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Paper and board — Determination of internal bond strength

Papier et carton — Détermination de la force de cohésion interne

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Contents

Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 6, *Paper, board and pulps*, Subcommittee SC 2, *Test methods and quality specifications for paper and board*.

This corrected version of ISO 16260:2016 replaces the entire text of the erroneously published version dated 2015-06-01.

Introduction

Paper and board sheets may, during printing, conversion or specific product applications, be subjected to impulses, impacts or shock loads of sufficient magnitude to cause structural failure. Commonly observed in-plane structural failures include surface picking, blistering and interior delimitation.

This International Standard describes one method for determining the internal bond strength of a product of pulp, paper or board. There are other published methods[4][8] for determining “Z” or thickness direction tensile strength, but in this method, the delaminating force is applied at a rate very much higher than in other methods. This method may, therefore, be preferred for predicting sheet performance under printing or converting conditions.

Paper and board — Determination of internal bond strength

1 Scope

This International Standard describes a method to measure the energy required to rapidly delaminate a test piece of paper or board. Rupture of the test piece in the “Z” or thickness direction is initiated by a pendulum having a defined mass, moving at a defined velocity.

The procedure is suitable for both single- and multi-ply papers and boards, including coated sheets and those that are laminated with synthetic polymer films. It is particularly suitable for papers and boards that may be subjected to z-direction[4][8] rapid impacts, impulses or shock loads during printing or conversion.

The test procedure entails the adherence of double-sided adhesive tape to both sides of the test piece under pressure. For this reason, the method may be unsuitable for materials that might be structurally damaged by compression or are porous enough to permit migration of the tape adhesive into or through the test piece.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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*

EN 755-2:2013, *Aluminium and aluminium alloys — Extruded rod/bar, tube and profiles — Part 2: Mechanical properties*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

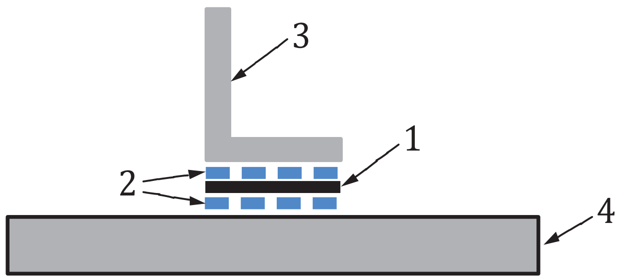
3.1
internal bond strength
average potential energy, expressed as J/m^2 of surface, required to delaminate a test piece under the conditions of the test

Note 1 to entry: The result is the difference of the potential energy before and the remaining energy after delaminating the test piece.

3.2
test assembly
test piece, laminated between two pieces of double-sided adhesive tape, with the bottom side of the lower tape adhered to a rigid metal anvil and the upper side of the upper tape adhered to an “L”-shaped aluminium platen

4 Principle

A square test piece is adhered to a flat metal anvil by means of double-sided adhesive tape. An "L"-shaped aluminium platen with the same surface area as the test piece is then adhered to the upper surface of the test piece, again, using double-sided adhesive tape. The assembly is shown in Figure 1. The assembly is secured in position and a pendulum allowed to impact the upper inside surface of the platen, causing it to rotate about its outside corner, splitting the test piece in the "Z" or thickness direction (see Figure 2). The energy absorbed in rupturing the test piece is calculated from the measurement of the subsequent over-swing of the pendulum and the known masses and dimensions of the system components.



Key

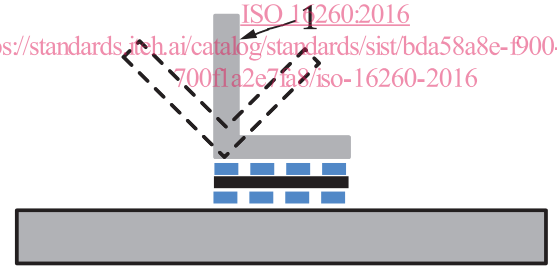
1 test piece

2 double-sided adhesive tape

3 aluminium platen

4 metal anvil

Figure 1 — Components of a test assembly



Key

1 pendulum strike point and direction

Figure 2 — Pendulum to anvil strike point

Precision data are provided in Annex B.

