WI 250808.13

T 541

BALLOT NO. 02 - SARG

DRAFT NO. 01

DATE June 9, 2026

WORKING GROUP CHAIR N/A

SUBJECT CATEGORY Physical Properties

RELATED METHODS See "Additional Information"

CAUTION:
This Test Method may include safety precautions which are believed to be appropriate at the time of publication of the method. The intent of these is to alert the user of the method to safety issues related to such use. The user is responsible for determining that the safety precautions are complete and are appropriate to their use of the method, and for ensuring that suitable safety practices have not changed since publication of the method. This method may require the use, disposal, or both, of chemicals which may present serious health hazards to humans. Procedures for the handling of such substances are set forth on Safety Data Sheets which must be developed by all manufacturers and importers of potentially hazardous chemicals and maintained by all distributors of potentially hazardous chemicals. Prior to the use of this method, the user must determine whether any of the chemicals to be used or disposed of are potentially hazardous and, if so, must follow strictly the procedures specified by both the manufacturer, as well as local, state, and federal authorities for safe use and disposal of these chemicals.

Internal Bond Strength of Paperboard (Z-Direction Tensile)

(*Five-year review of Official Method T 541 om-21)*

1. Scope and summary

1.1 This method describes a procedure for measuring the internal fiber bond strength (z-direction tensile strength) of paperboard using an instrument that separates a specimen adhered between a 6.45-cm^2 (1-$in.^2$) platen and a self-aligning platen.

1.2 The procedure consists of applying double (two-sided) coated, pressure-sensitive tape to both sides of a test specimen. The specimen is then placed between two platens and compressed uniformly over the entire specimen surface area. Uniform tension is then applied over the entire test area in a direction perpendicular to the plane of the sample (z-direction) to affect a separation.

1.3 The test is intended for paperboards and some papers which have internal fiber bond strength (cohesive strength) lower than the adhesive bond strength of the tape to the specimen and/or test platens. The material from which the platens are made will affect the adhesive strength between platen and tape. The selection of tape may also affect test results. These effects may be seen as tape failures or in some cases higher test values caused by adhesive migrating into sample. The adhesive bond strength of the tape is critical to reproducible test results. New batches of tape should be tested for consistent bond strength. Bond strength can be tested by performing peel tests on standard test plates, or by testing a stable reference sample.

1.4 Test results by this method do not correlate with TAPPI T 569 "Internal bond strength (Scott type)"

measurements. TAPPI T 569 uses a pendulum that impacts the top inside surface of a platen at a high speed causing it to rotate and split the paper specimen.

2. Significance

2.1 The internal bond strength of paperboard provides an indication of expected performance, e.g., strength of board in relation to glue bonding at carton side seams, and possible delamination on scoring, or use of high tack coatings.

2.2 This method has also been found useful for the evaluation of internal fiber bond of coated fine papers.

2.3 The results must be interpreted according to each user's requirement and to each end use.

3. Apparatus

3.1 *Tensile-compression tester, z-direction*, having:

3.1.1 A force measuring system with a minimum capacity of 890 ± 13.5 N (200 lbf) with a minimum resolution of 0.25% of full scale and an accuracy of at least 1% of full scale.

3.1.2 A 6.45 ± 0.05 cm^2 (1 $in.^2$) test platen area. Testers are supplied with a 6.45 cm^2 platen on one side and a larger platen on the other. This larger platen reduces the potential for edge effect errors caused by small misalignments of upper and lower platens.

3.1.3 A means of insuring platen parallelism. A self adjusting (swivel) mount for one of the tester platens is one means of insuring this criterion is met.

3.1.4 A test cycle consisting of a compression stroke (the instrument moves the platens together), a dwell time (to assure an adequate tape bond between the sample and tester platens), and a tension stroke (which causes the splitting of the test material, leaving a portion of the material on each of the tester platens).

NOTE 1: The data acquisition rate of the tensile-compression tester is a critical factor to its ability to capture accurate peak force values. Tests conducted with this method have a break time of approximately 150 to 300 milliseconds so it is the responsibility of the instrument manufacturer to take care in the design to provide an adequate sample rate to capture the peak force with sufficient accuracy.

3.2 *Double (two-sided) coated, pressure-sensitive tape*, 50 mm (2 in.) wide.

NOTE 2: The brand of tape or the strength characteristics cannot be named here, because manufactures constantly change formulations and properties. The adhesion of the tape to the paper must be stronger than the internal bonding of the sample. This can be verified by examining the sample after testing and verifying that the tape did not separate from the sample or the platen. Strength properties of the tapes are affected with ageing and storage so the manufacture’s recommendations must be followed to ensure accurate test results.

3.3 *Paper cutter.*

4. Calibration

4.1 Check the accuracy and linearity of the tensile compression tester by the manufacturer's suggested methods using dead weights or a traceable force gauge.

NOTE 3: If dead weight calibration is to be used to check the force gauge, extreme care and caution should be observed when balancing weights. A falling weight is dangerous.

NOTE 4: If recalibration (other than resetting zero) is required, consult the manufacturer's equipment specifications.

5. Sampling and test specimens

5.1 Obtain samples in accordance with TAPPI T 400 “Sampling and Accepting a Single Lot of Paper, Paperboard, Containerboard, or Related Product.”

