
**Corrugated fibreboard —
Determination of edgewise crush
resistance (unwaxed edge method)**

*Carton ondulé — Détermination de la résistance à la compression sur
chant (méthode sans enduction de cire)*





COPYRIGHT PROTECTED DOCUMENT

© ISO 2013

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

	Page
Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Principle	1
5 Apparatus	1
6 Sampling	2
7 Conditioning	2
8 Preparation of test pieces	2
9 Procedure	3
10 Calculation	3
11 Test report	4
Annex A (informative) Examples of suitable cutting devices	5
Annex B (informative) Precision data	6
Bibliography	8

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. 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. 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.

The committee responsible for this document is ISO/TC 6, *Paper, board and pulps*, Subcommittee SC 2, *Test methods and quality specifications for paper and board*.

This fifth edition cancels and replaces the fourth edition (ISO 3037:2007), which has been technically revised. Specifications for the compression testing machine have been replaced by reference to ISO 13820. Details of acceptable cutting devices have been moved to an informative annex and have been replaced by specifications of the quality of cut. In addition, precision data have been inserted in [Annex B](#).

Introduction

A variety of methods for the determination of edgewise crush resistance are in use in different parts of the world. These can be classified into three groups as follows:

- a) Those in which a carefully cut rectangular test piece is tested without any special treatment or modification (e.g. ISO 3037).
- b) Those in which the edges of the test piece to which the force is applied are waxed, to prevent the test result being influenced by “edge effects” (e.g. ISO 13821, *Corrugated fibreboard — Determination of edgewise crush resistance — Waxed edge method*).
- c) Those in which the test piece edges are not waxed but the shape of the test piece is such that the length is substantially reduced at a point midway between the loaded edges, in order to induce the failure to occur away from those edges (e.g. JIS Z 0403-2).

The dimensions of the test piece vary from one group to the other and, in group c), the methods vary in the shape and method of reducing the length, and in whether or not the test piece is held in a clamp during crushing.

The methods may not give the same numerical results, but it can be shown that most of them can be used to predict the top-to-bottom compression strength which will be achieved when the board is properly converted into a transport package.

This International Standard describes a method from group a). It is intended as a method for quality measurement and quality specification purposes and is selected because it correlates with the top-to-bottom compression strength of the final transport package and because it is the simplest and most operationally convenient method, an important factor when large numbers of tests need to be conducted. However, it does not measure the actual intrinsic compressive strength of the corrugated fibreboard, giving lower results than most of the methods in groups b) and c). This systematic difference is due to edge effects.

Other methods may be used for other purposes, particularly when the object of the test is to study fundamental structural characteristics of the package.

There are methods available for calculating the edgewise crush resistance from the compression strength of the component papers.

Corrugated fibreboard — Determination of edgewise crush resistance (unwaxed edge method)

1 Scope

This International Standard specifies an unwaxed edge method for the determination of the edgewise crush resistance of corrugated fibreboard. It is applicable to all corrugated fibreboard grades.

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 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.

3.1

edgewise crush resistance

maximum force per unit length that a test piece of corrugated fibreboard can support until the onset of failure when a compressive force is applied with the flute structure perpendicular to the loading surfaces

4 Principle

A rectangular test piece of corrugated fibreboard, placed between the platens of a compression tester with the flutes perpendicular to the surfaces of the platens, is subjected to an increasing compressive force until failure occurs. The maximum force sustained by the test piece is measured.

5 Apparatus

5.1 Fixed-platen compression testing machine as described in ISO 13820. It is preferable to avoid the use of emery paper on the platens.

While it is safer to avoid the use of emery paper on the platens, because it is a requirement of other test methods, the platens may be faced with very fine emery paper of a grade not coarser than 00. Where this is done, due regard should be paid to maintaining the flatness and parallelism requirements specified for the faces.

NOTE A flexible beam compression tester per ISO 13820 is not recommended for this test method as there are significant questions regarding its ability to be maintained with sufficient parallelism to provide accurate test values for these specimens.

5.2 Cutting device, such as a high-speed table saw or Billerud-type cutter (see [Annex A](#)), capable of cutting test pieces to the quality of cut described in [8.3](#) and [8.4](#).

