STN	**Vlnitá lepenka** **Určenie pevnosti v tlaku na hranu** **(metóda s nevoskovanými hranami)** **(ISO 3037: 2022)**	**STN** **EN ISO 3037** 50 0342

Corrugated fibreboard - Determination of edgewise crush resistance (non-waxed edge method) (ISO 3037:2022)

Táto norma obsahuje anglickú verziu európskej normy.
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 02/23

Obsahuje: EN ISO 3037:2022, ISO 3037:2022

Oznámením tejto normy sa ruší
STN EN ISO 3037 (50 0342) z februára 2014

136390

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 3037

December 2022

ICS 85.080.30

Supersedes EN ISO 3037:2013

English Version

Corrugated fibreboard - Determination of edgewise crush resistance (non-waxed edge method) (ISO 3037:2022)

Carton ondulé - Détermination de la résistance à la compression sur chant (méthode sans enduction de cire) (ISO 3037:2022)

Wellpappe - Bestimmung des Kantenstauchwiderstandes (Verfahren für ungewachste Kanten) (ISO 3037:2022)

This European Standard was approved by CEN on 25 November 2022.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. EN ISO 3037:2022 E

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European foreword

This document (EN ISO 3037:2022) has been prepared by Technical Committee ISO/TC 6 "Paper, board and pulps" in collaboration with Technical Committee CEN/TC 172 "Pulp, paper and board" the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2023, and conflicting national standards shall be withdrawn at the latest by June 2023.

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Endorsement notice

The text of ISO 3037:2022 has been approved by CEN as EN ISO 3037:2022 without any modification.

INTERNATIONAL STANDARD

ISO 3037

Sixth edition
2022-11

Corrugated fibreboard — Determination of edgewise crush resistance (non-waxed edge method)

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

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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).

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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,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 172, *Pulp, paper and board,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This sixth edition cancels and replaces the fifth edition (ISO 3037:2013), which has been technically revised.

The main changes are as follows:

— the title has been changed from "Corrugated fibreboard - Determination of edgewise crush resistance (unwaxed edge method)" to "Corrugated fibreboard - Determination of edgewise crush resistance (non-waxed edge method)";

— the introduction has been updated to highlight the impact of edge effects and the incomparability of different test methods;

— information about the corrugated fibreboard grades has been added to the scope;

— Clause 3 has been updated;

— Clause 6 has been revised;

— Clause 9 has been updated and a constant feed rate has been added;

— Clause 11 has been added to refer to precision data in Annex B;

— Clause 12 has been updated;

— Annex A has been revised;

— the bibliography has been updated.

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

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 four groups as follows:

a) Those in which a carefully cut rectangular test piece is tested without any special treatment or modification (e.g. this document).

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).

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).

d) Those in which carefully cut rectangular test pieces are tested with edges clamped to prevent the result from being influenced by edges effects (e.g. TAPPI T 839).

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 might not give the same numerical results and experience has shown that results for the four groups of test methods will not correlate. It can be shown that most of them can be used (at varying levels of accuracy) to predict the top-to-bottom compression strength that will be achieved when the board is properly converted into a transport package, provided that the formula to predict BCT values from ECT results is based on data from the ECT method being used.

This document describes a method for 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), c) and d). This systematic difference is due to edge effects.

Other methods can 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 (non-waxed edge method)

1 Scope

This document specifies a non-waxed edge method for the determination of the edgewise crush resistance of corrugated fibreboard. The force is applied in the direction of the flute axis.

This method is applicable to single-wall (double-faced), double-wall, and triple-wall corrugated fibreboard.

It is applicable to all corrugated fibreboard flute types if no buckling and/or tipping occurs during measurement. This method is also applicable to test samples taken from corrugated cases and other converted products.

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 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 fixed platen compression-testing equipment*

3.1.3
tipping
failure mode distinct from pure compression, where the load drops off because the sample leans or falls over during the test

Note 1 to entry: This occurs primarily due to sample edge imperfections leading to a sideways component to the applied load.

3.2 Abbreviated terms

BCT box compression test

ECT edgewise crush test

4 Principle

A rectangular test piece of corrugated fibreboard, placed between the platens of a compression testing machine with the direction of the flute axis, 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, in accordance with ISO 13820.

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 can 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.

The possibility of erroneous test results is sufficiently low to allow the use of emery paper in all ISO test methods in which the use of this compression testing machine is now required, provided that a grade with a grain size of at least 240 (equivalent to type 00 in the USA) is used.

