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T _____ 577 _____

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WORKING GROUP
CHAIRMAN _____ Dave Carlson _____

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.

Score bend test
(Five-year review of Official Method T 577 om-13)
(Editorial changes from Draft 2 incorporated)

1. Introduction

When folding cartons fail to perform properly in a production operation it is difficult to understand the source of the problem. This procedure provides useful information to the carton manufacturer, converter, printer or product filling operation to evaluate the performance of a paper carton on a package filling and sealing line.

2. Scope

This procedure is used to determine the score bend resistance of a scored and unscored sample of a paperboard carton. Score bend resistance of a score on a paper carton is an important parameter to determine the force required to close a carton flap during a product filling operation on a packaging machine.

3. Significance

3.1 Score quality of paperboard cartons affects product performance in end use applications, such as a die-cutting or filling operation on a packaging line.

3.2 Score bend resistance can be used to determine the effects of carton aging and moisture when a finished carton product is used on a packaging line.

3.3 The determination of score bend resistance is not only important for quality control of the manufactured product, but also for configuring machinery that controls cartons on form, fill and seal lines.

4. Definitions

4.1 *Score* is defined as an impression or partial cut in a flat material for the purpose of facilitating bending, creasing, or folding.

4.2 *Score ratio* is defined as the ratio of two score bend measurements expressed as a percentage. The calculation is based on the force required to bend a scored paperboard carton to the force required to bend an unscored paperboard sample.

4.3 *Score bend resistance* is defined as the peak force required to bend a scored or unscored sample to 90°.

5. Apparatus¹

5.1 A bending fixture capable of applying bending force at a constant speed of $12.0^\circ/\text{s} \pm 0.5^\circ/\text{s}$ and allowing sufficient travel to ensure a maximum of 90° bend of the sample (see Figure 1).

5.2 Bending fixture designed to bend the sample 90.0°. The bending fixture must be balanced so that during a test cycle with no sample in place, the fixture produces a reading less than 20.0 g.

5.2.1 Moveable bending plate to bend the sample at the score line.

5.2.2 Angle gage to accurately record and indicate sample angle to a maximum of 90° to within 0.5° or better.

¹ Names of suppliers of testing equipment and materials for this method may be found on the Test Equipment Suppliers list, available as part of the CD or printed set of Standards, or on the TAPPI website general Standards page.

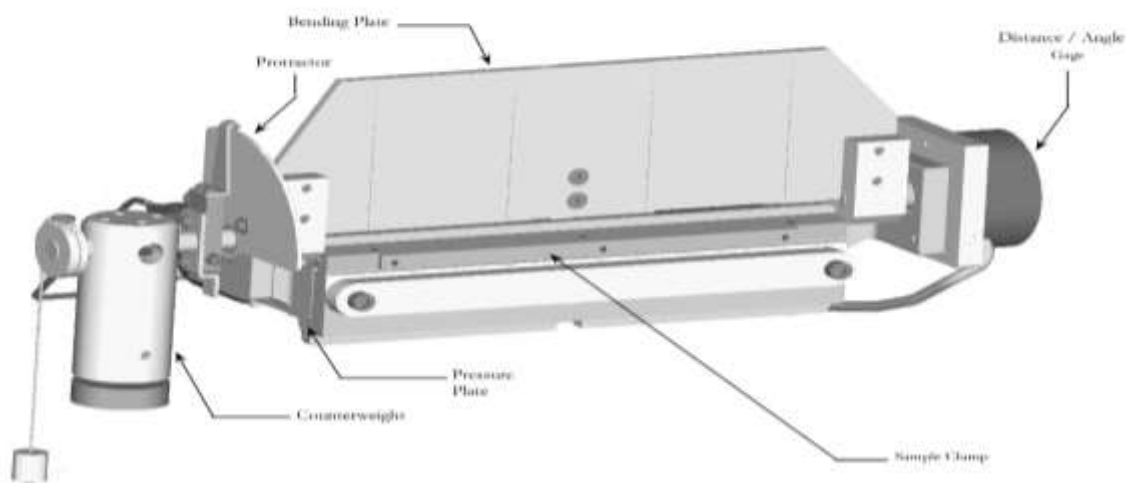


Fig. 1. Bending fixture

5.2.3 Sample clamp to firmly affix sample in place. The sample must be clamped along the entire width of the sample. An air-operated clamp is recommended.