5.3 Guide blocks, two rectangular, smooth-finished, blocks of dimensions approximately 20 mm x 20 mm x 100 mm, to support the test piece and keep it perpendicular to the platen surfaces. It is advisable to fit each guide block with a probe, to enable each block to be moved safely during the test.

6 Sampling

If the average quality of a lot of corrugated fibreboard is to be determined, sampling shall be carried out in accordance with ISO 186. If another type of sample is to be tested, make sure that the test pieces taken are representative of the sample received.

7 Conditioning

The sample shall be conditioned in accordance with ISO 187.

8 Preparation of test pieces

8.1 Prepare the test pieces in the same atmospheric conditions as used to condition the sample.

8.2 Using a sharp blade and a procedure that ensures the cuts are parallel, cut, from the sample, specimens with the following dimensions: 100,0 mm \pm 0,5 mm in the direction perpendicular to the flutes and 70 mm to 300 mm in the direction parallel to the flutes, such that test pieces can be obtained from an undamaged area of the sample.

8.3 From undamaged areas of the specimens ([8.2](#)), using an appropriate cutting device ([5.2](#)), cut sufficient test pieces 25,0 mm \pm 0,5 mm in the direction parallel to the flutes, so that 10 valid tests are obtained. Each test piece will then measure 25,0 mm \pm 0,5 mm in height (the direction of the flutes) and 100,0 mm \pm 0,5 mm in length (the direction perpendicular to the flutes).

If a Billerud-type cutter ([5.2](#)) is used, insert the uncut strip until it almost contacts the end stop, and ensure that a sufficient length of strip extends on the other side of the blades and that the edge is in contact with the squareness guide.

Irrespective of the method of cutting, the edges subjected to load shall be cleanly cut, straight, parallel and perpendicular to the board surfaces ([8.4](#)).

8.4 Test piece quality. Each test piece shall be examined for quality.

The width of the test piece shall not vary by more than 0,1 mm along its length.

Cleanness of cut is judged by inspection of the test pieces. Flutes shall show no discernible distortion, and the cut edges shall not be furry or have loose fibres visible when inspected under normal laboratory conditions, i.e. under room lighting with no magnification.

Straightness, parallelism and perpendicularity may be judged by the following procedure.

Stand two test pieces on their cut edges on a plane surface with two of their faces almost touching. With perfectly flat board, the two adjacent faces should appear flat and parallel to each other over their whole surface. If the board is warped, this may not be so, but the test pieces are acceptable if they stand vertically on their bottom edges, if the top cut surfaces appear flat and parallel to each other and at right angles to the liner surfaces close to the cut, and if the cut ends of the test pieces appear to be in the same plane. It should not be possible to see light under the cut edge of either test piece, when a load of about 1 N (equivalent to light finger pressure) is applied to the top edge.

Rotate one test piece end-for-end (rotate 180° about its vertical axis) and invert it (rotate 180° about its horizontal axis), then invert the other test piece. In each configuration, the criteria of the preceding paragraph shall apply.

Test other pairs of test pieces in the same way.

With cutters of the high-speed saw and Billerud type ([Annex A](#)) and any other type of cutter, where relevant, these checks should be done when the cutter is first used to establish that it is operating correctly. Thereafter, the checks should be done periodically to ensure that the cutter remains in good condition.

NOTE The quality of test piece cutting can have a significant effect on the test results and it is therefore essential that this be maintained to the highest possible standard. More information on the importance of accurate, parallel cutting can be found in the References in the bibliography.

9 Procedure

Conduct the tests in the standard atmosphere that was used in [Clause 7](#).

With the platens of the compression tester ([5.1](#)) conveniently separated, place the test piece on one of its 100 mm cut edges onto the lower platen. Support it by placing a guide block ([5.3](#)) on each side. The guide blocks may be relocated away from the test piece when the load reaches about 50 N. They may be either left on the platen or removed from it. If applicable, take whatever action is appropriate to ensure that the weight of the guide blocks does not contribute to the force reading.

Operate the tester until the test piece fails. Test failure can be identified by a maximum in the load-deflection curve, which often corresponds to visual compression in the body of the specimen and/or curling of the edges of the specimen where they are in contact with the loading platens.

Record, to the nearest 1 N, the maximum force, F_{\max} , developed up to the moment when instant failure occurs. Repeat the test on sufficient test pieces, so that at least 10 valid results are obtained.

