INTERNATIONAL STANDARD ISO 3036

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

Board — Determination of puncture resistance

Carton — Détermination de la résistance à la perforation

First edition — 1975-06-15

UDC 676.27 : 676.017.42 : 539.42 **Ref. No. ISO 3036-1975 (E)**

Descriptors : corrugated cardboards, tests, impact tests, measurement, perforating strength.

Price based on 3 pages

FOREWORD

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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 3036 was drawn up by Technical Committee ISO/TC 6, *Paper, board and pulps,* and circulated to the Member Bodies in January 1973.

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

Belgium	India	Spain
Canada	Ireland	Sweden
Czechoslovakia	Israel	Switzerland
Egypt, Arab Rep. of	New Zealand	Thailand
Finland	Norway	Turkey
France	Poland	United Kingdom
Germany	Romania	U.S.A.*
Hungary	South Africa, Rep. of	U.S.S.R.

* with the exception of sub-clause 5.1.1.

No Member Body expressed disapproval of the document.

Printed in Switzerland

Board — Determination of puncture resistance

0 INTRODUCTION

Several makes of instrument, differing only in minor details, are used for the measurement of the puncture resistance of board. The results obtained with these different makes of instrument are similar but not necessarily identical. Therefore, for purposes of comparison, it is essential to ensure that the same make of instrument is used for all tests.

1 SCOPE

This International Standard specifies a method for determining the puncture resistance of board.

2 FIELD OF APPLICATION

This method is applicable to all types of heavy board, including corrugated fibreboard, especially those used in the manufacture of packing cases.

3 REFERENCES

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

ISO 187, *Paper and board — Conditioning test samples.*

4 PRINCIPLE

Subjection of a test piece from a representative sample of board to puncture by a triangular pyramid puncture head attached to a pendulum.

Measurement of the energy required to force the puncture head completely through the test piece, i.e. to make the initial puncture and to tear and bend open the board.

5 APPARATUS

5.1 Description of apparatus

The apparatus used is a puncture tester, which produces an impact by means of a pendulum.

The bed plate of the frame of the instrument shall be firmly attached to a strong base to prevent energy losses. The instrument shall be accurately levelled, and shall not vibrate during the test.

NOTE — The instrument shall be so designed that the energy contained in the pendulum in each of the measuring ranges corresponds to the respective scale (see annex).

The instrument consists of the following elements :

5.1.1 Pendulum and puncture head

The pendulum is fitted with an arm, having the shape of a 90° circular arc, to which the puncture head is attached. Both pendulum and arm shall be strong enough to minimize deformation and vibration when the test is carried out.

The puncture head shall be a right-angled triangular pyramid, 25 ± 0,7 mm high, with edges between sides honed to a radius between 1,0 and 1,6 mm.

One of the edges of the base of the pyramid shall be parallel to the axis of rotation of the pendulum, and the opposite corner of the base shall point towards the axis of rotation.

The axis of symmetry through the effective point of the puncture head shall be vertical when it is half-way through the horizontal plane through the axis of the pendulum.[1)]

At the release point, the pendulum shall be in the horizontal position, which is determined by measuring through an angle of 90° from the pendulum with its centre of gravity at rest.

5.1.2 Interchangeable weights

By the use of interchangeable weights that can be attached to the pendulum, several ranges of energy are provided.

The range selected shall be such that the test result will be between 20 and 80 % of the maximum value of the corresponding scale.

5.1.3 Release mechanism

A safety catch shall be provided to prevent accidental release of the pendulum. The release mechanism shall not impart any acceleration or deceleration to the pendulum.

1) To allow the use of existing instruments, a tolerance of ± 12,5 mm is acceptable on the distance between the mid-point and the horizontal plane.

5.1.4 Collar

The neck of the puncture head shall be fitted with a close-fitting collar designed so as to slip off its seating and to keep open the aperture in the test piece after the puncture head has passed through. This is to prevent the corrugated fibreboard from springing back on the arm and braking the pendulum, thus altering the test result.

The loss of energy due to friction when the collar is forced off its seating shall be measurable and shall not exceed 0,25 J. This loss of energy shall be compensated for in the reported test results.

5.1.5 Clamping device

To hold the test piece, two horizontal clamping plates are provided, the upper plate being fixed. The lower face of the upper clamping plate, which contacts the test piece, shall be on the horizontal plane through the axis of the pendulum, or up to 7 mm above it.

Both clamping plates shall be sufficiently rigid to withstand the clamping forces employed, without deformation.

The effective clamping dimensions of the clamping plates shall be not less than 175 mm × 175 mm.

The upper clamping plate shall have an opening in the centre in the form of an equilateral triangle with sides 100 ± 2 mm in length. The aperture in the lower plate should preferably be identical and coincident with that in the upper plate; however, a centrally positioned circular aperture, with a diameter 90 ± 2 mm may be used[1].

