WI 210308.05

T 811

BALLOT NO. 02 SARG

DRAFT NO. 02

DATE October 26, 2023

WORKING GROUP
CHAIR David Crouch

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.

Edgewise compressive strength of corrugated fiberboard (short column test)

(Five-year review of Official Method T 811 om-17)

(Underscores, notes, and strikethroughs show changes from Draft 1)

1. Scope

1.1 This method describes procedures for determining the edgewise compressive strength (ECT), perpendicular to the axis of the flutes, of a short column of single-, double-, or triple-wall corrugated fiberboard (*1*).

2. Significance

2.1 Research has shown that the edgewise compressive strength of specimens with flutes vertical, in combination with the flexural stiffness of the combined board and box dimensions, relates to the top-to-bottom compressive strength of vertically fluted corrugated fiberboard shipping containers (*2, 3*).

2.2 This method may also be used for comparing the edgewise compressive strength of different lots of similar combined boards or for comparing different material combinations (*4, 5*).

2.3 This method is referenced in the alternate requirements of National Railroad Freight Committee, Uniform Freight Classification, and the National Motor Freight Traffic Association Inc./American Trucking Association, National Motor Freight Classification. The carrier classification rules (Alternate Rule 41, Item 222) define the minimum ECT requirements for corrugated boxes used in the common carrier surface transportation system.

Moved (insertion) [1]

3. Apparatus

3.1 *Rigid Support Compression Tester.* Two platens, one rigidly supported and the other driven. Each platen shall have a working area of approximately 100 cm^2 (16 $in.^2$). The platens must not have more than 0.050 mm (0.002 in.) lateral relative movement, and the rigidly supported platen not more than 0.150 mm (0.006 in.) movement, perpendicular to the surface, within a load range of 0 to 2224 *N* (0-500 lbf). Within the specimen contact area, each platen shall be flat within 0.0025 mm (0.0001 in.) of the mean platen surface, and the platens shall remain parallel to each other within 1 part in 2000 throughout the test (*6*).

3.1.1 Within a range of platen separations necessary to cause compressive failure of the test specimen, and within a load range of 0 to 2224 *N* (0-500 lbf), the speed of the driven platen shall be controllable at 12.5 ± 0.25 mm (0.5 ± 0.01 in.) per minute. (For convenience, the test machine should be capable of rapid return and automatic, settable positioning).

3.1.2 The driven platen shall be moveable to achieve an initial platen separation of at least 60 mm (2.36 in.).

3.1.3 The tester shall have a means for measuring and indicating the maximum load sustained by the test specimen with an accuracy of 0.5% of reading or better between a measured load of 440 N (100 lb.) and the equipment's maximum load. Below this measured load, the accuracy shall be 2.2 N (0.5 lbf), or better. The optimum range for the tester should have a suitable capacity such that a majority of the expected results fall near the 50% capacity mark or all should fall within the 10-90 % of the designed capacity of the machine

3.2 A means for cutting specimens having clean, parallel and perpendicular edges, within the tolerances specified in 6.2 and 6.3. Opposite edges shall be parallel to each other and perpendicular to adjacent edges (*7, 8*).

3.2.1 *Knife cutter,* single knife device with guides or, preferably, a twin-knife device to cut the test specimens according to the specifications in Section 6. The knives must be sharp and of the single-bevel type and arranged in the device so that the unbevelled side is toward the test piece and at 90° to the specimen's surface.

3.3 A means for supporting the specimen at the initiation of the test so that the applied force is parallel to the flutes.

3.3.1 *Metal guide blocks* (Fig. 1) to be used with the waxed edge specimens (7.5). Two are required to align the specimen vertically in the testing machine the dimensions given on Figure 1 are suggested dimensions. The actual size of the block is not crucial as long as it provides support for the sample until the platens close enough to support the sample.

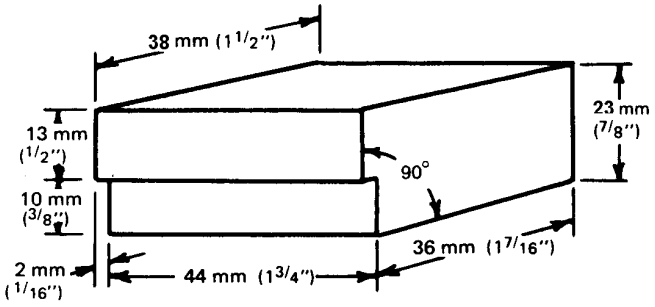

Fig. 1. Metal guide block.

4. Sampling

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

5. Conditioning

Precondition and condition the sample in accordance with TAPPI T 402 "Standard Conditioning and Testing Atmospheres for Paper, Board, Pulp Handsheets, and Related Products." Condition waxed-edge specimens an additional minimum of 2 hours after waxing and before testing (*9*)

6. Test specimens

6.1 From each test unit accurately cut at least 10 specimens with the knife device described in 3.2.1 that will cut clean, parallel, and perpendicular edges.

