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Paper and board — Determination of tensile strength

Papier et carton — Détermination de la résistance à la traction

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

Prior to 1972, the results of the work of the Technical Committees were published as ISO Recommendations; those documents have subsequently been transformed into International Standards. As part of that process, in 1974 Technical Committee ISO/TC 6, *Paper board and pulps,* reviewed ISO Recommendation R 1924-1971 and found it suitable for transformation. International Standard ISO 1924-1974 therefore replaced ISO Recommendation R 1924-1971.

ISO Recommendation R 1924-1971 had been approved by the Member Bodies of the following countries :

Australia	Greece	Sweden
Belgium	India	Switzerland
Canada	Israel	Thailand
Czechoslovakia	Netherlands	Turkey
Egypt, Arab Rep. of	Norway	United Kingdom
Finland	Portugal	U.S.S.R.
France	Romania	
Germany	South Africa, Rep. of	

The Member Body of the following country had expressed disapproval of the Recommendation on technical grounds :

U.S.A.

The Member Body of the following country had disapproved the transformation of ISO/R 1924 into an International Standard :

Sweden

ISO 1924-1976, the second edition of this International Standard, contains the modifications which were circulated in the form of an amendement, to the Member Bodies in March 1975.

This amendment has been approved by the Member Bodies of the following countries :

Australia	India	Romania
Belgium	Iran	South Africa, Rep. of
Canada	Ireland	Sweden
Czechoslovakia	Italy	Switzerland
Finland	Mexico	Turkey
France	Netherlands	United Kingdom
Germany	New Zealand	U.S.A.
Hungary	Norway	

The Member Body of the following country expressed disapproval of the amendment :

Bulgaria

This second edition cancels and replaces ISO 1924-1974.

Printed in Switzerland

Paper and board – Determination of tensile strength

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies a method for measuring the tensile strength of paper and board.

The procedure described in this International Standard is applicable, within the limitation of the instruments used, to all types of paper and board generally up to a grammage (basis weight) of 400 g/m^2.

It does not apply to combined corrugated board.

This International Standard has been prepared in a form which has a general application and is not limited to any particular type of tensile testing apparatus.

2 REFERENCES

ISO/R 186, *Method of sampling paper and board for testing.*

ISO 187, *Paper and board – Conditioning of test samples.*[1]

ISO 536, *Paper and board – Determination of grammage.*

3 DEFINITIONS

For the purposes of this International Standard, the following definitions apply :

3.1 tensile strength : The limiting resistance of a test piece of paper or board submitted to a breaking force applied to each of its ends under the conditions defined in this International Standard.

3.2 breaking length : The calculated limiting length of a strip of paper or board of any uniform width, beyond which, if such a strip were suspended by one end, it would break under its own weight.

4 PRINCIPLE

Measurement of the tensile force required to cause failure of a test piece of given dimensions when applied under standardized test conditions.

5 APPARATUS

Any system may be used which is capable of acting on the test piece at the defined rate and of permitting the tensile force at the moment of failure to be read to an accuracy of 1 %.

The rate of loading should be so adjustable that failure of the test piece can be obtained in a mean time of 20 ± 5 s[2]. When a substantially inextensible material is gripped between the clamps and a full scale reading is obtained in 20 s, the rate of loading at any time shall not differ by more than 5 % from the rate of loading 1 s later.

The centre line of the clamps and of the test piece shall lie along the same axis, which shall also be parallel to the direction of the applied force. The clamping surfaces of the two clamps (flat clamps) or lines of contact (line contact clamps) shall be in the same plane and so aligned that they hold the test piece in that plane throughout the test.

The clamps shall grip the test piece firmly along its full width, without slipping, throughout the test.

At the start of the test the lines of contact (if line contact clamps are used) or the inner edges of the contact areas shall be 180 ± 2 mm apart and shall be perpendicular to the direction of application of the force throughout the test.

6 PREPARATION OF THE TEST PIECE

6.1 Sampling

Sampling shall be carried out in accordance with ISO/R 186. The samples shall be conditioned in accordance with ISO 187, and an equal number of test pieces for machine direction and cross direction tests shall then be cut. No creases, obvious flaws or watermarks shall be included in the test area and test pieces shall not include any part of the sample within 15 mm of the edge of any sheet or roll. If it is necessary to include watermarks, this fact shall be reported.

The edges of the test piece shall be straight, parallel and undamaged and the width accurately known to within 0,1 mm. Many instruments are designed to take a test piece

1) At present at the stage of draft. (Revision of ISO/R 187-1961.)

