	11	3,9
23/8/10	~127	262	3	9	3,5
22/8/10	~127	275	4	11	3,9

Table B.2 — Estimation of the reproducibility CMT_{A0}

Number of laboratories/trials/ determinations	Mass per unit area	Property mean	Reproducibility standard deviation	Reproducibility	Reproducibility in percent
			s_R	R	
	g/m²	N	N	N	%
19/8/10	~127	268	8	21	7,8
23/8/10	~127	262	8	21	8,0
22/8/10	~127	275	7	18	6,6

In 2015 a German interlaboratory test, in which five laboratories participated, was performed for four paper grades from 60 g/m² to 90 g/m². Further tests were carried out by a CEPI-CTS round-robin program in 2016, in which eight laboratories participated. The data are presented in Table B.3 and Table B.4.

Table B.3 — Estimation of the repeatability CMT_{A30}

Number of laboratories/ determinations	Mass per unit area	Property mean	Repeatability standard deviation	Repeatability	Repeatability in percent
			s_r	r	
	g/m²	N	N	N	%
5/10	60	59	3	7	12,2
5/10	70	75	3	8	11,1
5/10	80	98	4	12	12,3
5/10	90	137	6	15	11,0
8/10	100	156	10	26	16,8
8/10	145	356	15	43	12

Table B.4 — Estimation of the reproducibility CMT_{A30}

Number of laboratories/ determinations	Mass per unit area	Property mean	Reproducibility standard deviation	Reproducibility	Reproducibility in percent
			s_R	R	
	g/m²	N	N	N	%
5/10	60	59	3	7	12,3
5/10	70	75	4	12	15,5
5/10	80	98	6	16	16,1