WI 200808.18

T 556

DRAFT NO. 2-SARG

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WORKING GROUP CHAIRMAN 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 Material 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.

Bending resistance of paper and paperboard by single-point bending method

(Five-year review of Official Method T 556 om-16)

(No changes from previous draft: Standard reaffirmed)

1. Scope

This procedure is used to measure the bending resistance of paper and paperboard in the machine and cross machine directions, by determining the bending resistance in mN of a 38 mm (1.5 in.) wide vertically clamped sample, at 15° or 7.5° deflection. For this method the standard bending angle is 15 ± 0.1°. For specimens that break or are otherwise unsuitable at 15° a bending angle of 7.5 ± 0.1° shall be used.

2. Significance

2.1 Bending resistance affects the product performance in many converting operations and end use applications including printing, packaging, etc.

3. Definitions

3.1 *Bending resistance*, the resistance offered to a bending force by a rectangular specimen, which is clamped along one side, measured under specified conditions. The bending resistance is considered to be measured towards the side (felt or wire) that is concave during bending. Bending resistance is commonly referred to as "stiffness"; however, this is incorrect for the engineering meaning of the wording.

3.2 *Machine direction bending resistance*, the bending resistance of a specimen, clamped with its machine direction perpendicular to the line of clamping.

3.3 *Cross direction bending resistance*, the bending resistance of a specimen, clamped with its cross direction perpendicular to the line of clamping.

4. Apparatus

4.1 A bending resistance tester (in Fig. 1, an enlarged diagram of the external bending assembly is shown in alternate positions) consisting of a clamp (B) 38.0 ± 0.1 mm (1.5 in.) wide with clamping surfaces mounted at 90 ± 1.0°. It can be pivoted about a vertical axis (A) through the front edge of the clamping nip, and turned at a constant speed of 5° ± 0.5° per second through bending angles of 7.5 ± 0.1° or 15.0 ± 0.1°.

NOTE 1: Commercially available apparatus may have other fixed or variable bending angles available up to 30°; however, they are not included in the scope of this method. Results obtained using these alternate angles must be reported accordingly, as indicated in section 9.1.

4.1.2 A knife (C) mounted vertically at 90 ± 1.0° and attached to a transducer (D). The length of knife-edge is 16 ± 2 mm (0.6 ± 0.08 in.) and the edge is centrally placed relative to the width of the test piece. The distance from its edge to the pivot axis of the clamp (A) is normally adjusted to 50.0 ± 0.1 mm (2.0 in.) or 10.0 ± 0.1 mm (0.4 in.). The knife is also mounted at 90 ± 0.1° in the direction perpendicular to the specimen.

NOTE 2: Commercially available apparatus may have other available bending lengths from 1.0 mm to 25.0 mm; however, they are not included in the scope of this method. Results obtained using these alternate bending lengths must be reported accordingly, as indicated in section 9.1.

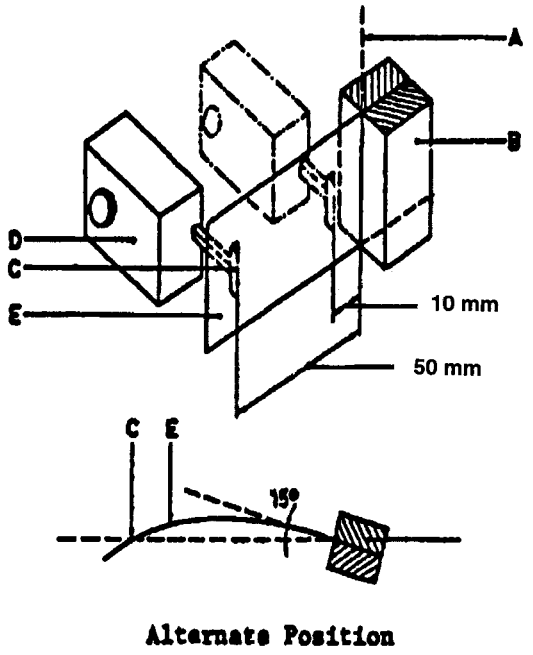

Fig. 1. Principle of the bending resistance tester: A. pivoting axis; B. clamping device; C. blunt knife-edge; D. force transducer with adjustable knife; E. test piece. The alternate position of the measurement head is indicated by the dashed lines.

4.1.3 The clamp must be at least 38 mm (1.5 in.) wide and at least 20 mm (0.8 in.) long with two flat and parallel jaws clamping the test piece uniformly. Normally, a clamping pressure of 200 ± 50 kPa (30 ± 7 psi) is suitable.

NOTE 3: Too low clamping pressure will give too low a bending resistance due to slippage between the surfaces of the jaws and the test piece. Too high a clamping pressure may, if thickness reduction occurs in the testing of low-density papers, also give too low a bending resistance. In case of uncertainty, make tests with varying clamping pressures. In general, the correct clamping pressures maybe considered to be that which gives the highest bending value.

4.1.4 The force transducer (D) shall have a range between 0–1000 mN (0–2.25 lbf), or an optional 0–10,000 mN range, with an accuracy of ± 1.0% of the nominal range. The transducer should have minimum sensitivity to lateral forces, and its movement in its response direction should be less than 0.05 mm (0.002 in.) when covering the full range of measurement.

4.1.5 An electronic holding circuit that can be checked accurately with dead weight loads and which records the maximum force exerted on the knife-edge with an error over the entire range of the measurement not exceeding 2% of the scale reading, but not greater than 1% of the load range.

