NOTICE: This standard has either been superseded and replaced by a new version or withdrawn.
Contact ASTM International (www.astm.org) for the latest information

Designation: D 5803 – 97 (Reapproved 2002)

An American National Standard

Standard Test Method for Tensile Strength at Zero-Span ("Wet Zero-Span Tensile")[1]

This standard is issued under the fixed designation D 5803; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

The determination of the tensile strength of paper and paperboard when dry or wet is described in Test Methods D 828 and D 829, respectively. In these procedures, the standard effective specimen length is defined by the tensile tester grip separation at the start of the test. This standard grip separation, sometimes called gage length or span, is 180 mm (7.1 in.). Other gage lengths are permitted for specific testing purposes and are described in the respective test methods.

At a gage length of 180 mm, the measured tensile strength of a sheet of paper or paperboard is heavily impacted by sheet structural characteristics such as formation, basis weight, fiber orientation, and other structural characteristics, and is essentially unchanged at gage lengths ranging from 50 to 200 mm. Sheet structural characteristics, in turn, are dependent upon fundamental properties of the individual fibers and the way these properties are impacted throughout the entire papermaking process. This is true whether the specimens for testing are taken from an early or intermediate point in the papermaking process, or are sampled after the finished paper material has been produced.

At a gage length of zero, however, tensile strength is highly dependent upon fundamental strength and other quality properties of individual fibers rather than sheet structural properties. Tensile data measured at a gage length of zero is typically higher than that measured using Test Method D 828, because the strength of individual fibers, as opposed to the cumulative effect of fiber properties (particularly bonding) on sheet characteristics is being measured.

Tensile strength data at a gage length of zero may be used to assess the retention of fiber strength and fiber quality parameters through the entire fiber processing chain, thereby providing opportunities to optimize fiber characteristics and utilization in various paper grades. Tensile strength values determined at a gage length of zero contribute to our understanding of finished sheet strength and are of increasing importance in measuring the impact of new pulping, bleaching, and papermaking processes on fiber quality characteristics. In turn, fiber quality characteristics impact fiber processing and utilization considerations, and of most importance, the overall finished paper or paperboard properties and quality.

For ease in communication, as well as theoretical considerations, very short-span measurement of fibers in sheeted form is generally done at "zero-span," that is, at an effective gage length of 0.00 mm (0.000 in.). When the specimen is tested in the dry state, this measurement is generally referred to as "zero-span tensile strength." When the specimen is tested after wetting, the measurement is described as "wet zero-span tensile strength."

1. Scope

1.1 This test method provides a quick, reliable means to measure the wet zero-span tensile strength of a specimen of sheeted material.

1.2 In cases where fibers are to be tested prior to finished production of paper or paperboard, a random standard aggregate of pulp fibers, or handsheet, produced using a standardized procedure, such as, TAPPI T 205 is required.

1.3 This test method requires specimens such as those described in 1.2.

1.4 While testing is possible on finished paper or paperboard, information on fiber quality from intermediate steps in the pulping or papermaking process, or both, is frequently

[1] This test method is under the jurisdiction of ASTM Committee D06 on Paper and Paper Products and is the direct responsibility of Subcommittee D06.92 on Test Methods.

Current edition approved Dec. 10, 1997. Published November 1998. Originally approved in 1995. Last previous edition approved in 1995 as D 5803 – 95.

Copyright © ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States.

Documents
Document Sharing Hub
Full document details: ASTM D5803-97(2002)

more useful for improving finished paper and paperboard quality or improving fiber utilization of recycled fibers, or fibers subjected to new pulping, bleaching, or finishing processes (**1**, **2**, **3**, **4**).[2]

1.5 The modifications of this test method required for testing finished paper is straightforward; however, testing shall be done in the two principle directions of the sheet, as required in Test Method D 829. The finished paper or paperboard will generally have nonrandom fiber orientation, resulting in different strength properties in the two principle directions of the finished sheet. Testing of sheets having a grammage greater than 100 g/m^2, which includes some paper materials described as paper and many paperboards, is difficult because of problems associated with clamping of individual fibers as the number of fibers per unit area increases.