The force holding the test piece between the clamping plates shall be at least 250 N and not more than 1 000 N. If the instrument has no device for measuring the clamping force, the force applied shall in any case be sufficient to ensure that the test piece does not slip when the test is carried out.

5.1.6 Measurement indicator

The test result shall be indicated by a friction-loaded pointer operating over a dial on which the several scales corresponding to the energy ranges are engraved. The scale divisions shall be calibrated in joules[2].

The friction mounting of the pointer shall be just sufficient to ensure smooth operation without over-run.

5.2 Adjustment of the instrument

For all measuring ranges, the effective point of the puncture head shall be within ± 5 mm of the horizontal plane through the axis of rotation of the pendulum, when the centre of gravity of the pendulum is at its lowest point.

5.3 Instrument checks

No compensation for loss of energy due to friction shall be made in the calibration of the measuring scales.

Energy loss due to friction in the bearings of the pendulum and to air resistance shall not exceed 1 % of the measuring scale.

To measure energy loss due to collar friction, a slip-off device shall be provided which catches the collar when the pendulum is allowed to swing freely from the release point.

Energy losses due to pointer friction shall be determined by twice allowing the pendulum to make a free swing from the release position. The first swing shall carry the pointer close to the scale zero. The second free swing, made without resetting the pointer, shall carry the pointer nearer to the zero reading. The difference between the two readings represents the energy loss due to pointer friction.

When making re-adjustments to the settings of the measuring scales, the following checks shall be made :

Allow the pendulum to come to rest, with its centre of gravity at the lowest point, then move the pointer towards the maximum scale value. When the drive pin just touches the pointer, the latter shall indicate the maximum scale value. Carry out an analogous check with the pendulum in the horizontal position, 180° from the release point, when the pointer shall indicate zero.

5.4 Calibration

See the annex.

6 SAMPLING

Sampling shall be carried out in accordance with ISO/R 186.

7 PREPARATION OF TEST PIECES

Prepare test pieces with minimum dimensions 175 mm × 175 mm from the sample selected in accordance with clause 6. These test pieces shall be free from conversion machine marks, irregularities and damage. In no instance shall the puncture area be less than 60 mm from the edge of the test piece or from any crease, score, or printed area. If for some reason a printed area is used for the test, this fact shall be clearly stated in the test report.

8 CONDITIONING

The test pieces shall be conditioned in accordance with ISO 187.

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1) To allow the use of certain existing types of instrument the lower plate may have a centrally positioned circular aperture with a diameter up to 100 mm.

2) Many existing instruments are calibrated in GE units and kgf.cm :

1 GE unit = 0,029 8 J

1 kgf.cm = 0,098 J

9 PROCEDURE

Carry out the tests in the standard atmosphere specified in clause 8.

Place the test piece between the clamping plates and clamp it with a constant force. If the instrument is equipped with a clamping force measuring device, record the force.

Adjust the pendulum mass, using the supplementary weights as necessary, to operate over the energy range that will contain the expected test result within 20 and 80 % of its maximum value.

With the pendulum held by the release mechanism, slide the collar over its seating on the neck of the puncture head, and set the indicating pointer to the maximum scale value.

Then operate the release mechanism so that the puncture head completely pierces and passes through the test piece. Read the amount of energy used, representing the work in puncturing the test piece and overcoming the friction in the instrument, from the appropriate scale. Scale readings shall be taken to the nearest 0,1 J for measuring ranges up to 12 J and to the nearest 0,2 J for measuring ranges above 12 J.

Compensate the test result for predetermined energy losses caused by friction in the apparatus if the friction is greater than or equal to 1 %.

Unless otherwise agreed between the interested parties, make ten replicate tests from each side of the material, five tests from each side with the cross direction or the flutes parallel with the axis of rotation of the pendulum, and five tests from each side with the cross direction or the flutes perpendicular to the axis of rotation of the pendulum.

10 EXPRESSION OF RESULTS

Calculate the arithmetic mean puncture resistance in joules; report the results to the nearest 0,1 J for values up to 12 J and to the nearest 0,2 J for values above 12 J.

If the mean puncture resistance for the two sides of the test piece differs by more than 10 % of the highest value, report the values separately; otherwise, report the mean.

11 TEST REPORT

The test report shall include the following particulars

a) a reference to this International Standard;

b) the date and place of testing;

c) the make and type of test instrument used;

d) a description and identification of the material tested;

e) the conditioning atmosphere used;

f) the number of replicate tests carried out;

g) the arithmetic mean of all the replicate test results, in joules;

h) if required, the separate arithmetic mean and range of the results for each configuration, i.e. the results of the tests made from each direction and from each side;

i) the clamping force, in newtons;

j) details of any deviation from this test method;

k) any other information which may assist in the interpretation of the test results.

ANNEX

CALIBRATION

It is not easy to calibrate the instruments used for this test; where calibration is necessary, reference may be made to ISO/R 442, *Verification of pendulum impact testing machines for testing steels*, in which sub-clause 5.1 describes a method of determining the initial potential energy.

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