WI 200308.01

T 803

DRAFT NO. 01

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WORKING GROUP CHAIRMAN N/A

SUBJECT CATEGORY Fiberboard Shipping Container Testing

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.

Puncture test of container board
(Ten-year review of Classical Method T 803 cm-10)
(no changes from Draft 1; editorial corrections incorporated)

1. Scope

This tester (Fig. 1) measures the energy required to puncture container board or corrugated board with a pyramidal point affixed to a pendulum arm. Results are reported in "puncture units," comprised of two major components: the energy to tear the material and the energy to bend it out of the way of the point.

2. Significance

2.1 Damage in use, similar to that occurring in this test, may result from contact with solid objects, such as the end of a piece of lumber or the corner of a wooden box.

2.2 The test evaluates, in a composite fashion, some fabrication factors and properties of the materials.

NOTE 1: In single and double wall corrugated board this method measures the energy to puncture the board and the energy to bend the

board back to allow penetration of the point and arm through the test specimen. It is widely used as well on triple wall board. Here the clearance between the puncture point and the aperture in the loose plate 13.2 mm (0.5 in.) can be less than the thickness of the board. As a result, for some triple wall board, the total energy measured combines the energy for puncture and bending with that necessary to crush the board.

3. Apparatus

3.1 *Puncture test apparatus*[1] (see Fig. 1), consisting of the following:

3.1.1 *Pendulum*, incorporating an arm in the form of an arc of 90°.

3.1.2 *Puncture point*, affixed to the end of the arm and having the shape of a right angle triangular pyramid 25 ± 0.7 mm (1 ± 0.03 in.) high, with leading edges rounded, base edges left sharp, and the point honed to 1.57 ± 0.05 mm (0.062 ± 0.002 in.) radius. The total tearing length of the head is 107.7 mm (4.24 in.).

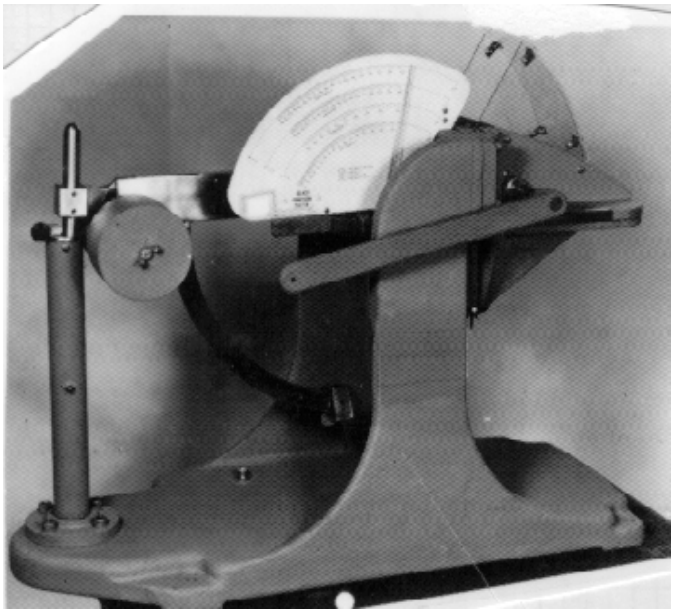

Fig. 1. Puncture tester.

3.1.3 *Puncture point collar*, loose fitting around the base of the puncture point to avoid friction that would result if the punctured material rubbed against the puncture arm.

3.1.4 *Trigger*, or latch, to hold the pendulum in a horizontal position.

3.1.5 *Clamping jaws*, spring actuated, for rigidly holding the specimen to be tested in a horizontal plane.

3.1.6 *Pointer and scale*, to indicate the arc through which the pendulum travels after passing through the specimen. Scale graduations correspond to the weights used.

3.1.7 *Augmenting weights*, which when attached result in scale values up to least 38.87 J (1300 units of energy)

[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.

when the pendulum starts in the horizontal position. Addition of weights to the pendulum arm changes the scale on which the reading is taken.

3.1.8 *Loose plate*, inserted between the clamping jaws when testing material to define the test area (means should be provided for securing the plate once it has been properly positioned). The loose plate is removed before checking the zero reading of the apparatus.

3.1.9 *Adjustable screw*, bearing against the pointer assembly during the measuring of half the pendulum swing, permitting adjustment of the full-scale position of the pointer.

NOTE 2: For testing lighter materials, the apparatus can be supplied with an attachment that allows the release of the pendulum at a 45° angle. An auxiliary low scale is also supplied which when attached to the standard scale plate provides additional calibration from 0-0.90 J (0-30 units) and allows reading of half a unit. Modified machines for heavier material are also available.