1.6 Modifications such as those in 1.5 are not described in this test method. If modifications are made, they must be acknowledged and clearly described in the report as deviations from the standard procedure.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 586 Test Method for Ash in Pulp, Paper, and Paper Products[3]

D 828 Test Method for Tensile Properties of Paper and Paperboard Using Constant-Rate-of-Elongation Apparatus[3]

D 829 Test Methods for Wet Tensile Breaking Strength of Paper and Paper Products[3]

D 1193 Specification for Reagent Water[4]

D 1968 Terminology Relating to Paper and Paper Products[3]

E 122 Practice for Calculating Sample Size to Estimate, With a Specified Tolerable Error, the Average for Characteristic of a Lot or Process[5]

2.2 *TAPPI Standards:*

T 205 Forming handsheets for physical tests of pulp[6]

T 220 Physical testing of pulp handsheets[6]

3. Terminology

3.1 For definitions used in this test method, refer to Terminology D 1968 or the *Dictionary of Paper*.[6]

4. Summary of Test Method

4.1 A sample is selected and a handsheet is prepared using TAPPI T 205 or another agreed-upon procedure.

4.2 A specimen of the prepared handsheet is cut for testing such that the specimen width is approximately 5.6 mm wider than the zero-span jaws which will be used in the testing.

4.3 The specimen is wetted with reagent water using a sponge and wet roller.

4.4 The wet specimen is inserted into the jaws of a suitable tensile tester having grips which are adjusted to at an effective gage length of 0.00 mm or "zero-span".

4.5 The tensile tester is activated and the wet zero-span tensile strength is determined and reported in newtons per centimetre, or in other units of user choice.

5. Significance and Use

5.1 The wet zero-span tensile test measures the tensile strength at the moment of tensile failure of wet fibers, which are clamped in the two jaws of a suitable tensile tester. The wet zero-span tensile value may be used to assess the tensile strength of individual fibers in their length dimension when wet.

5.2 For unbeaten chemical pulps, the wet zero-span tensile test is a very sensitive measure of the loss in individual fiber strength in the length dimension (axial tensile strength of the individual fibers) due to pulping and bleaching.

5.3 For mechanical pulps, the wet zero tensile test is a very sensitive measure of quality and strength of the finished sheet in terms of fines content and particle size, because the absence of a harsh chemical environment over a significant time means that the strength of the individual fibers undergoes minimal change.

5.4 Wet zero-span tensile data may be used to indicate individual fiber strength and guide the best utilization of fibers of unknown history, such as recycled fiber material.

5.5 The relationship between the strength of a fibrous sheet is determined by methods such as Test Methods D 828 and D 829 fibers, and the strength of the individual fiber comprising the sheet is important to overall properties of the finished sheet and may be studied using this test method.

5.6 More theoretical interpretations of wet zero-span will be found in the early work of Van den Akker (**5**) and the later work of Boucai (**6**). See Appendix X1.

6. Apparatus

6.1 *Clamping Jaws*, two adjacent, spatially aligned clamping jaws in initial intimate contact ("zero-span"), which reliably and reproducibly exert a very high, optimum, and uniform clamping pressure on fibers in a test specimen after the specimen has been wetted with reagent water using a defined procedure. The essential elements that shall be incorporated into any wet zero-span tester are shown in Fig. 1.

6.1.1 The clamping pressure required ensures a maximum clamping effect but cannot totally prevent the microslippage, whereby the tensile load transmitted in the clamped fibers is dissipated by frictional shear into the clamping jaws. This microslippage means that the ends of some fibers will slip out from beneath a clamping jaw, thereby diminishing the number of fibers carrying the load at tensile failure. For this reason, careful interpretation of the wet zero-span tensile strength value must be exercised in order to separate effects due to the relative number of fibers which are carrying the load at failure

[2] The boldface numbers in parentheses refer to the list of references at the end of this test method.

[3] *Annual Book of ASTM Standards*, Vol 15.09.

[4] *Annual Book of ASTM Standards*, Vol 11.01.

[5] *Annual Book of ASTM Standards*, Vol 14.02.

[6] Available from the Technical Association of the Pulp and Paper Industry (TAPPI), P.O. Box 105113, Atlanta, GA 30348.

AVA Documents Document Sharing Hub

Full document details: ASTM D5803-97(2002)