SRI LANKA STANDARD 479: 2017
(ISO 3035: 2011)
UDC 621.798.142

METHOD OF TEST FOR

THE DETERMINATION OF FLAT CRUSH RESISTANCE OF CORRUGATED FIBREBOARD

(Second Revision)

SRI LANKA STANDARDS INSTITUTION

Sri Lanka Standard

METHOD OF TEST FOR THE DETERMINATION OF FLAT CRUSH RESISTANCE OF CORRUGATED FIBREBOARD

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SLS 479: 2017
(ISO 3035: 2011)

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SRI LANKA

Sri Lanka Standards are subject to periodical revision in order to accommodate the progress made by industry. Suggestions for improvement will be recorded and brought to the notice of the Committees to which the revisions are entrusted.

This Standard does not purport to include all the necessary provisions of a contract.

Sri Lanka Standard
METHOD OF TEST FOR THE DETERMINATION OF FLAT CRUSH RESISTANCE OF CORRUGATED FIBREBOARD
(Second Revision)

FOREWORD

This Sri Lanka Standard was approved by the Sectoral Committee on Chemical and Polymer Technology and was authorized for adoption and publication as a Sri Lanka Standard by the Council of the Sri Lanka Standards Institution on 2017-07-21.

This Sri Lanka Standard was first published in 1979 and First Revision which was an adoption of ISO 3035 : 1982 was published in 2004. The International Standard ISO 3035 : 1982 has been technically revised in 2011. **ISO 3035: 2011** has been accepted to adopt as the Second revision to **SLS 479** to be referred for the determination of flat crush resistance of corrugated fibreboard.

This Standard is identical with **ISO 3035: 2011**, Corrugated fibreboard- Determination of flat crush resistance, published by the International Organization for Standardization (ISO).

TERMINOLOGY AND CONVENTIONS :

The text of the International Standard has been accepted as suitable for publication, without deviation, as a Sri Lanka Standard. However, certain terminology and conventions are not identical with those used in Sri Lanka Standards. Attention is therefore drawn to the following :

a) Wherever the words 'International Standard' appear referring to a particular standard, they should be interpreted as "Sri Lanka Standard".

b) The comma has been used throughout as a decimal marker. In Sri Lanka Standards it is the current practice to use the full point at the base as the decimal marker.

c) Wherever page numbers are quoted, they are ISO page numbers.

Cross References

International Standard	Corresponding Sri Lanka Standard
ISO 2439:2008, Flexible cellular polymeric materials — Determination of hardness (indentation technique)	No corresponding Sri Lanka Standard

SLS 479: 2017

INTERNATIONAL STANDARD

ISO 3035

Third edition
2011-11-01

Corrugated fibreboard — Determination of flat crush resistance

Carton ondulé — Détermination de la résistance à la compression à plat

Reference number
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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 3035 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 third edition cancels and replaces the second edition (ISO 3035:1982), which has been technically revised. In this revision, the instrument is clarified according to ISO 13820, relevant terms are defined, a precision statement is added, and other minor text corrections have been made.

Introduction

Fibreboard shipping containers can be subjected to compressive forces in the thickness direction as part of the manufacturing process, as well as during shipment or storage. These forces can compress the flute structure and reduce the structural integrity (stacking strength) of the corrugated material. Resistance to this type of crushing is an important measure of the performance characteristics of the container.

INTERNATIONAL STANDARD **ISO 3035:2011(E)**

Corrugated fibreboard — Determination of flat crush resistance

1 Scope

This International Standard specifies a method for the determination of the flat crush resistance of corrugated fibreboard used in the manufacture of shipping containers.

This International Standard is applicable to single-faced and single-wall (double-faced) corrugated fibreboard.

This International Standard is not applicable to double-wall (double-double-faced) corrugated fibreboard and to microflute corrugated fibreboard, since the end-point of the test is not clearly defined or observable.

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
flat crush
maximum crushing force, applied perpendicular to the surface of the fluting structure, sustained before complete collapse of the structure

3.2
collapse
point where the sidewalls of the flutes are no longer able to support load because they have suffered compression damage

NOTE At this point, the fluting profile appears similar to that of a mushroom (see Figure 2).

3.3
flat crush resistance
flat crush divided by the area of the test piece under the condition of test

NOTE The flat crush resistance is expressed in kilopascals.

