INTERNATIONAL STANDARD

ISO 1924-3

First edition
2005-07-01

Paper and board — Determination of tensile properties —

Part 3: Constant rate of elongation method (100 mm/min)

Papier et carton — Détermination des propriétés de traction —

Partie 3: Méthode à gradient d'allongement constant (100 mm/min)

Reference number
ISO 1924-3:2005(E)

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 1924-3 was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*, Subcommittee SC 2, *Test methods and quality specifications for paper and board*.

ISO 1924 consists of the following parts, under the general title *Paper and board — Determination of tensile properties*:

— *Part 2: Constant rate of elongation method* [1)]

— *Part 3: Constant rate of elongation method (100 mm/min)*

Part 1: *(Constant rate of loading method)* was withdrawn in 2004 as it was considered obsolete.

1) In Part 2, a constant rate of elongation of 20 mm/min is used.

Introduction

This part of ISO 1924 has been developed in order to specify the conditions for determining the tensile properties of paper, including tensile stiffness and tensile stiffness index, using a higher rate of elongation than specified in ISO 1924-2, which is the most commonly used part where tensile strength, stretch at break, tensile energy absorption and modulus of elasticity are measured. In ISO 1924-2, the tensile properties are measured at a constant rate of elongation of 20 mm/min at a test span of 180 mm. For the measuring of tensile stiffness in this part of ISO 1924, a higher accuracy in the recording of elongation, compared to ISO 1924-2, is also required.

This part of ISO 1924 specifies the fastest of the two methods. In addition to the properties measured in ISO 1924-2, the tensile stiffness is also measured. The tensile properties are measured at a constant rate of elongation of 100 mm/min at a test span of 100 mm, and the elongation is recorded with a higher accuracy than the accuracy in ISO 1924-2.

This part of ISO 1924 differs from existing standards for testing tensile properties in that the test span, i.e. the distance between the clamping lines, is 100 mm irrespective of the kind of sample to be tested. The rate of elongation has been increased to 100 mm/min in order to reduce the testing time, thus making it possible to test a greater number of samples within a given time period.

NOTE The results of tensile tests depend on the rate of elongation applied and the test span. The rate dependence and the effect of test span may vary with paper grade and are different for tensile strength, strain at break, tensile energy absorption and tensile stiffness. In a study within SCAN-test, comparing the results achieved using ISO 1924-2 and this part, the tensile strength increased by 5 % to 15 % when the rate of elongation was increased from 20 mm/min (at a test span length of 180 mm) to 100 mm/min (at a test span length of 100 mm).

It is not possible to predict the exact relationship between the results for any particular paper whose tensile properties are determined using ISO 1924-2 and this part of ISO 1924. This relationship may only be determined by laboratory experimentation.

In this part of ISO 1924, the same terminology and symbols are used as in general literature concerning physics and mechanics of materials.

Paper and board — Determination of tensile properties —

Part 3:
Constant rate of elongation method (100 mm/min)

1 Scope

This part of ISO 1924 specifies a method for measuring the tensile strength, strain at break, tensile energy absorption and tensile stiffness, using a testing machine operating with a constant rate of elongation (100 mm/min). This part of ISO 1924 also specifies equations for calculating the tensile index, the tensile energy absorption index, the tensile stiffness index and the modulus of elasticity.

When tensile stiffness is to be determined, a greater accuracy is required in the elongation measurement than when the other tensile properties are to be determined. If the elongation is determined with the lower accuracy, the tensile stiffness value obtained is not in accordance with this part of ISO 1924.

This part of ISO 1924 is applicable to all papers and boards, including papers of high extensibility, such as creped papers and extensible sack papers, but with the exception of low-density papers such as tissue papers and tissue products for which ISO 12625-4[2] is recommended.

2 Normative references

The following referenced documents are indispensable for the application of this document. 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*

ISO 534, *Paper and board — Determination of thickness, density and specific volume*

ISO 536, *Paper and board — Determination of grammage*

3 Terms and definitions

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

3.1
tensile strength
maximum tensile force per unit width that paper and board will withstand before breaking under the conditions defined in this standard test method

3.2
tensile index
tensile strength divided by the grammage

3.3
elongation
increase in length of a test piece

3.4
strain
ratio of the elongation of a test piece to the initial test length

NOTE The initial test length of the test piece is the same as the initial span between the clamping lines.

3.5
strain at break
strain at the maximum tensile force

3.6
tensile energy absorption
amount of energy per unit surface area (test length × width) of a test piece when it is strained to the maximum tensile force

3.7
tensile energy absorption index
tensile energy absorption divided by the grammage

3.8
tensile stiffness
maximum slope of the curve obtained when tensile force per unit width is plotted versus strain

3.9
tensile stiffness index
tensile stiffness divided by the grammage

3.10
modulus of elasticity
tensile stiffness divided by the thickness

4 Principle

A test piece of given dimensions is strained to break at a constant rate of elongation using a testing machine that automatically records both the tensile force and the elongation. From the recorded data, the tensile strength, the strain at break, the tensile energy absorption and the tensile stiffness are calculated.