Verification of the measuring instrument compliance using an impact device is described in Annex C.

5 Apparatus and technical data

5.1 Apparatus

5.1.1 Device for the preparation of the test assembly, with the dimensions 25,4 mm ± 0,2 mm × 25,4 mm ± 0,2 mm for testing by pressing the components of the test assembly together at a controlled pressure for a controlled time. During the pressure cycle, the aluminium platen (5.1.4) should be securely clamped in position to prevent flexing.

NOTE Most commercially available preparation stations are capable of simultaneously preparing five test assemblies.

Ensure that the test instrument is levelled in the front–back and left–right directions and the pendulum is horizontal when in the latched position.

5.1.2 Pendulum, mounted on a pedestal by means of a horizontal spindle supported on low-friction bearings. The pendulum shall be free to rotate from a horizontal position through at least 180°. At its free end, the pendulum carries a metal striker ball which contacts the inside face of the aluminium platen on the test assembly when the pendulum reaches the vertical position. To minimize energy losses due to vibration, the centre of gravity of the pendulum should be at the point of impact of the striker ball with the aluminium platen. There should be no looseness in the construction of pendulums that have augmented weight assemblies.

5.1.3 A means for securing the pendulum in a horizontal position, with provision for a rapid, vibration-free release.

5.1.4 Test assembly, is formed from a stationary anvil (base) and a separable aluminium platen that is a right angle in cross section together with the test piece and adhesive tape (see Figure 1).

Anvils intended for use in multiple test piece preparation stations should be indelibly marked to ensure that they are always placed in the same position in the preparation station. The test assembly is securely held in position so that the pendulum strikes the centre of percussion of the aluminium platen when the axis of rotation is at the outside corner of the right angle of the platen (see Figure 2).

5.1.5 A means of registering the peak angular swing of the pendulum after impact with the test assembly.

5.1.6 A means to convert the peak angular swing of the pendulum to an internal bond strength value. Commonly employed methods include optical encoder computer and mechanical scale/friction pointer.

5.1.7 An optional means to extend the range of the instrument. This may be achieved by fitting pendulums of different masses, or by adding augmenting weights to the pendulum, or reducing the surface area of the test piece by an amount not exceeding 50 %. The user of this International Standard should consult the manufacturer of the test instrument regarding the installation and verification of such options. Any such modifications to the instrument shall be included in the test report.

5.1.8 Device suitable for cutting strips of the test material 25,4 mm ± 0,2 mm (5.2.5) wide and of sufficient length to mount in the test assembly preparation device.

5.1.9 Knife or multi-blade cutting device, for separating test assemblies prepared in a multi-station test assembly preparation device.

5.1.10 Double-sided adhesive paper tape, with a creped release liner (see 5.2.4).

5.1.11 Solvent, suitable for removing adhesive residue from the anvils and aluminium platens.

5.2 Technical data

5.2.1 Instrument/pendulum ranges

Table 1 — Instrument and pendulum ranges

	Range 0	Range 1 SB low	Range 2 SB high	Range 3
Measuring range (J/m^2) (recommendation, otherwise, manufacturers' instructions)	50 to 400	100 to 600	200 to 1 200	300 to 2 400
Corresponds to Scott-Bond (SB) scale.		Low-range 0 to 525	High-range 210 to 1 050	
Pendulum length, *L*, (mm), to ±0,2 mm	228,6	228,6	228,6	228,6
Reduced pendulum length[a], *Lred*, (mm)	130 to 140	145 to 170	170 to 190	180 to 200
Mass of pendulum ±4 g	133	190	380	760
Tolerance range potential energy[a] Potential Energy (Nm) calculated from m × g × h	0,29 to 0,31	0,41 to 0,44	0,84 to 0,88	1,60 to 1,72

a The decisive factor is the potential energy that is stored in the pendulum at the start of the test. Once the pendulum is released, the potential energy is converted into kinetic energy as the pendulum impacts the aluminium platen. The determination of the reduced pendulum length serves as a fast check-up of the device's condition. A more accurate examination is possible by applying the method described in 5.2.3 (reduced pendulum length, *Lred*).