5.2 From each sample, cut five specimens at least 50 × 50 mm (2 × 2 in.), free from folds, wrinkles, or other abnormalities.

NOTE 5: Handle the specimens only by the edges, to minimize samples exposure to contaminants that may affect test results. Do not bend or flex the specimens in any manner or damage the edges.

6. Procedure

6.1 Precondition, condition, and test the specimens in an atmosphere in accordance with TAPPI T 402 "Standard Conditioning and Testing Atmospheres for Paper, Board, Pulp Handsheets, and Related Products."

6.2 Cut two 50.4 mm × 50.4 mm (2 × 2 in.) pieces of double-sided pressure sensitive tape. Remove one side of the protective liner from one of the pieces, pressure sensitive tape and fix the tape to one side of the specimen. Avoid air bubbles under the tape by keeping very slight tension on the tape during placement. Repeat this procedure on the other side of the specimen.

6.3 Clean platens with ethyl alcohol or similar prior to each day's testing or when adhesive residues are built up on the platens. Dry the platens with a dry tissue or soft cloth.

6.4 Remove protective liner from the tape on both sides of the specimen. Place the specimen between the platens of the tester, approximately centering it on the platen on which it is placed. Ensure platens are parallel before starting a test.

6.5 Zero the force on the tensile-compression tester.

6.6 Start the tester. The cycle consists of:

6.6.1 A compression stroke with a contact force of 890 ± 13.5 *N* (200 lbf). Sample thickness may affect contact pressure on some instruments.

6.6.2 A 6 ± 1 second dwell time. Sample thickness may affect dwell time on some testers.

6.6.3 A tension stroke at a controlled rate of 66 ± 5 mm/min. (2.60 in/min).

NOTE 6: Platens that are not kept clean will exhibit tape failures.

NOTE 7: Very high fiber bond strength may cause a very abrupt failure, resulting in a jarred maximum-reading indicator on some dial type instruments. If this occurs, read the maximum value of the test itself (the gauge needle), not the position of the maximum-reading indicator after it has been jarred. Make sure that frictional drag of the maximum-reading indicator does not significantly subtract from the actual maximum value for all tests.

6.7 Remove the tested specimen from the platens, being careful not to touch the platens. If the platens must be touched to remove tape or other material, clean the platens again with solvent and dry them. Return the maximum-reading indicator to zero if required and test the remaining specimens.

6.8 Any indication of tape-platen bond failure or tape-specimen bond failure invalidates a test. Increasing the compression-dwell time generally results in an adequate bond.

7. Report

7.1 Report minimum, maximum, and average (or the average and standard deviation) in kilopascals. The scale reading in newtons is multiplied by 1.55 to convert to kPa. Alternatively for units reading in pounds the test area is 1 square inch and the scale reading indicates pounds per square inch.

7.2 Report any deviation in test procedure or apparatus.

7.3 Report the manufacture, brand, or identification code of the tape used.

8. Precision

8.1 Repeatability (within a laboratory) = 6%

8.2 Reproducibility (between laboratories) = 34%

Repeatability and reproducibility are estimates of the maximum difference (at 95% confidence) that should be expected when comparing test results for materials similar to those described below under similar test conditions. These estimates may not be valid for different materials and testing conditions.

8.3 These estimates of repeatability and reproducibility listed above are based on data from the CTS Paper & Paperboard Interlaboratory Program from testing conducted between 2008 and 2010. The results include

more than 30 samples, including: uncoated offset, coated cover, uncoated cover, linerboard, and uncoated recycled paperboard. Between 12 and 20 laboratories were included in the calculations for each sample. The precision estimates are based on 5 determinations per test result and 1 test result per lab for each round of testing / sample. Only laboratories that reported performing the testing in accordance with this method and adhering standard conditioning atmospheres were included in the calculations. See Table 1.

Table 1. Data table

Material	*Mean*	*Repeatability*		*Reproducibility*	
		r	*%r*	*R*	*%R*
Uncoated RPB and linerboard	55	3.0	5.4%	13.6	24.3 %
Uncoated cover	63	3.7	5.6%	17.6	29.4%
Coated cover	73	6.2	7.9%	27.9	37.2%
Offset	86	4.7	5.5%	38.4	44.3%

Results listed in pounds force per square inch (psi).

9. Keywords

Adhesion, Cohesion, Paperboard, Bond strength, Fiber bonding, Tensile strength

10. Additional information

10.1 Effective date of issue: To Be Assigned

10.2 It is recommended that a supply of standard materials be maintained in several test ranges (or in the range normally encountered) for periodic testing (once per month) so as to detect any deterioration or damage to the equipment.

10.3 Changes in the 2010 version include revision of the notes regarding the tape and insertion of new precision data. Changes in the 2015 version included: (1) rewriting section 1.1 to better describe the method because the instrument subjects the sample to the force, no force to the sample; (2) including in 2.2 why this method is useful for coated fine paper; (3) changing 3.1.1 to have a force of 890 N instead of 900 N because the conversion from the original 200 lbf to Newton specification was not precise; (4) adding a definition of compression stroke in 3.1.4; (5) changed 6.2 to include the tape size and to describe the process of removing the protective liner, which is applied to the specimen; and (6) minor editorial.

Your comments and suggestions on this procedure are earnestly requested and should be sent to the TAPPI Standards Department.

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