
International Standard



3781

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Paper and board — Determination of tensile strength after immersion in water

Papier et carton — Détermination de la résistance à la traction après immersion dans l'eau

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Descriptors : paper, board, test, tensile strength test, immersion method, test material.

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (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 authorized 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 3781 was developed by Technical Committee ISO/TC 6, *Paper, board and pulps*.

This second edition was submitted directly to the ISO Council, in accordance with clause 6.11.2 of part 1 of the Directives for the technical work of ISO. It cancels and replaces the first edition (i.e. ISO 3781-1976), which had been approved by the member bodies of the following countries:

Belgium	Ireland	Sweden
Bulgaria	Israel	Switzerland
Canada	Italy	Thailand
Czechoslovakia	Mexico	Turkey
Finland	Netherlands	United Kingdom
France	Norway	USA
Germany, F.R.	Poland	USSR
Hungary	Romania	
Iran	South Africa, Rep. of	

The member bodies of the following countries had expressed disapproval of the document on technical grounds:

Australia
New Zealand

Paper and board — Determination of tensile strength after immersion in water

1 Scope and field of application

This International Standard specifies methods for the determination of the wet strength of paper by measuring its tensile strength after it has been immersed in water for a specified period.

In principle, the method is applicable to board as well as to paper, provided that an appropriate soaking time is agreed between the interested parties.

2 References

ISO 186, *Paper and board — Sampling for testing*.

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

ISO 1924, *Paper and board — Determination of tensile strength*.

3 Definitions

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

3.1 wet tensile strength: The maximum force that a test piece of paper or board will stand, after soaking in water, before it breaks, under the specified conditions.

3.2 wet strength retention: The ratio of the value of the tensile strength of a paper or board in the wet state to that of the same paper or board in the dry state, measured under the specified conditions.

4 Principle

Immersion in water, for the appropriate period of time, of a test piece of the paper or board to be tested and determination of the tensile strength.

5 Apparatus and material

5.1 Apparatus, complying with ISO 1924 for dry tensile testing.

5.2 Soaking attachment (optional), as described in the annex.

5.3 Water for soaking: use distilled or deionized water, at the temperature specified for conditioning in ISO 187.¹⁾

6 Sampling

Specimens shall be selected in accordance with ISO 186.

7 Test pieces

7.1 Preparation

Test pieces shall be prepared in accordance with ISO 1924.

NOTE — If the soaking attachment (see the annex) is used (see 8.2.2), it may be convenient to have the clamps only 100 mm apart. A convenient length for the test piece is then about 150 mm.

7.2 Conditioning

7.2.1 For dry tensile tests and for tests which involve soaking for less than 1 h, the specimen and the test pieces shall be conditioned in accordance with ISO 187. Conditioning is not necessary before soaking for 1 h (or longer).

7.2.2 If the material has been specially treated (for example, with urea-formaldehyde), care shall be taken to ensure that sufficient time has elapsed after treatment for the wet strength to be fully developed before soaking the test pieces.

1) Preferred temperature: 23 ± 1 °C.

8 Procedure

8.1 Normal procedure

In the absence of any agreement to the contrary, soak the test pieces until saturated; normally, this means a soaking time of 1 h. Use water as specified in 5.3 and a suitable shallow dish.

Boards and other hard-sized papers may require a soaking time of 24 h or longer to attain a satisfactory degree of saturation. The appropriate soaking time may be selected to simulate particular conditions of use, by agreement between the interested parties.

After soaking, remove the test pieces from the dish, lightly blot them to remove surplus water and immediately test them by the method specified in ISO 1924.

8.2 Procedure for very absorbent papers

8.2.1 General

For very absorbent papers, it is recommended that only the centre portion of the test piece be wetted, while the portion held by the clamps remains dry.

NOTE — For very low wet-strength papers, multiple test pieces may be required, and the number of plies used should be stated in the test report.

Either of the following procedures may be used.

8.2.2 Straight-pull method

Loop the test piece, with the centre portion downwards, and immerse the apex of the loop in water. The water should contact the test strip uniformly across its width, and flow over the upper surface. The wetted length, including that resulting from wicking, should be at least 25 mm, but not more than 50 mm.

At the end of the soaking time, withdraw the loop and remove the excess water by lightly blotting the apex of the looped test piece with absorbent paper.

Carefully straighten the loop, and, without undue strain, position the test piece in the tensile tester, so that the wetted portion is equidistant from the clamps. Apply the tensile stress within 20 ± 1 s of first wetting the test piece, and complete the test as specified in ISO 1924.

8.2.3 Finch method

Use the soaking attachment (known as the Finch device), which enables the test piece to be immersed in water while in position on the tensile tester.

Fix the attachment squarely in position in the lower clamp of the tensile tester. Loop the dry test piece, which shall be about 150 mm long, under the dry horizontal rod and fix the two ends in the top clamp, making sure that the test piece is gently and evenly tensioned.

