BRITISH STANDARD

BS 3748:1992
ISO 2493:1992

Method for

Determination of resistance to bending of paper and board

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Paper and Printing Standards Policy Committee (PAM/-) to Technical Committee PAM/11, upon which the following bodies were represented:

British Fibreboard Packaging Association
British Paper and Board Industry Federation (PIF)
British Printing Industries Federation
British Telecommunications plc
Envelope Makers' and Manufacturing Stationers' Association
Her Majesty's Stationery Office
Man-made Fibres Producers' Committee
Ministry of Defence
Paper Sack Development Association Ltd.
PIRA (The Research Association for the Paper and Board, Printing and Packaging Industries)
Post Office
Society of British Printing Ink Manufacturers
University of Manchester Institute of Science and Technology

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Contents

National foreword

This British Standard has been prepared under the direction of the Paper and Printing Standards Policy Committee. It is identical with ISO 2493:1992 *Paper and board — Determination of resistance to bending*, published by the International Organization for Standardization (ISO).

It supersedes BS 3748:1964 which is withdrawn.

Cross-references

International standard	Corresponding British Standard
ISO 186:1985	BS 3430:1986 *Method for sampling to determine the average quality of paper and board* (Identical)
ISO 187:1990	BS 3431:1973 *Method for the conditioning of paper and board for testing* (Technically equivalent)
ISO 5628:1990	BS 7424:1991 *Guide to general principles for determination of the bending stiffness of paper and board by static methods* (Identical)

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 4, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This International Standard specifies a method, based on the beam principle (see ISO 5628), for determining the resistance to bending of paper and board.

This International Standard applies to the measurement of the resistance to bending of paper and board, most commonly within the range 20 mN to 10 000 mN, but on some instruments down to about 2 mN. The method may also be applied to some more resistant materials.

The method is applicable only to instruments which use a bending angle of 7,5° or 15°.

The method does not apply to corrugated boards but may be applied to the components of such boards.

NOTE 1 Different types of instruments do not give comparable results.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 186:1985, *Paper and board — Sampling to determine average quality.*

ISO 187:1990, *Paper, board and pulps — Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples.*

ISO 5628:1990, *Paper and board — Determination of bending stiffness by static methods — General principles.*

3 Definitions

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

3.1
resistance to bending

the force, in newtons or millinewtons, required to deflect a rectangular test piece, clamped at one end, through a bending angle of 15° when the force is applied at a bending length of 50 mm and near to the free end of the test piece, normal to the plane which includes the near edge of the test piece clamp and the point or line of application of the force

NOTE 2 Certain instruments give readings in terms of bending moment (see clause **11**).

3.2
bending length

the constant radial distance between the clamp and the position on the test piece at which the force is applied

3.3
bending angle

the angular difference between the initial position of the plane which passes through the line of clamping and the line of application of force and the position of the same plane at the end of the test

3.4
free length

the initial length of the test piece that projects from the clamps

4 Principle

Measurement of the force required to bend a test piece clamped at one end through a specified angle; the force is applied at a constant bending length.

5 Apparatus

Any system may be used that is capable of acting on the test piece to measure the resistance to bending as defined in **3.1** to a degree of precision in accordance with the specification for instrument accuracy.

The clamp should grip the test piece across the full width and along its length for a distance of 12,5 mm ± 0,5 mm when test pieces are inserted. The test piece should not be restrained at the free end except by the friction imposed by the surface of the free end of the test piece on the indicating or recording mechanism.

The nominal bending length is 50 mm. This bending length allows the use of several types of instrument. However, for the most accurate work the results shall be corrected for differences in the nominal bending length (see clauses **6** and **11**).

NOTE 3 The Taber stiffness tester utilizes a bending length of 51,8 mm and is calibrated to give results as bending moment and it is therefore necessary to convert the instrument readings to millinewtons to obtain the resistance to bending (see clause **11**).

The instrument employed shall

— produce and/or indicate a bending angle of 15° ± 0,3° (or 7,5° ± 0,3°);

— accept the appropriate bending length;

— accept a test piece width of 38 mm ± 0,2 mm;

— develop the rate of bending such that a bending angle of 15° is reached in not less than 3 s (L & W instrument) and not more than 20 s (Taber instrument);

NOTE 4 It is essential that during the test bending is a continuous operation and the rate of bending should be reasonably constant.

— be accurate to ± 2 % of the scale reading.

Equipment for cutting the test piece to the required accuracy is also required, for example a die cutter or a double knife cutter.

6 Calibration

The instrument shall be calibrated and the accuracy of the apparatus checked at regular intervals. The method of calibration depends on the type of instrument and reference should be made to the instrument manual. Calibrated spring steel test pieces may be used for routine checking of the calibration.

NOTE 5 With Taber instruments the friction of the pendulum bearing is important and should be such that the number of free swings between 15° and 7,5° is not less than 10.