10 Calculation

10.1 Calculate the mean maximum force, \bar{F}_{\max} , and standard deviation, $s_{F_{\max}}$.

10.2 Calculate the edgewise crush resistance R , expressed in kilonewtons per metre, to the nearest 0,01 kN/m using the equation:

$$R = \frac{\bar{F}_{\max}}{l} \quad (1)$$

where

\bar{F}_{\max} is the mean maximum force, in newtons;

l is the length of the test piece, in millimetres (100 mm).

10.3 Calculate the standard deviation of the edgewise crush resistance, s_R , expressed in kilonewtons per metre, to the nearest 0,01 kN/m, using the equation:

$$s_R = \frac{s_{F_{\max}}}{l} \quad (2)$$

where

$s_{F_{\max}}$ is the standard deviation of the maximum force, in newtons;

l is the length of the test piece, in millimetres (100 mm).

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) the type of compression tester used;
- d) the type of cutter used;
- e) identification of the sample and description of the product tested;
- f) the conditioning atmosphere used;
- g) the edgewise crush resistance and its standard deviation;
- h) the number of replicate tests;
- i) any other information which may assist in the interpretation of the results.

Annex A (informative)

Examples of suitable cutting devices

A.1 High-speed table saw equipped with a small-tooth, no-set, hollow ground blade and minimum clearance throatplate, and with the saw blade at 90° to the table supporting the sample.

A.2 Billerud-type cutter fitted with flat, straight, parallel and sharp blades approximately 0,5 mm thick, sharpened to a bevel of about 3 mm. If single-bevel blades are used, the blades should be mounted so that the plane sides of the blades face each other, i.e. inwards. The blades of such a cutter must be kept in good alignment. A Billerud-type cutter is usually unsuitable for cutting test pieces from triple-wall board and some heavyweight double-wall board.

It is recommended that the blades of this type of cutter should not be used more than 50 times between sharpening or replacement.

Annex B (informative)

Precision data

The estimates of repeatability and reproducibility are based on data from the CEPI-CTS (Confederation of European Paper Industries Comparative Testing Service) round 1 in 2011.

The calculations have been made according to ISO/TR 24498[2] and TAPPI Test method T 1200 sp-07[3].

The repeatability standard deviation reported in Table B.1 is the “pooled” repeatability standard deviation that is, 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 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 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-laboratories standard deviation. The reproducibility standard deviation includes both the between-laboratories standard deviation and the standard deviation within a laboratory, viz:

$$s_{\text{repeatability}}^2 = s_{\text{within lab}}^2$$

but

$$s_{\text{reproducibility}}^2 = s_{\text{within lab}}^2 + s_{\text{between lab}}^2$$

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.

Table B.1 — Estimation of repeatability of the test method from CEPI-CTS

Material	Number of laboratories	Mean value kN/m	Standard deviation s_r (kN/m)	Coefficient of variation $C_{V,r}$ (%)	Repeatability limit r (kN/m)
Pre-cut sample level 1	14	6,84	0,124	1,813	0,344
Pre-cut sample level 2	15	11,5	0,30	2,61	0,83
Lab-cut sample level 1	14	6,40	0,147	2,297	0,407
Lab-cut sample level 2	13	10,3	0,23	2,23	0,64

Table B.2 — Estimation of reproducibility of the test method from CEPI-CTS

Material	Number of laboratories	Mean value kN/m	Standard deviation s_R (kN/m)	Coefficient of variation $C_{V,R}$ (%)	Reproducibility limit R (kN/m)
Pre-cut sample level 1	14	6,84	0,277	4,054	0,769
Pre-cut sample level 2	15	11,5	0,50	4,35	1,39
Lab-cut sample level 1	14	6,40	0,563	8,790	1,559
Lab-cut sample level 2	13	10,3	1,22	11,86	3,39

Bibliography

- [1] ISO 5725-1, *Accuracy (trueness and precision) of measurement methods and results — Part 1: General principles and definitions*
- [2] ISO/TR 24498, *Paper, board and pulps — Estimation of uncertainty for test methods*
- [3] TAPPI T 1200, *Interlaboratory evaluation of test methods to determine TAPPI repeatability and reproducibility*
- [4] ERIKSSON L. *Boxboard Containers*, March and April 1979