4 Principle

A test piece of corrugated fibreboard is subjected to an increasing force applied perpendicularly to the surface by a compression tester having two flat and parallel platens, until the fluting collapses.

The maximum force sustained by the test piece is divided by the test piece area.

5 Apparatus

5.1 Flat crush tester, a motor-driven, platen-type compression testing machine in accordance with ISO 13820, and also calibrated in accordance with ISO 13820.

NOTE The results can be significantly lower when a beam-deflection compression tester is used in comparison with testing using a platen-type compression tester, particularly in the case where flutes might lean due to lateral movement. In fixed platen equipment, the platens are restrained against horizontal movement with the sample faces, leading to possible differences in the failure dynamics picked up by the crush tester.

5.2 Cutting instrument, with a circularly guided knife to cut test pieces with the cut edges clean and perpendicular to the facings of the corrugated fibreboard. Commonly used test piece areas include 5 000 mm^2 (79,8 mm $\pm$ 0,5 mm in diameter), 6 450 mm^2 (90,6 mm $\pm$ 0,5 mm in diameter) and 10 000 mm^2 (112,8 mm $\pm$ 0,5 mm in diameter). When the flat crush resistance is expected to exceed the capacity of the crush tester on a 5 000 mm^2 sample, a smaller test piece area (commonly 3 220 mm^2, 64,0 mm $\pm$ 0,5 mm in diameter) may be used.

Test pieces of other uniform shapes may be used, as long as the test area specifications are complied with, crushing of the edges is avoided when the samples are cut, and fractional flute counts are avoided.

6 Sampling

Sampling shall be carried out in accordance with ISO 186. If the test specimens are to be taken from corrugated shipping containers, they should be taken from areas away from score lines, joints and closures, but may include printed areas that reflect the overall state of the samples.

If the tests are made on another type of sample, make sure that the test specimens taken are representative of the sample received.

7 Conditioning

The sample shall be conditioned in accordance with ISO 187.

8 Preparation of test pieces

Using the cutting instrument (5.2), in the same standard atmosphere as that used for conditioning the sample, cut a sufficient number of test pieces to enable at least ten valid tests to be made.

9 Procedure

Carry out the tests in the same standard atmosphere as used for conditioning the sample. Test at least ten test pieces.

Place a test piece (see Figure 1) centrally on the lower platen and operate the flat crush tester (5.1) until the fluting collapses (see Figure 2). The rate at which the platens approach each other shall be 12,5 mm/min $\pm$ 0,25 mm/min. Record the maximum force sustained by the test piece before collapse of the fluting, to the nearest 10 N.

In the event of the flutes leaning sideways during the test (see Figure 3), ignore this test result, and make further tests on fresh test pieces as needed to obtain ten valid tests.