5 Apparatus

5.1 Tensile testing machine, including means of determining the force (i.e. a load-cell), the elongation and the area between the force-elongation curve and the elongation axis. The testing machine is designed to strain a test piece at a constant rate of elongation of 100 mm/min ± 10 mm/min, and to record both the tensile force and the elongation.

NOTE 1 The true elongation rate is less than the rate of movement of the moving clamp due to the deflection of the load-cell and the testing machine. This rate difference has, however, normally a negligible effect on the strength values.

The testing machine shall have two clamps for holding the test piece. Each clamp shall be designed to grip the test piece firmly, but without damage, along a straight line across the full width of the test piece (the clamping line), and have a means of adjusting the clamping force.

NOTE 2 The clamping line is the contact zone resulting from gripping the test piece between a cylindrical and a flat surface or between two cylindrical surfaces whose axes are parallel. For certain grades of paper, “line contact” clamps may not be appropriate and it may be necessary to replace them with another type of gripping surface. Other types of clamps may be used, provided no slippage of, or damage to, the test piece occurs during the test.

When the test piece is clamped, the clamping lines shall be parallel to each other within an angle of 1°, see Figure 1. During the test, the angle between the clamping lines shall not change by more than 0,5° in the plane of the test piece. The centre-line of the test piece shall be perpendicular to the clamping lines within an angle of 1°.

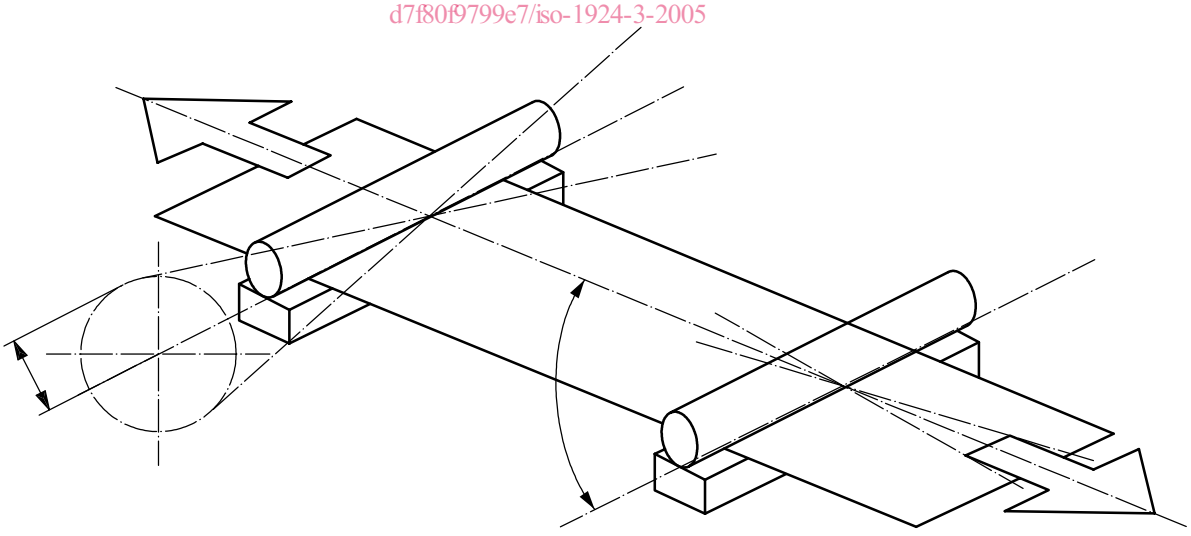
If there is any suspicion that the test piece slips, a test with different clamping forces shall be carried out. If the clamping force influences the strain at break, this means that the test piece may be slipping in the clamp. If the strain at break is independent of the clamping force, then no slipping in the clamps occurs.

The applied tensile force shall be parallel to the test piece centre-line, in the direction of the test piece, within an angle of 1°. The distance between the clamping lines (the test span) shall be 100 mm ± 0,5 mm.

The apparatus shall have means of recording the elongation and the force as follows:

Property	Elongation	Force
Tensile strength	—	to an accuracy of 1,0 % of the true force
Strain at break	to an accuracy of 0,1 mm	—
Tensile energy absorption	to an accuracy of 0,1 mm	to an accuracy of 1,0 % of the true force
Tensile stiffness	to an accuracy of 0,01 mm, in the range 0 to 1 mm	to an accuracy of 1,0 % of the true force

The elongation shall be calculated from the change in distance between the clamps, or by the use of an extensometer.



Clamping lines parallel to each other within an angle of 1°

Centre-line of test piece perpendicular to clamping line within an angle of 1°

Tensile force parallel to the test piece centre-line within an angle of 1°

Figure 1 — Clamping line and test piece relationship

NOTE 3 If the elongation is calculated from the movement of the moving clamp, the deflection of the load-cell and of the testing machine must be taken into consideration and adjusted for.

5.2 Device for cutting test pieces to the dimensions required (see 7.3).