5.2.2 Aluminium platen/anvil

Aluminium platen:

Alloy EN AW 6060 T66 (AlMgSi0,5 F 22) according to EN 755-2:2013, Table 38.

Devices where the alloy, used for the platen, cannot be identified, only original aluminium platen shall be used.

NOTE "Newer" devices have a marking on the platen that identifies the alloy used. This is not the case for "old" devices.

Compensation: The scales of the Scott-Bond devices contain a compensation that takes account of the original alloy of the platen. If the alloy is changed, the compensation used may not be appropriate and this would lead to erroneous values being obtained. This correction factor is not applicable for digital devices.

Surface: Surface roughness: *Rz* ≤ 3,8 µm[1][2]

Mass of an aluminium platen: (11,3 ± 0,2) g

Wear and tear: Replacement after 10 000 measurements or when there are significant traces of deformation or pendulum markings.

Anvil:

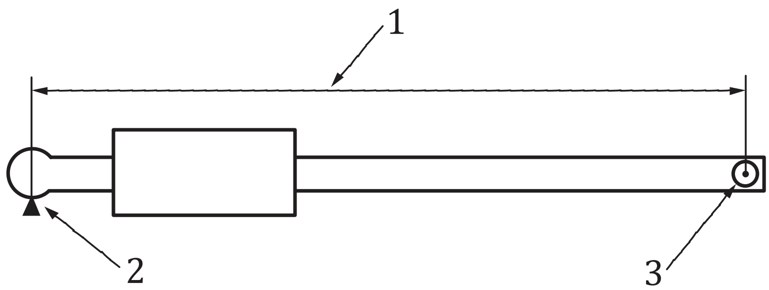
Surface roughness: Rz ≤ 3,8 µm[1][2]

5.2.3 Pendulum

Pendulum point of impact onto the aluminium platen: Centred on the anvil and (21 ± 0,2) mm from the aluminium platen's lower edge without a sample and without adhesive tape.

Quality of the pendulum bearing: Energy loss when freely oscillating <1 %.

Pendulum length: (228,6 ± 0,2) mm, measured as indicated in Figure 3.



Key

1 distance between contact point and centre of pendulum rotation, 228,6 mm ± 0,2 mm

2 contact point for m(90°) total mass at 90° deflection

3 centre of rotation

Figure 3 — Reduced pendulum length, *Lred*

This calculation determines the position of the centre mass on the centreline of the pendulum shaft. It is determined by measuring the average period, t_S, of one oscillation. Deflect the pendulum ≤3 and measure the time for at least 10 oscillations to get a reliable average. Calculate *Lred* according to Formula (1):

$$Lred = \left(\frac{t_s}{2\pi}\right)^2 \times g \qquad (1)$$

where

t_S is the average period of one oscillation (s);

g is the acceleration due to gravity (m/s²).

5.2.4 Adhesive tape

The adhesive tape shall be according to:

Finat FTM1 = 15 N/(25,4 mm ± 0,2)

NOTE 1 ASTM D 3330/D3330M-0,4 (2010) (= 56 N/100 mm) is used by many, but the specification does not give the same precision as the FINAT method.

NOTE 2 In the list below, examples of tapes are given that fulfil the above requirements:

— Nitto P-50TM1);

— Tesa tesafix 4961TM1);

— 3MTM1) type 410 M.

The customer and supplier should agree which adhesive tape, of those fulfilling the above requirement, is to be used.

5.2.5 Test piece

The test piece size shall be 25,4 mm ± 0,2 mm edge length

1) This information is given for the convenience of user of this International Standard and does not constitute an endorsement by ISO of these products.