6.1.1 Sample away from scorelines, joints, and closures. Specimens should be representative of the materials being tested. For example, if roughly 25% of a box is printed, roughly 25% of the samples should be collected from the printed areas. Specimens should not be taken from obviously damaged areas and/or areas not representative of the container as a whole.

6.2 Cut the specimens to a width of 50.8 ± 0.8 mm (2.00 ± 0.03 in.) so that the loading (width) edges are parallel to each other (within the ability of the cutting and measuring tools) and perpendicular to the axis of the flutes (Fig. 2).

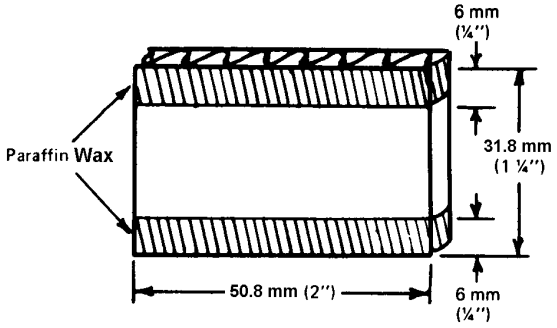

Fig. 2. Edgewise test specimen for B-flute.

6.3 Cut the specimens to a height of 31.8 ± 1.6 mm (1.25 ± 0.06 in.) for B-flute, 38.1 ± 1.6 mm (1.50 ± 0.06 in.) for C-flute, and 50.8 ± 1.6mm (2.00 ± 0.06 in.) for A-flute and typical-double- and triple-wall board (*1,6*). These heights meet the Euler criteria for pure compression failure in a short column for their respective structures (*8*). For some thin double-wall board (e.g., EB double-wall), and for other flute structures (e.g., E flute), different heights may be required to achieve a pure compression failure in the test specimens.

NOTE 1: In some U.S. Federal and Military Specifications and Standards for corrugated board, the short column crush test is required. The procedure is technically identical and references T811 for sample size and preparation.

NOTE 2: In some testing protocols (e.g., compliance with National Motor Freight Classification item 222), alternate numbers of specimens may be required for testing. The test procedure is technically identical to that described here in Sections 4-7.

NOTE 3: Specimen parallelism, height, and edge quality can all have significant impact on the test results, and care should be taken to produce specimens as square and precise as possible. Different cutting tools produce specimens with varying levels of parallelism. (15)

Deleted: ISO 13821 is the ISO test method that is identical to T811 (except ISO 13821 allows cutting of specimens with various devices such as band or table saw). However other procedures are sometimes used which require different specimen dimensions, specimen geometry (*10*), or specimen support techniques. These may include, but are not limited to: TAPPI T 839 "Edgewise Compressive Strength of Corrugated Fiberboard using the Clamp Method (Short Column Test)" (*11*), TAPPI T 838-cm "Edge Crush Test Using Neckdown" (*12*), and FEFCO test Method No. 8 (ISO 3037) "Edgewise Crush Resistance of Corrugated Fiberboard." Each of these methods yields slightly different numerical values, either higher or lower, on the same samples, because the mode of failure is different for each test method. While there is a global correlation across grades for each of the methods, the correlation within grades is much poorer, masked by the combined variability of the methods being compared. These facts should be considered when attempting to match the results of one test with results of another.

Deleted: The procedures described in Notes 1, 2, and 3 will not necessarily yield the same results as this test method. (*13, 14*)

6.4 Prepare test specimens with waxed edge reinforcement as follows: Dip each loading edge in molten paraffin at 69-74°C (156-165°F) approximate melting point, 52°C (125°F), to a depth of 6 mm (1/4 in.) and hold there until the absorbed paraffin, as determined visually, begins to migrate above the 6 mm (1/4 in.) dipped zone. Normally, a 3 second dip in molten paraffin is satisfactory. If excessively rapid migration is encountered, reduce the temperature of the molten paraffin. Immediately after dipping, momentarily blot the loading edges of the specimen on paper toweling preheated on a hot plate maintained at 77-82°C (171°-180°F).

NOTE 4: The following alternative procedure for impregnating the loading edges of specimens with paraffin wax is permissible. Place the edge on a paraffin wax saturated pad, such as paper toweling, heated on a hot plate maintained at 77-82°C (171-180°F) until the paraffin wax impregnates the specimen to the desired 6 mm (1/4 in.) depth. Generally, this method is slower than the dipping method and therefore permits better control of the depth of paraffin wax penetration for specimens in which paraffin wax migration is rapid.