4.1.6 Sample cutter, to cut specimen (E), 38 mm ± 0.1 mm (1.5 in.) and 76 mm (3 in.) long.

5. Sampling

5.1 Obtain a sample of the paper or paperboard in accordance with TAPPI T 400 "Sampling and Accepting a Single Lot of Paper, Paperboard, Containerboard, or Related Product."

5.2 Select test units free from watermarks or unusual flaws or creases in the area to be tested.

5.3 Avoid unnecessary handling of test units prior to testing.

6. Test specimens

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

6.2 From each test unit cut 20 specimens, one ply at a time to 38.0 ± 0.1 mm wide (1.5 in.) and 76 mm long (3 in.), 10 with the long edge parallel to the machine, and 10 with the long edge parallel to the cross direction.

7. Procedure

7.1 When testing paperboard, set the knife-edge of the bending resistance tester 50.0 ± 0.1 mm (2.0 in.) from the pivot axis of the clamp. For paper, set the knife-edge at 10.0 ± 0.1 mm (0.4 in.).

7.2 Position the specimen in the clamp so that the longer side is horizontal and the clamped end of the specimen fills the clamp. Make sure that the test piece is long enough to have a free length beyond the ~~clamp~~ knife edge of 7± 3 mm.

7.3 Adjust the knife carefully until it just makes contact with the specimen along a vertical line and so that the force indicator just reacts but registers no more than 1 mN. Avoid bending the specimen before the test begins.

7.4 Start pivoting the clamp, watch the instrument and note the maximum scale reading when the clamp has turned through 15°, the full bending angle.

7.5 If the maximum force is obtained before the test piece has been pivoted through 15°, a break is indicated. If more than 10% of the test pieces break, a 7.5° test angle should be used.

7.6 Use clamping length and test angle determined in 7.1 and 7.5, and a test speed of 5 ± 0.1° per second.

7.7 Use each specimen only once. Test 10 specimens in the cross machine and 10 in the machine direction. For each direction test 5 specimens toward the wire side and 5 toward the felt side.

8. Calculations

8.1 Calculate the mean bending resistance separately for the wire and felt sides. If the difference between these means exceeds 10%, report them separately; otherwise report the grand mean.

8.2 Report the bending resistance in the machine and cross directions in millinewtons as follows:

less than 100 mN	to the nearest 1 mN
100–1000 mN	to the nearest 10 mN
over 1000 mN	to the nearest 100 mN

8.3 Values cannot be converted from one clamping length to another or from one bending angle to another.

NOTE 3: Since test values cannot be converted from one clamping length or bending angle to another, it is important to use the same conditions if comparisons are made.

9. Report

9.1 The bending angle of 15° or 7.5°. Report any deviation from the standard test procedure, as when alternate bending angles or clamping lengths are used.

9.2 The clamping length of 50 mm or 10 mm (2 in. or 0.4 in.).

9.3 The specimen length 76 mm (3 in.).

9.4 The specimen width 38 mm (1.5 in.).

9.5 The results as described in 8.1 and 8.2.

9.6 Since length and width are critical dimensions, report must specify same in SI or English units.

10. Precision

10.1 In an inter-laboratory study, eight laboratories measured the Bending Resistance at a bending angle of 15° degrees.

10.2 Five different paper grades were used. The following estimates of repeatability and reproducibility are based on data from these selected samples.

10.3 Participants were asked to follow the SCAN-P 29:95 method, which this method is based on.

10.4 Testing is based on 10 determinations per test result and 1 test result per lab, per material:

Repeatability = 4.7%

Reproducibility = 6.4%

The chart below shows representative data on which the figures above are based.

Table 1. Precision data T 556 (bending angle = 15°; test span length = 50 mm).

Basis weight g/m²	*Mean value (mN)*	*Repeatability (%)*	*Reproducibility (%)*
80MD	136	7	11
CD	56	12	10
180MD	69	4	5
CD	36	5	8
200MD	140	3	5
CD	74	3	6
260MD	374	3	4
CD	126	6	5
380MD	721	2	5
CD	376	2	5

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

10.7 The user of this data is advised that it is based on actual mill and laboratory testing. There is no knowledge of the exact degree to which the referenced test method was employed. The precision quoted provides an estimate of typical variation in test results which may be encountered when t his method is routinely used.

NOTE 4: The source of the data shown in Table 1 is the precision statement of the SCAN-P 29:95 method. SCAN-P 29:95 may be withdrawn and replaced by ISO 2493. The precision data has been restated to conform with TAPPI T 1200.

11. Keywords

Bend strength, Stiffness, Paper, Paperboard

12. Additional information

12.1 Effective date of issue: To be assigned.

12.2 SCAN-P 29:69 Scandinavian Pulp, Paper and Board Testing Committee, accepted May 1969, contains correlation information with a variety of stiffness and bending test methods.

12.3 Related Methods: ISO 2493 “Determination of Resistance to Bending”; TAPPI T 489 “Stiffness of Paper and Paperboard (Taber Type Stiffness Tester)”; TAPPI T 543 “Bending Resistance of Paper (Gurley Type Tester).”

12.4 Handsheets from some pulps showed that a study might need to be done due to higher than expected variability of the results from an independent study.

12.5 The only revision in the 2011 edition was to change the title to reflect a generic instrument reference.

Reference

Bulling, O., and Gavelin, G., *Svensk Papperstidning* **62** (8): 284 (1959).

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