Raise the container, with water in it, to the upper position so that the looped end of the test piece is immersed to a depth of not less than 19 mm. After 20 ± 1 s, lower the container. Immediately start the tensile test, as in 8.1.

NOTES

1 If the Finch device is used to measure the wet tensile strength, and a determination of wet strength retention is required, the dry tensile strength should be measured on the same device. Use the dry tensile strength measured with the Finch device for calculating wet strength retention only.

2 If the Finch device is used, and only the wet tensile strength is required, the test result should be divided by 2 to obtain the wet tensile strength of a single test piece (see 9.3).

8.3 Number of tests

For the wet tensile test, carry out ten tests in the machine-direction and ten in the cross-direction.

If the dry tensile strength is also to be measured (for determination of wet strength retention), repeat the twenty tests with dry test pieces.

9 Expression of results

9.1 General

Calculate the results separately for the machine-direction and the cross-direction. The calculations are given in ISO 1924 for dry tensile strength.

The results may be expressed as

- mean wet tensile strength, in kilonewtons per metre width;
- mean wet strength retention, i.e. as a percentage of the corresponding mean value in the dry state.

9.2 Normal and straight-pull methods

Calculate the tensile strength, S , in kilonewtons per metre width, using the formula

$$S = \frac{X}{W}$$

where

W is the width, in millimetres, of the test piece;

X is the scale reading, in newtons.

9.3 Finch method

NOTE — The tensile strength of the test piece measured on the Finch device is twice that in a normal tensile test.

Calculate the tensile strength, S , in kilonewtons per metre width, using the formula

$$S = \frac{0,5 X}{W}$$

where W and X have the same meaning as in 9.2.

10 Precision

In the present state of knowledge, no general statement can be made as to the precision of this method.

11 Test report

The test report shall include the following particulars:

- a) reference to this International Standard;
- b) soaking time (if other than 1 h);
- c) type of tensile tester used;
- d) the length and width of the test piece;
- e) the number of plies used (in the case of very weak papers);
- f) the results (in accordance with clause 9) and the 95 % confidence limits of the mean value;
- g) details of any items regarded as optional, or not specified in this International Standard or in the International Standards to which reference is made, and any other features that may have affected the results.

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Annex

Description of soaking attachment

The object of the soaking attachment (Finch device) is firstly to enable tensile tests to be carried out immediately after short soaking periods and secondly to avoid the difficulty of handling wet test pieces of low strength.

The Finch device (see the figure) consists of a rigid inverted metal stirrup of width about 38 mm and length about 76 mm. A horizontal rod, of length about 28 mm and diameter about $5 \pm 0,05$ mm, is attached to the metal stirrup as shown. Between the metal straps which form the framework of the stirrup is a small easily removable container for holding water. Spring clips hold the container in position (as shown in the figure) and also enable it to be slid up and down and to be left in either the raised or the lowered position. However, in view of the short immersion period (20 s) standardized for the types of paper that normally require to be tested in this way, it is on the whole more convenient to slide the container up and hold it for the requisite period of time. The friction sliding device is very useful, however, for special cases in which longer soaking times are necessary. The depth of immersion is not less than 19 mm so that a total length of paper of at least 38 mm is under water during the soaking time. A metal tongue at the bottom of the apparatus permits the device to be fastened securely in the lower clamp of the tensile tester. It is essential, in constructing this apparatus, to ensure that it is quite rigid so that the tensile force is applied evenly to the test strip.

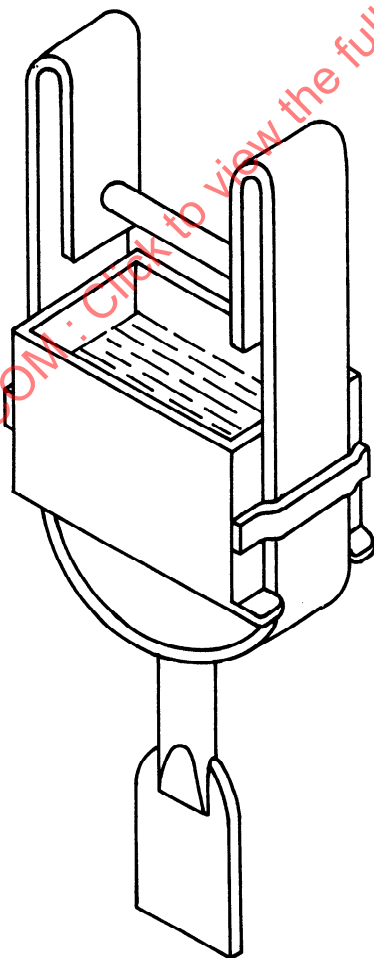


Figure — Finch device