NOTE 5: When reinforcing the loading edges of waxed or curtain coated boards, take care that the heat of the reinforcing paraffin wax does not adversely affect the integrity of the board's structure in the area of the edge wax impregnation. Evidence of proper treatment will be that in performing the test, failure occurs away from the reinforced area.

7. Procedure

7.1 Perform all tests in the conditioning atmosphere.

7. 2 Set the rate of platen movement for each rigid support compression machine to 12.5 ± 0.25 mm (0.5 ± 0.01 in.) per minute.

7. 3 Measure the width (nominally 50.8-mm (2-in.)) dimension of each specimen to the nearest 1 mm (1/32 in.).

7. 4 Center the specimen on the platen. Place a guide block on each side of the specimen centrally located relative to it so that the flutes are held perpendicular to the platen. Place the blocks' largest faces ~~face~~ up, with the offset ends adjacent and in contact with the specimen above the paraffin areas.

7. 4.1 Apply a compressive force to the specimen. Verify the platen movement rate described in 7.2 or 7.3. When the force on the specimen is between 22 and 67 *N* (5 and 15 lbf), remove both guide blocks and, without altering the platen movement rate, continue to apply force until the specimen fails. A valid test is when one or both liners have buckled in the unwaxed center portion of the specimen. If neither liner shows a buckling failure in the unwaxed area of the specimen, or if failure occurs in the waxed portion of the sample, declare the test invalid.

7.5 Record the maximum load in newtons (pounds-force), the specimen width, and whether or not the specimen exhibited a valid failure.

8. Report

8.1 For each test unit, report:

8.1.1 Average maximum load per unit width for valid tests calculated from average maximum load and specimen width in kilonewtons per meter (pounds-force per in.).

8.1.2 Standard deviation among valid determinations in kilonewtons per meter (pounds-force per in.).

8.1.3 Number of valid test determinations.

8.1.4 A description of material tested.

8.1.5 A statement that the test was conducted in compliance with this test method and a description of any deviations.

9. Precision

9.1 Repeatability (within a laboratory) = 4%.

9.2 Reproducibility (between laboratories) = 19%.

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.

9.3 The estimates of repeatability and reproducibility listed above are based on data from the CTS Containerboard Interlaboratory Program using testing conducted in 2005 and 2006. The data included 17 rounds of testing on 5 different samples of "C" flute corrugated board in either 42-26-42 or 35-26-35 board combinations. The precision estimates are based on 10 determinations per test result and 1 test result per lab for each of the 17 rounds of testing. Only laboratories that reported using rigid-platen type instruments and TAPPI standard conditioning atmospheres are included in the calculations.

9.4 *Additional Information.* The precision statement above (9.1 through 9.3) replaced information derived from a study conducted in October 1966 in cooperation with the ASTM Committee D-6, Sub IV, October 1966, among nine laboratories on five different corrugated combinations. The estimates of repeatability (6%) and reproducibility (23%) are not significantly changed in this revision. However it should be noted that the 1966 results would have been derived from analog, deflecting-beam type instruments.

10. Keywords

Corrugated boards, Edge crush tests, Compression strength.

11. Additional information

11.1 Effective date of issue: To be assigned.

11.2

Moved up [1]: This method is referenced in the alternate requirements of National Railroad Freight Committee, Uniform Freight Classification, and the National Motor Freight Traffic Association Inc./American Trucking Association, National Motor Freight Classification. The carrier classification rules (Alternate Rule 41, Item 222) define the minimum ECT requirements for corrugated boxes used in the common carrier surface transportation system.¶

11.2 Related methods: ISO 13821 "Corrugated Fiberboard – Determination of Edgewise Crush Resistance – Waxed Edge Method." ISO 13821 is the ISO test method that is identical to T811 (except ISO 13821 allows cutting of specimens with various devices such as band or table saw). However other procedures are sometimes used which require different specimen dimensions, specimen geometry (10), or specimen support techniques. These may include, but are not limited to: TAPPI T 839 "Edgewise Compressive Strength of Corrugated Fiberboard using the Clamp Method (Short Column Test)" (11), TAPPI T 838-cm "Edge Crush Test Using Neckdown" (12), and FEFCO test Method No. 8 (ISO 3037) "Edgewise Crush Resistance of Corrugated Fiberboard." Each of these methods yields slightly different numerical values, either higher or lower, on the same samples, because the mode of failure is different for each test method. While there is a global correlation across grades for each of the methods, the correlation within grades is much poorer, masked by the combined variability of the methods being compared. These facts should be considered when attempting to match the results of one test with results of another.

11.3 The 2011 revision made minor corrections to the language usage throughout the document.

11.4 Earlier versions of this test method included the *Flexible Beam Compression Tester* as approved test equipment. While this test can be performed on a flexible bean tester the results from the test will be less accurate and will not meet the precision statement included with this procedure.

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Deleted: See also Note 3.

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12. Literature cited

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