INTERNATIONAL STANDARD 2493

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Paper and board — Determination of stiffness — Static bending method

First edition — 1973-11-01

UDC 676.017

Ref. No. ISO 2493-1973 (E)

Descriptors : papers, paperboards, tests, bend tests, stiffness tests.

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.

International Standard ISO 2493 was drawn up by Technical Committee ISO/TC 6, *Paper, board and pulps,* and circulated to the Member Bodies in September 1971.

It has been approved by the Member Bodies of the following countries :

Australia	India	South Africa, Rep. of
Austria	Iran	Spain
Belgium	Israel	Sweden
Bulgaria	Italy	Switzerland
Czechoslovakia	New Zealand	Thailand
Egypte, Arab Rep. of	Norway	Turkey
Finland	Poland	United Kingdom
France	Portugal	U.S.A.
Hungary	Romania	

The Member Bodies of the following countries expressed disapproval of the document on technical grounds :

Germany
Netherlands

Printed in Switzerland

Paper and board — Determination of stiffness — Static bending method

0 INTRODUCTION

There are a number of different methods of measuring stiffness of paper and board using static bending. Of these, the most widely used one is that described in this International Standard, although some other methods may be equally satisfactory. The publication of this International Standard does not preclude the publication of other recommended methods of measuring stiffness based either on static bending or on alternative principles.

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies a static bending method for determining the stiffness of paper and board.

This International Standard applies to the measurement of the stiffness of paper and board, most commonly within the range 20 to 10 000 mN (corresponding to a range of grammage of approximately 150 to 1 500 g/m^2) but, on some instruments, down to about 2 mN (approximately 60 g/m^2 grammage). The method may also be applied to some stiffer materials.

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

2 REFERENCES

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

ISO/R 187, *Method for the conditioning of paper and board test samples.*

3 DEFINITIONS

For the purpose of this International Standard the following definitions apply :

3.1 stiffness : The degree of resistance offered by paper or board when it is bent under the conditions specified in this International Standard. This is measured as the bending force.

NOTE — Certain instruments give readings in terms of bending moment (see section 11).

3.2 bending force : The force in newtons necessary to deflect a rectangular test piece, clamped at one end, through a bending angle of 15° when the force is applied 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.

3.3 bending length : The constant radial distance between the clamp and the position on the test piece at which the force is applied.

3.4 bending angle : The angle between the initial plane of the test piece and the plane passing through the line of clamping and the line of application of force at the end of the test.

3.5 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 given angle; the force is applied at a constant distance from the line of clamping.

5 APPARATUS

Any system may be used that is capable of acting on the test piece to measure the bending force as defined in 3.2 to a degree of precision in accordance with the specification for instrument accuracy.

The clamp should grip the test piece across its full width and along its length for a distance of not less than 12,7 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 that have been found satisfactory[1]. For the most accurate work, however, the results shall be corrected for differences in the nominal bending length (see sections 6 and 11).

1) These include the Taber stiffness tester, the Kenley stiffness tester and the Lorentzen and Wettres stiffness tester No. 188.

The instrument employed shall comply with the following requirements, within the given limits of accuracy :

- bending angle 15 ± 0,1° (or 7,5 ± 0,1°);
- bending length $50 \begin{smallmatrix}+2,5\\-0,1\end{smallmatrix}$ mm;
- test piece width 38 ± 0,2 mm;
- rate of bending such that a bending angle of 15° is reached in not less than 3 s and not more than 20 s. It is essential that bending during the test is continuous and the rate of bending should be reasonably constant;
- scale readings accurate to ± 2 % on the appropriate range.

Equipment for the cutting of the test piece to the required accuracy is also required. This may consist of a knife and template, a guillotine or a punch.

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. An absolute calibration using weights to measure the force is recommended, but in certain cases spring steel test pieces may be used for checking of calibration and accuracy.

7 SAMPLING

Select units and sheets and take specimens according to ISO/R 186.

8 CONDITIONING

The samples shall be conditioned in accordance with ISO/R 187, and sample preparation and testing shall be carried out in the conditioning atmosphere specified.

9 PREPARATION OF TEST PIECES

Cut test pieces of the following dimensions : 38 ± 0,2 mm wide by 75 ± 5 mm long. A minimum number of ten test pieces is required in each test direction (twenty if tests to one side only are possible, see section 10).

There shall be no folds, creases, visible cracks or other defects on the area to be tested and the test piece shall not include any part of the sample that is less than 15 mm from the edge of the sheet or reel. If watermarks are present, this should be stated in the test report.

NOTE – When testing the machine direction or cross direction stiffness of the paper, the appropriate direction is perpendicular to the width of the test piece.

10 PROCEDURE

Carry out the operations involved in the measurement of stiffness of each test piece in the manner recommended for the type of instrument in use.

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

The standard bending angle is 15°. For many materials such as wax laminated boards and boards thicker than about 0,5 mm the standard bending angle of 15° is excessively high and leads to "creep" or to cracking of the material during test. Consequently tests may also be carried out using a bending angle of 7,5°, results so obtained being multiplied by 2 to give the stiffness as defined. Such results are normally higher than results 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.

Deflect each test piece through an angle of 15° (or 7,5°) 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° (or 7,5°) to the other side of the unstressed position. In each direction take the reading as soon as the 15° (or 7,5°) deflection has been reached. 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 should be tested. No test piece shall be re-used after it has been removed from the instrument clamp.

When each test piece is deflected to both sides of the unstressed position, ten test pieces and twenty readings are required. For instruments in which each test piece is deflected to only one side of the unstressed position twenty test pieces and twenty readings are required. Where a distinct partial fracture or considerable permanent deformation of the test piece occurs during a test, the results of this test shall be ignored.

NOTE – When adjustment of the instrument will not compensate for test piece curl and there are no flat samples available it may still sometimes be necessary to obtain a stiffness test result even at the cost of reduced accuracy. In such cases draw the sample gently over a smooth edge, applied to the outside of the curved sheet, preferably prior to cutting and conditioning the test pieces. This operation can, however, result in a serious loss of stiffness and, if it is necessary, it should be clearly stated in the test report.

11 CALCULATION AND EXPRESSION OF RESULTS

Calculate the arithmetic mean of the twenty readings and express the stiffness in newtons to three significant figures.

For instruments giving readings of stiffness in grams-force the result may be expressed as stiffness in newtons by multiplying the reading in grams-force by $9,81 \times 10^{-3}$.

For instruments giving readings as values of bending moment in gram-force centimetres (sometimes called "units" or "Taber units") the result may be expressed as stiffness in newtons by multiplying the units figure by $9,81 \times 10^{-3}$ and dividing by the bending length in centimetres. This is normally 51,8 mm on such instruments.

For the most accurate work the effect of the precise bending length used on the stiffness shall be taken into account. Over the narrow range of bending lengths

permitted (50 to 52,5 mm) the bending force (F) is inversely proportional to the square of the bending length (L):

$$F = \frac{K}{L^2}$$

Consequently, where L is the bending length in millimetres,

$$\text{Stiffness} = \frac{L^2}{2\,500} \times \text{measured bending force}$$

When the force or bending moment is determined using a bending angle of 7,5° the results obtained should be multiplied by 2 to give the stiffness as defined.

12 TEST REPORT

The test report shall include the following particulars, results being given separately for machine direction and cross direction tests :

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 direction of the test;

f) the number of replicate tests carried out if other than ten (or twenty);

g) the mean stiffness in millinewtons or newtons to three significant figures. The coefficient of variation or the 95 % confidence limits may also be given if required;

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

i) any deviations from this International Standard, and details of any features that are optional.