4. Adjustment and calibration

4.1 Place the apparatus on a rigid, heavy foundation of convenient height, and bolt it down so that it is level in both horizontal directions. The preferred mount is a separate concrete base. Adjust the apparatus with the entire clamping assembly unbolted and, with the newer instruments, swing the hinged assembly away from the path of the pendulum. With older instruments, completely remove the assembly from the machine.

4.2 *Pendulum friction*. Remove the weights and weight-support stud, put the puncture-point collar in place on the puncture head, rotate the pointer to a position below the zero mark, and then latch and release the pendulum. The pendulum should swing for a minimum of 8 minutes before coming to rest. If it does not, clean and lubricate the bearing.

4.3 *Zero reading*. Remove the weights and stud; remove the loose plate and fix the puncture-point collar on the puncture head. Allow the pendulum to hang vertically on its pivot shaft. Then with adjusting screw, align the pointer exactly on full scale. With the pointer set to about 25 mm (1 in.) above zero on the scale, raise the pendulum until the latch engages. Release the pendulum. If the scale reading is not zero, loosen the four set screws that position the latch tongue as required. Repeat this procedure until the scale reading is zero.

4.4 *Pointer friction*. Latch the bare pendulum, without the weights or weight stud and with the collar attached to the puncture head. Remove the clamping plate, rotate the pointer to the full-scale reading, release the pendulum, and note the position of the pointer at maximum travel. Then without moving the pointer, re-latch the pendulum and release it thus allowing it to swing and push the pointer further. Adjust the pointer friction by means of the screw in the stud projecting from the pointer hub, so that the additional movement is not more than two units. Recheck the friction with the pointer at mid-scale to guard against reducing the friction too much. If too much friction has been removed, the pointer will move or “bounce” below the position indicated in the second step.

4.5 *Puncture point collar adjustments*. Place the collar in the same position each time on the end of the puncture point head. A dot of paint on one side of the collar to match a dot on the point base is an easy way to fix this position. An adjustable pin determines the force needed to dislodge the collar. This force is 1.0 ± 0.15 *N* (3.6 ± 0.5 oz.) pull when the collar is in a horizontal position. The puncture head extends at least 0.38 mm (0.015 in.) beyond the outer edge of the collar when the collar is attached to the puncture point. Keep the flange angle at approximately 135°.

4.6 *Clamp load*. A force of 245 ± 22 *N* (55 ± 5 lb.) applied downward from the middle of the lower plate should open the clamp 6 mm (1/4 in.). Tighten or loosen the wing nuts at the bottom of the spring tube to adjust this pressure if necessary. To check that the clamping is uniform over the test specimen, place a number of strips of the thinnest specimen to be tested between the jaws at various points. If any can be removed easily, change the jaw alignment until the load is uniform.

4.7 *Center of gravity*. If the center of gravity of the pendulum does not lie in the proper plane, addition of auxiliary weights will shift the pointer zero and necessitate the changing of both the pointer and the latch adjustments when changing scales. The alignment of the center of gravity may be most conveniently checked by removing the weights and stud from the pendulum, allowing the pendulum to come to its rest position (with collar attached at the puncture point) and gently rotating the pointer clockwise until it just touches its adjusting screw. If the center of gravity lies in the proper plane, no shift of the pointer will occur. If the pointer shifts, the center of gravity is incorrect. Correct it by shifting the balancing weight in or out on its screw. The weight is adjusted at the factory and then staked in place. It should never be moved unless it is certain that the center of gravity is incorrect. If adjustment appears to be required, it is good to first check the pendulum with all combinations of weights and by rotating the weights to make sure that they are concentric before returning the pendulum to the factory for adjustment.

4.8 *Loose plate*. Secure the loose plate beneath the upper clamping jaw in such a manner that the vertical projection of the lower edges of the puncture point are equidistant from the triangular edges of the loose plate opening when the base of the puncture head is 31.8 mm (1 1/4 in.) below the upper clamping jaw.

4.9 *Puncture point*. Be sure that the three corners at the base of the puncture point are equidistant [within 1.5 mm (1/16 in.)] when the base of the puncture point is 31.8 mm (1 1/4 in.) below the upper clamping jaw; that its apex does not deviate from the plane equidistant from the pendulum bearing by more than 1.5 mm (1/16 in.); and that its apex does not deviate from a plane equidistant from the pendulum bearing by more than 1.5 mm (1/16 in.); and that its edge farthest from the axis of rotation is parallel to that axis. The condition of the puncture point is important.