2) This rate is not always possible without modification using existing commercial testing apparatus, on all types of paper (for rapidity in routine testing, 10 ± 5 s is often used but this will give results about 2 % higher than the specified method).

15 mm wide but greater widths (for example, 25 or 50 mm) may be used if the design of the clamps permits this. The minimum length of test piece should in general be 250 mm but instrument jaw design may require the preparation of longer or shorter test pieces.

The central 180 mm of the test piece shall be handled as little as possible before testing.

6.2 Conditioning

Test pieces shall be conditioned and tested in an atmosphere in accordance with ISO 187. The duration of the conditioning process will be determined by the type of material being tested.

6.3 Cutting of test pieces

Sufficient test pieces shall be cut from each specimen to enable at least ten tests to be made in both the machine direction and cross direction.

7 PROCEDURE

7.1 Calibration of apparatus

Set up the apparatus as recommended by the manufacturer. A suitable method of calibration is to apply weights to the clamp actuating the load-indicating mechanism with the instrument otherwise in its normal working condition. Note the scale reading when the system comes into equilibrium in the same time as that used in actual testing. Check the correct operation of the indicating mechanism, which should be free from excessive backlash, lag, or friction. If errors of more than 1 % are found, use a correction curve.

7.2 Test method

Unless otherwise stipulated in this method, carry out the operation involved in the measurement of the tensile strength of each test piece in the manner recommended by the manufacturer of the apparatus in use.

The test length (the distance between the closest points at which the test piece is firmly gripped) shall initially be 180 ± 2 mm (see note 1).

By an initial trial experiment, select a rate of application of tensile force which causes failure in a mean time of 20 ± 5 s.

Clamp the test piece within the jaws of the apparatus so that no slipping occurs during the test; (it is essential that the test piece be clamped in such a manner that its edges are parallel to the direction of application of the tensile force, and the test length at the start of the test is within the tolerance of ± 2 mm given above). Ignore tests which result in failure within 10 mm of the line of contact, or the inner edge of the contact area of the clamps (see note 2).

Read the breaking force to a consistent number of decimal places and record to two or three significant figures, as the graduations allow, and note the "time to break" to the nearest second.

If breaking length is required, determine the grammage (basis weight) of the material according to ISO 536.

NOTES

1 In some instances, the dimensions of the specimens are not such as to permit test pieces to be cut as specified in this procedure. This is frequently true, for instance, in the case of laboratory handsheets. In such cases the test length shall preferably be 100 ± 2 mm and the length used shall be clearly stated in the report. With test lengths shorter than 180 mm, higher results will normally be obtained.

2 If test pieces regularly break at or near a clamp, find the reason and rectify it.

8 EXPRESSION OF RESULTS

Calculate the tensile strength as follows :

$$S = \frac{X}{w}$$

Calculate the breaking length as follows :

$$L = \frac{1}{9,8} \times \frac{S}{g} \times 10^3$$

$$\text{or } L = \frac{1}{9,8} \times \frac{X}{w \times g} \times 10^3$$

where

L is the breaking length in machine direction or cross direction, in kilometres;

S is the tensile strength in machine direction or cross direction, in kilonewtons per metre width;

g is the grammage (basis weight), in grams per square metre;

w is the width of the test piece, in millimetres;

X is the scale reading (breaking force), in newtons.

Alternatively, L may be calculated from the formula

$$L = \frac{X \times l}{9,8 \times m}$$

where

l is the initial test length between the clamps, in millimetres;

m is the mean mass of strip between the clamps, in milligrams.

NOTE — For instruments calibrated in kilograms-force, scale readings shall be multiplied by 9,8 to give the breaking force X in newtons.

9 PRECISION

The precision of the test depends on the variability of the paper tested and no general value for precision can be given. For different papers, coefficients of variation from 2,6 to 11 % have been reported in the literature for replicate determinations of tensile strength within a single laboratory, with an average of about 6 %.

The coefficient of variation of mean results for a single paper obtained within a single laboratory is about $6/\sqrt{10}$ % when ten replicate tests are carried out.

10 TEST REPORT

The test report shall include the following particulars for the machine direction and cross direction :

a) the mean values of S (expressed in kilonewtons per metre width to three significant figures) or L (expressed in kilometres to one decimal place);

b) the mean value of the "time to break", expressed to the nearest second;

c) the number of tests;

d) the coefficient of variation of the result;

e) the test piece length and width;

f) the temperature and relative humidity used;

g) any deviation from this International Standard.