NOTE 6 Steel springs can lose their stiffness over long periods of time and do not provide a calibration which is traceable to a primary standard as required by accreditation schemes.

7 Sampling

Samples shall be taken in accordance with ISO 186.

8 Conditioning

The samples shall be conditioned in accordance with ISO 187 and test piece preparation and testing shall be carried out in the same conditioning atmosphere used to condition the samples.

9 Preparation of test pieces

When testing the machine direction or cross direction resistance to bending, the appropriate direction is perpendicular to the width of the test piece.

Cut test pieces of the following dimensions: 38 mm ± 0,2 mm wide by not less than 70 mm long. A minimum of 10 test pieces is required in each required principal direction if the instrument deflects the test pieces to one side only and five in each direction if the instrument deflects the test pieces to both sides (see clause **10**).

There shall be no folds, creases, visible cracks or other defects in the area to be tested. If watermarks are present, this shall be noted in the test report.

10 Procedure

Insert the test piece in the clamp in such a manner that the length that projects from the clamp (the free length) is 57 mm ± 3 mm and the test piece is correctly aligned.

NOTE 7 Overtightening the clamps can result in damage to the test piece and incorrect reading. The clamping pressure should just be sufficient to hold the test piece without slippage during the test.

Carry out the operations involved in the measurement of the resistance to bending in the manner recommended in the instruction manual for the type of instrument in use.

The standard bending angle is 15°. For many materials such as wax laminated boards and board thicker than about 0,5 mm, the standard bending angle of 15° is excessive and leads to "creep" or cracking of the material during test. When "creep" or cracking occurs, tests may be carried out using a bending angle of 7,5° to give the resistance to bending. Such results are normally higher than half the result obtained using a bending angle of 15°. Where this procedure is carried out, the bending angle used shall be clearly stated in the test report.

NOTE 8 The result obtained at 7,5° should not be converted to 15° by multiplying by two since the relationship is not directly proportional.

NOTE 9 Care is required when using the Taber instrument to ensure that the bending angle is not exceeded.

Should the instrument be so designed that deflection is possible to one side only of the unstressed position then equal numbers of test pieces with opposing surfaces towards the direction of deflection shall be tested.

Should the instrument be so designed that the deflection is possible to two sides, deflect each test piece through an angle of 15° to one side of the unstressed position and then immediately return the test piece through the zero position and deflect it through an angle of 15° to the other side of the unstressed position. In each direction take the reading as soon as the 15° deflection has been reached.

When each test piece is deflected to one side only of the unstressed position, a minimum of 10 test pieces and 10 readings are required for each principal direction tested.

For instruments in which each test piece is deflected to two sides of the unstressed position a minimum of five test pieces and 10 readings (five to each side) are required for each principal direction tested.

Carry out the appropriate number of tests for each required principal direction.

No test piece shall be reused after it has been removed from the instrument clamp.

11 Calculation and expression of results

Calculate the mean of the readings for each principal direction tested and express the resistance to bending in newtons or millinewtons to three significant figures.

When using instruments which give the results in terms of bending moment, it is necessary to divide by the bending length (radial distance between the edge of the clamp and the position at which the force is applied) in order to determine the resistance to bending in terms of applied force. This International Standard defines the resistance to bending as the force required to deflect the test piece through 15° when the test piece length is 50 mm. The force required to bend the test piece is inversely proportional to the square of the bending length, so that if the bending length varies from 50 mm (up to the limit of 51,8 mm, see note 3) it becomes necessary to correct for this deviation.

For example, in the case of the Taber 150-B instrument the bending length is normally 51,8 mm and the scale is graduated in gf·cm. Thus with no loading weight the force F, expressed in millinewtons, applied at the bending length (5,18 cm) is given by the following equation

$$F = \frac{R \times 9{,}81}{5{,}18}$$

where

R is the scale reading, in gram-force centimetres;

9,81 is the factor to convert gram-force centimetres to millinewton centimetres;

5,18 is the test piece bending length, in centimetres.

The resistance to bending B, expressed in millinewtons, as defined in **3.1** at the specified test length of 50 mm is given by the equation

$$B = \frac{R \times 9{,}81}{5{,}18} \times \left(\frac{51{,}8}{50{,}0}\right)^2 = \mathrm{R} \times 2{,}03$$

12 Test report

The test report shall include the following information:

a) reference to this International Standard;

b) the date and place of testing;

c) description and identification of the material tested;

d) the type of instrument used;

e) the number of replicate tests carried out;

f) the mean resistance to bending, expressed in newtons or millinewtons to three significant figures, given separately for each principal direction tested;

g) the standard deviation of the test results for each principal direction tested;

h) the bending angle used if other than 15°;

i) any deviations from this International Standard.

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List of references

See national foreword.

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British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

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