5. Sampling and test specimens

5.1 Sample the board in accordance with TAPPI T 400 “Sampling and Accepting a Single Lot of Paper, Paperboard, Containerboard, or Related Product.” From each test unit of the sample, select representative specimens at least 300 × 300 mm (12 × 12 in.); see Procedure for number of specimens depending on nature of material to be tested. Make all tests at least 95 mm (3 3/4 in.) from an edge, score line, or imperfection.

6. Conditioning

6.1 Precondition and condition the specimens and test in the atmosphere specified in TAPPI T 402 “Standard Conditioning and Testing Atmospheres for Paper, Board, Pulp Handsheets, and Related Products.”

7. Procedure

7.1 Before making each test, place the puncture point collar on the base of the point and set the pointer about 25 mm (1 in.) above the expected reading. Raise the pendulum to the horizontal position and latch it.

7.2 One test result is comprised of one set of individual punctures.

7.2.1 On single wall, double wall, and triple wall corrugated and solid fiberboard, four punctures comprise a set. The plane of the curved pendulum arm is used as the reference in relating the position of the specimens to the testing machine. Directions refer to the direction of the corrugations of corrugated board or grain direction of uncombined sheets or solid fiber. The orientation of the specimens for a set follows; (a) parallel, with one surface down; (b) parallel, with the other surface down; (c) perpendicular, with one surface down; and (d) perpendicular, with the other surface down.

7.2.2 On uncombined sheets or single-faced corrugated boards, make a set of two punctures per test with specimens oriented as follows: (a) parallel, with smooth surface down (so that the smooth facing is impacted by the puncture point); and (b) perpendicular, with smooth surface down.

7.3 Clamp each specimen, then release the pendulum. After the pendulum has completed its swing, note the reading to the nearest one-half division on the proper scale. It is not advisable to perform a test giving a reading within the upper or lower quarter of the scale. In such a case, add or remove weights to use another scale. The weights to be used for each scale are indicated on the scale plate of the apparatus. Follow the same procedure for testing lightweight material, but use the bare pendulum without additional weight or stud, release the pendulum from the 45° position, and use the auxiliary low scale.

NOTE 3: The condition of the puncture point is important. It should be protected from abuse and damage, so that its surfaces remain smooth and free of nicks and scratches. Clean the surface of the point with a degreasing agent, such as heptane, after each puncture is made on a wax-coated, asphalt laminated, or other specially treated board which may transfer material to the point.

8. Report

Report the average of at least two test sets in scale units of three significant figures. (Each unit is equal to 0.0299 joules.) Also report the weights applied and the angle of release.

9. Precision

9.1 The value of repeatability and reproducibility have been calculated for test results each of which is the average of the set as defined in 7.2 (four individual tests). These values were based on work performed in 2006 by 12 packaging labs in conjunction with the Collaborative Testing Services Inc. Each lab received six sample sets of converted board, representing both heavy and light weight single wall, double wall, and triple wall. Because four individual punctures are combined to produce a single test result, the values reported below are significantly smaller than the variation expected for individual punctures.

9.2 The repeatability as defined in TAPPI T 1200 "Interlaboratory Evaluation of Test Methods to Determine TAPPI Repeatability and Reproducibility" is 10.0 %.

9.3 The reproducibility as defined in TAPPI T 1200 "Interlaboratory Evaluation of Test Methods to Determine TAPPI Repeatability and Reproducibility" is 17 % of puncture units for all single wall, double wall, and triple wall less then 1300 puncture units, and 29 % of puncture units for triple wall of 1300 puncture units or greater.

10. Keywords

Container boards, Corrugated boards, Puncture tests, Bending, Puncture resistance

11. Additional information

11.1 Effective date of issue: To be assigned.

11.2 Related methods: ISO 3036-1975.

11.3 *Revisions*.

11.3.1 Changes in the 2006 revision include elimination of the procedure for measuring stiffness (this was rarely used), addition of information regarding crushing of triple wall board and of how to treat pendulum friction, clarification of the description of the apparatus, changes in the precision statement, and addition of the reference to the ISO method.

11.3.2 Changes in the 2010 revision include minor reorganization of the text and edits for language, as well as a shift of the method from an "Official Method" to a "Classical Method," reflecting the relatively infrequent use of this testing method and its continuing historical importance.

References

1. Beach, R. L., "Puncture Testing of Box Board," *Paper Trade* J. **108** (5):30 (1939).
2. Wells, S. D. Kaplan, A. B. and Ayers, L. R., "Tests on Fiber Containers - The Beach Puncture Tester," *Paper*

Trade J. **116** (13):29 (1943).

3. Van Den Akker, J. A. and Wink, W. A., "Instrumentation Studies: LX. The Beach Puncture Tester," *TAPPI* **33** (12):114A (1950).

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