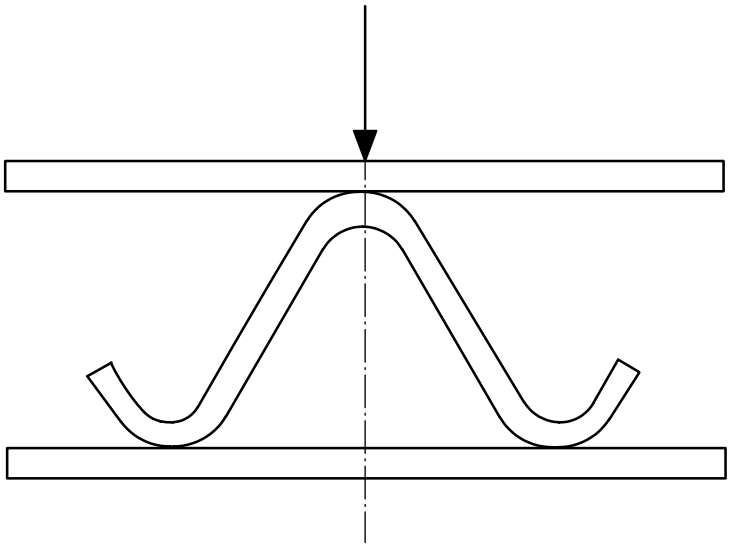

Figure 1 — Test piece before being subjected to pressure

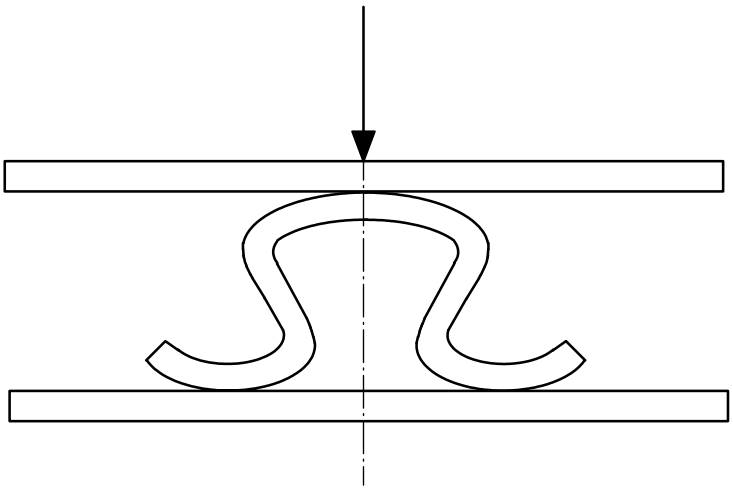

Figure 2 — Test piece after crushing

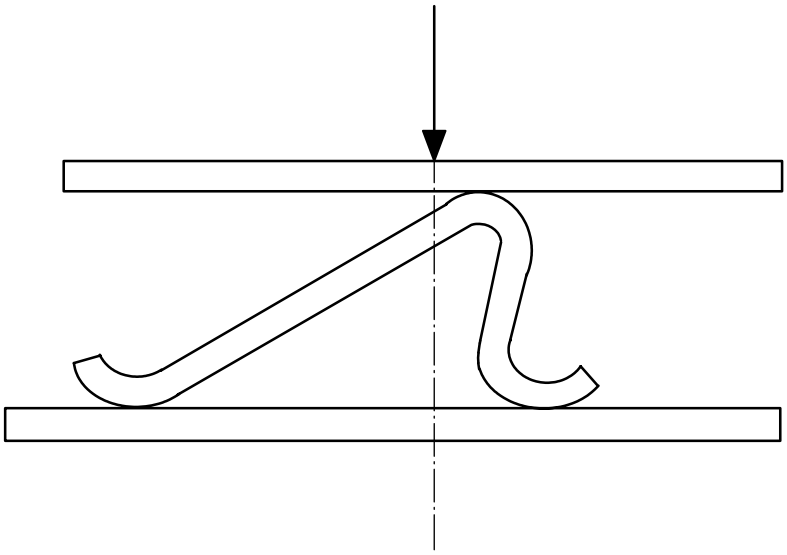

Figure 3 — Flute beginning to lean, for example as a result of sideways movement of the test piece or platens

Flutes may lean sideways because of relative sideways movement of the platens, because of damage to test pieces, especially during cutting, or because of an inherent fault in the corrugated fibreboard. Check the first two by testing further test pieces with the direction of the flutes in the flat crush tester at right angle to the original direction and ensuring that great care is taken in cutting. If the test pieces still fail with leaning flutes, it is probable that the corrugated fibreboard is at fault. Test a sufficient number of test pieces so that at least ten valid test results (without leaning flutes) are obtained. If all samples fail with leaning flutes, the average of ten test results shall be reported with a comment in the test report that the samples failed via leaning flutes.

Normally, a preliminary end-point occurs when the tips of the corrugation flatten on one or both sides of the test piece. This should not be confused with the final end-point when the corrugations collapse completely.

10 Expression of results

Calculate the mean and standard deviation of the crushing force from the valid test results. Calculate the flat crush resistance, X, in kilopascals, using the Equation:

$$X = \frac{\bar{F}}{A} \times 10^6 \quad (1)$$

where

$\bar{F}$ is the mean maximum crushing force, in kilonewtons;

A is the area of the test piece, in square millimetres.

Report the mean flat crush resistance to the nearest kilopascal. Calculate and report the standard deviation of the flat crush resistance to the nearest kilopascal.

11 Test report

The test report shall include the following information:

a) a reference to this International Standard (ISO 3035:2011);

b) the date and place of testing;

c) a description and identification of the product tested, including the nominal flute structure;

d) the area of the test piece;

e) the type of flat crush tester used and the rate of loading (in accordance with ISO 13820);

f) the conditioning atmosphere used;

g) the flat crush resistance and the standard deviation, as stated in Clause 10;

h) the number of test pieces rejected because of leaning flutes (record also the test results where this number exceeds two; see Clause 9);

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

Annex A
(informative)

Precision

A.1 General

Precision data is available from several different international sources, for testing performed using a motor-driven platen crush tester as described in 5.1. Industry studies (TAPPI-CTS) have found that the precision depends on the type of equipment used.