5.3 A force indicator capable of measuring and recording the applied force to within 1.0% of the full-scale range of the load indicator. Instruments equipped with a 20 N (4.4 lbf) load cell are usually sufficient for paperboard material. It may be necessary to use a 50 N (11lbf) or 100 N (22 lbf) load cell for materials which exhibit a higher score bend resistance.

6. Test specimens

6.1 From each test unit of a sample obtained in accordance with TAPPI T 400 “Sampling and Accepting a Single Lot of Paper, Paperboard, Containerboard, or Related Products,” test specimens should be flat with no bends at the scored or unscored area and free of defects or delaminations. Test specimens can be from the roll stock or a converted or finished product sample which will be used during a product filling operation on a packaging machine.

6.2 Prepare a scored and unscored test sample with dimensions of at least 25.4 mm (1.0 inch) and of sufficient length to allow a measurement of a scored and unscored section on the same sample (Figure 2). The length of unscored board above the score line must be between 50.8 mm (2.0 inches) and 152.4 mm (6.0 inches). If there is insufficient sample length to test scored and unscored area on the same specimen, cut an unscored sample to the same dimensions as the scored sample from an unused section of the same board as the scored sample.

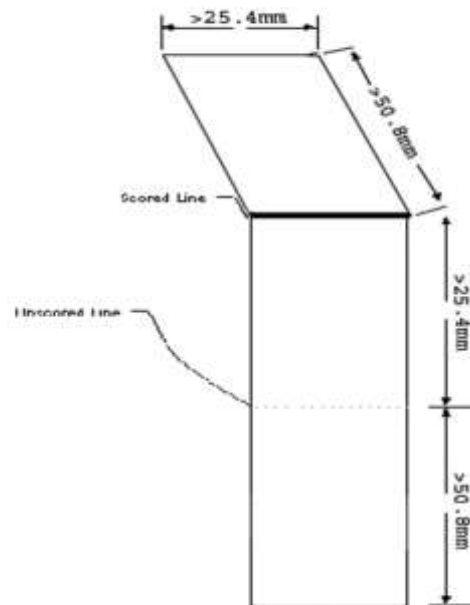


Fig. 2. Test sample, indicating minimum dimensions for each part of the specimen.

7. Conditioning

7.1 Precondition, condition, and test samples in accordance with TAPPI T402 “Standard Conditioning and Testing Atmospheres for Paper, Board, Pulp Handsheets and Related Products.”

7.2 If TAPPI conditions cannot be achieved, report temperature, humidity and sample moisture content in accordance with TAPPI T412 “Moisture in Pulp, Paper, and Paperboard.”

8. Test procedure

- 8.1 Verify accuracy of the tester and bending fixture before testing.
 - 8.1.1 Level the tester according to manufacturer’s instructions (see Appendix A.1.1).
 - 8.1.2 Verify the load cell according to manufacturer’s instructions (see Appendix A.2.1).
 - 8.1.3 Check the balance of the bending plate according to manufacturer’s instructions (see Appendix A.4.1).
 - 8.1.4 Check the air pressure of the air operated bending plate, 2.60 bar (30 psi) is recommended.
- 8.2 Set the test to measure maximum force between 0.0° and 90.0°.
- 8.3 Open sample clamp
- 8.4 Sample Placement

8.4.1. Scored Sample: Place scored sample in the sample clamp, being sure to center the sample horizontally in the sample clamp. The scored line on the sample must be located centrally between the slot on the bending plate and the sample clamp bar (see Figure 3).



Fig. 3. Slot on the bending plate and the sample clamp bar

8.4.2. Unscored Sample: Per Fig 2, the unscored portion of the test piece shall be placed a minimum of 25.4 mm (1.0 in.) from the scored section of the test piece, and the location of the test piece shall be as close to parallel to the scored test line as possible. To facilitate the location, a light ink mark may be placed on the edges of the specimen equidistant from the edges of the scored sample. Place the marked unscored sample in the sample clamp, being sure to center the sample horizontally in the sample clamp. The location of the line on the unscored sample must be located centrally between the slot on the bending plate and the sample clamp bar (see Figure 3).

8.5. Zero the force indicating device if needed.

8.6. Record maximum force obtained in bending the sample during the test from zero (the starting point) to 90° (the end point).

8.7. Test 10 scored/unscored pairs from each sample selected.

8.8. Repeat 8.3-8.7, until both scored and unscored sample/samples have been tested. (See paragraph 6.2 to see when a second sample is needed.)