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 × 20 mm × 100 mm, to support the test piece and keep it perpendicular to the platen surfaces. It is recommended 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.

Sample away from score lines, joints, and closures and ensure that the test pieces are free of visible folds, creases, cracks, washboarding, converting machine marks or other defects. If not possible, it shall be mentioned in the test report.

NOTE 1 Especially, washboarding of corrugated board can have a severe impact on the test values.

If printed areas are tested, it shall be mentioned in the test report.

NOTE 2 When testing of finished packaging is undertaken, testing of printed areas can be encouraged or required in some situations so that test values are representative of the material examined. In this case, random sampling of the packaging material will lead to a fraction of samples from the printed area in rough proportion to the fraction of the box that has been printed. Because printed areas can be affected in the printing process, including printed areas can increase the variation in the test results.

7 Conditioning

The samples 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 samples.

8.2 Using a sharp blade and a procedure that ensures the cuts are parallel, cut, from the samples, test pieces with the following dimensions: 100,0 mm ± 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 test pieces (8.2), using an appropriate cutting device (5.2), cut sufficient test pieces 25,0 mm ± 0,5 mm in the direction parallel to the flutes, so that 10 valid single results are obtained. Each test piece will then measure 25,0 mm ± 0,5 mm in height (the direction of the flutes) and 100,0 mm ± 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).

Some corrugated board grades tend to buckling or tipping. If buckling or tipping occurs during the test, the test pieces and the results of the latter shall be rejected and it can be necessary to test more than 10 test pieces to receive 10 valid single results. Buckling or tipping shall be mentioned in the test report.

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 can 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, which might not be the case, 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 (see 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.

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 state. More information on the importance of accurate, parallel cutting can be found in Reference [6].

NOTE The quality of the test piece cutting can be influenced by the operator, the cutting device and general handling. The variation of results, caused by the cutting device, can be up to 5 % (see Reference [5]).

9 Procedure

Conduct the tests in the standard atmosphere that was used in Clause 7.

With the platens of the compression testing machine (5.1) conveniently separated, place the test piece on one of its 100 mm cut edges onto the lower platen. The test piece can be supported by placing a guide block (5.3) on each side to prevent the test piece from tipping over. If used, the guide blocks shall be relocated away from the test piece when the load reaches about 50 N. They can 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.

The constant feed rate of the compression testing machine is (12,5 ± 0,25) mm/min.

NOTE Different speeds are commonly used in different parts of the world. The use of other feed rates [e. g. (10,0 ± 0,25) mm/min] can have an impact on the test values, due to different strain rates of the applied load.

The feed rate used shall be reported in the test report. Operate the compression testing machine 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 test piece and/or curling of the edges of the test piece 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, $\bar{F}_{\mathrm{max}}$, and standard deviation, $s_{F\mathrm{max}}$.

10.2 Calculate the edgewise crush resistance, R, expressed in kN/m, to the nearest 0,01 kN/m using Formula (1):

$$R = \frac{\bar{F}_{max}}{l} \tag{1}$$

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 kN/m, to the nearest 0,01 kN/m, using Formula (2):

$$s_R = \frac{s_{F_{max}}}{l} \tag{2}$$

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 Precision

The repeatability and reproducibility of this method were determined by conducting an interlaboratory comparison study with several types of samples. A description of the samples used in this study and the interlaboratory comparison results are presented in Annex B.

12 Test report

The test report shall include the following information:

a) a reference to this document, i.e. ISO 3037:2022;

b) the date and place of testing;

c) the type of compression testing machine used;

d) the constant feed rate used in (mm/min);

e) the type of cutter used;

f) identification of the sample and description of the product tested including flute type;

g) the conditioning atmosphere used;

h) the mean value of the edgewise crush resistance, its standard deviation and the coefficient of variation;

i) the number of replicate tests;

j) any other information which can assist in the interpretation of the results;

k) if applicable, state if printed areas were tested and specify the rough proportion of the printed area tested;

l) if applicable, state if buckling or tipping occurred;

m) any deviations from the procedure.

Annex A
(informative)

Examples of suitable cutting devices

a) A 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.

b) A 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 shall 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.

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/TS 24498 and TAPPI Test method T 1200 sp-07[4].

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.

The repeatability and reproducibility limits reported in Table B.1 and Table B.2 are estimates of the maximum difference that 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:

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

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.

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

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ICS 85.080.30

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