The calculations were made according to ISO/TR 24498[1] and TAPPI Test method T 1200 sp-07[2].

The repeatability standard deviation reported in Tables A.1 and A.3 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[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 $2{,}77 = 1{,}96\sqrt{2}$, provided that the test results have a normal distribution and that the standard deviation s is based on a large number of tests.

A.2 Precision data from TAPPI-CTS

The estimates of repeatability and reproducibility listed in Tables A.1 and A.2 are based on data from a round robin supervised by the CTS Containerboard Interlaboratory Program using testing conducted in 1995. Seven laboratories participated, testing three different sample materials. CTS determined in 1995, and reaffirmed in 2003, that there was no convincing evidence that variation in this test increases with increasing strength of the material being tested, so the expression of the variation is best described by a fixed unit and not by a percentage.

Table A.1 — Estimation of repeatability of the test method from TAPPI-CTS

Material	Number of laboratories	Mean value	Standard deviation s_r	Coefficient of variation $C_{V,r}$	Repeatability limit r
		kPa	kPa	%	kPa
42-26-33	7	208	14	6,7	38
52-26-52	7	215	11	5,0	30
42-33-42	7	271	15	5,6	42

Table A.2 — Estimation of reproducibility of the test method from TAPPI-CTS

Material	Number of laboratories	Mean value kPa	Standard deviation s_R kPa	Coefficient of variation $C_{V,R}$ %	Reproducibility limit R kPa
42-26-33	7	208	26	12,6	72
52-26-52	7	215	23	10,6	63
42-33-42	7	271	20	7,4	56

A.3 Precision data from CEPI-CTS

Estimates of repeatability and reproducibility from the CEPI-CTS program are based on round-robin work in 2008. Twelve or 16 laboratories participated, testing two different sample materials. For each material, 11 or 14 laboratories were included in the precision calculation (outliers not included).

Table A.3 — Estimation of repeatability of the test method from CEPI-CTS

Material	Number of laboratories	Mean value kPa	Standard deviation s_r kPa	Coefficient of variation $C_{V,r}$ %	Repeatability limit r kPa
Level 1	14	415	14	3,4	39
Level 2	11	653	24	3,7	66

Table A.4 — Estimation of reproducibility of the test method from CEPI-CTS

Material	Number of laboratories	Mean value kPa	Standard deviation s_R kPa	Coefficient of variation $C_{V,R}$ %	Reproducibility limit R kPa
Level 1	14	415	27	6,6	76
Level 2	11	653	43	6,5	118

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: $R = 1{,}96 \times \sqrt{2} \times \sqrt{s^2_{\text{within lab}} + s^2_{\text{between labs}}}$.

Bibliography

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

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

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

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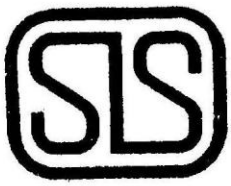

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SRI LANKA STANDARDS INSTITUTION

The Sri Lanka Standards Institution (SLSI) is the National Standards Organization of Sri Lanka established under the Sri Lanka Standards Institution Act No. 6 of 1984 which repealed and replaced the Bureau of Ceylon Standards Act No. 38 of 1964. The Institution functions under the Ministry of Science & Technology.

The principal objects of the Institution as set out in the Act are to prepare standards and promote their adoption, to provide facilities for examination and testing of products, to operate a Certification Marks Scheme, to certify the quality of products meant for local consumption or exports and to promote standardization and quality control by educational, consultancy and research activity.

The Institution is financed by Government grants, and by the income from the sale of its publications and other services offered for Industry and Business Sector. Financial and administrative control is vested in a Council appointed in accordance with the provisions of the Act.

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All members of the Technical and Sectoral Committees render their services in an honorary capacity. In this process the Institution endeavours to ensure adequate representation of all view points.

In the International field the Institution represents Sri Lanka in the International Organization for Standardization (ISO), and participates in such fields of standardization as are of special interest to Sri Lanka.

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