8.9. Calculate the average of the test results for the scored and unscored test results separately.

9. Interpretation of observations

The score ratio is determined as follows:

$$\text{Score ratio in \%} = \frac{\text{Average peak force of unscored sample}}{\text{Average peak force of the scored sample}} \times 100$$

10. Report

- 10.1 The bending force in grams-force (gf) for each test replicate.
- 10.2 The average and standard deviation bending force in gf for all replicates of a sample.
- 10.3 The average score ratio calculated as in section 9.
- 10.4 Any deviations from the procedures described in this method, Sections 5 through 8.

11. Precision

On the basis of studies made in accordance with TAPPI T 1200 “Interlaboratory Evaluation of Test Methods Used with Paper and Board Products,” the precision of test results representing the average of five (5) score bend readings are expected to agree within the amounts shown in Table 1. The interlaboratory study included four (4) laboratories and four (4) samples of printed paperboard measured at the score line.

Table 1. Score bend resistance of paperboard*

<i>Sample score length</i>	<i>Repeatability ratio, %r</i>	<i>Reproducibility ratio, %R</i>
A – 68 mm (2.68 in.) score	12.4%	31.1%
B – 122 mm (4.80 in.) score	6.3%	16.2%
C – 66 mm (2.80 in.) score	10.5%	22.9%
D – 150 mm (5.90 in.) score	5.5%	11.6%

*Note: The WGC for the initial development of T 577 in 2008 advised that the data to develop the Repeatability and Reproducibility table in this Precision Statement came from the Force measurement data, not the Score Ratio data.

12. Keywords

Scores, Score bend efficiency, Paperboard, Bend strength

13. Additional information

13.1 Effective date of issue: To be assigned.

13.2 TAPPI T 829 “Score quality test.” Score bend test using a u-channel and a straight blade corrugated sample.

13.3 Changes in the September 24, 2020 edition include extensive revisions and additions to Sections 8.4 through 8.9 to: (a) how to place the sample for the unscored sample; (b) clarify the beginning and end point of the test; and (c) add a sentence specifying that the averages of the scored and unscored test results be calculated. In addition, the calculation in Section 9 is revised to clearly show that the ratio is calculated using the two average figures. The WGC from the initial development of T 577 in 2008 confirmed that the Precision Statement results were developed from the Force Measurement data not the Score Ratio data.

Appendix

A.1 *Adjustment and maintenance of testing instrument.*

A.1.1 Before testing or verifying operation, the operator should ensure that the tester is level in both the side to side direction and the front to back direction.

A.1.2 Determine the proper clamping pressure of the sample clamp (if equipped with air clamps).

A.2 *Verification of testing instrument*

A.2.1 *Verification of force measuring system.* After leveling the instrument, verify the force measuring mechanism with standard weights by the dead weight method; for example, obtain readings at about (10) points evenly spaced throughout the force measuring scale, by applying known weights with increasing than decreasing increments. If readings differ by more than 1.0 %, construct a correction curve or calibrate according to the manufacturer’s instructions.

A.3 *Verification of the bending fixture*

A.3.1 Verify the bending fixture using spring steel plates with a thickness of $100 \mu \pm 2 \mu$ (0.004 ± 0.00008 in.) and a hardness of 48-52 Rockwell C.

A.3.2 A set of 3 plates of varying widths between $22 \text{ mm} \pm 2 \text{ mm}$ ($0.875 \text{ inch} \pm 0.00008 \text{ in.}$) and $100 \text{ mm} \pm 2 \text{ mm}$ ($3.93 \text{ in.} \pm 0.0008$) are suggested.

A.3.3 Obtain bending force readings at three intervals between 0° and 90° at increasing intervals. Spring steel plates have target values $\pm 10 \text{ g}$.

A.3.4 Air pressure setting for verification of spring steel plates is $5 \text{ bar} \pm 0.17 \text{ bar}$ ($500 \pm 17 \text{ kPa}$)

A.4 *Verification of the 90° bending angle*

A.4.1 During a test cycle, the protractor pointer will travel $90.0^\circ \pm 0.5^\circ$. To check this operation, first adjust the position of the upper bracket and load cell assembly to allow the protractor pointer to rest slightly below the 0.0° position. Cycle the testing instrument and verify the protractor pointer travels $90.0^\circ \pm 0.5^\circ$ and returns to the starting position.

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