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T 839

BALLOT NO. 03-SARG

DRAFT NO. 03

DATE May 16, 2024

WORKING GROUP
CHAIR Dave Carlson

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 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 Using the Clamp Method (Short Column Test)

(Five-year review of Official Method T 839 om-18)

(Underscores, notes, and strikethroughs show changes from Draft 2)

1. Scope

1.1 This method describes procedures for determining the edgewise compressive strength, with flutes vertical, loading perpendicular to the axis of the flutes, of a short column of single-, double-, or triple-wall corrugated fiberboard.

1.2 The method includes procedures for cutting the test specimen (saw cutting and knife cutting), one procedure for specimen support (spring support clamp fixture), and two procedures for applying the compressive force (constant strain rate, or constant load rate). Studies have shown that any combination of these procedures will yield similar test results with the stated precision (Section 9).

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 (*1*,*2*).

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 (*3*,*4*).

3. Safety precautions

3.1 Use care when cutting test specimens from sample sheets. Keep fingers and hands away from the knife blades. Handle knife blades with care when replacing them.

3.2 Use care when inserting the loaded test fixture into the compression tester.

4. Apparatus[1]

4.1 *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 are not to 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 at least 0 to 2224 N (0-500 lbf). Within a 100 cm^2 (16 $in.^2$) working 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 (.0125 mm/25 mm, .0005 in./1.00 in.) throughout the test (*5*).

4.1.1 Within a range of platen separations necessary to cause compressive failure of the test specimen, and within a load range of at least 0 to 2224 N (0-500 lbf), the speed of the driven platen shall be controllable at 12.5 ± 0.25 mm (0.50 ± 0.01 in.) per minute. (For convenience, the test machine should be capable of rapid return and automatic, settable positioning).

4.1.2 The driven platen shall be moveable to achieve an initial platen separation of at least 74 mm (2.9 in.).

4.1.3 The tester shall have a capacity of at least 2224 N (500 lbf).

[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.

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Deleted: 3.1 *Compression testing machine* meeting the requirements of either 3.1.1 or 3.1.2, and 3.1.3, 3.1.4, and 3.1.5.¶

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Deleted: 3.1.2 *Flexible Beam Compression Tester*. Two platens, one flexible beam supported and the other driven. Each platen shall have a working area of approximately 100 cm^2 (16 $in.^2$). 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. The platens are required to have not more than 0.05 mm (0.002 in.) lateral relative movement.¶
3.1.2.1 Within a range of platen separations necessary to cause compressive failure of the specimen, and within a load range of at least 0 to 2224 N (0-500 lbf), the speed of the driven platen shall be controlled so that the rate of force increase (without considering specimen deformation) is 111 ± 22 N/s (25 ± 5 lbf/s) (*5*).¶
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4.1.4 The tester shall have a means for measuring and indicating the maximum load sustained by the test specimen, with an accuracy of 0.5% or better between a measured load of 440N (100 lbf) and the equipment's maximum load. Below this measured load, the accuracy shall be 2.2N (0.5 lbf) or better.

4.2 *Knife cutter*, A single knife device with guides, or a twin-knife device with guides for cutting specimens having clean, parallel and perpendicular edges within the tolerances specified in 7.2 and 7.3. The knives must be sharp and arranged in the device so that it/they are at 90° to the specimen's surface. Opposite edges shall be parallel to each other and perpendicular to adjacent edges (6).

4.3 *Test fixture* (Fig. 1) consisting of,

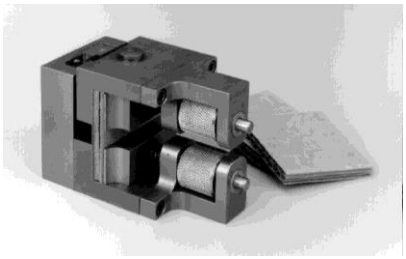

Fig. 1. Test fixtures may vary in appearance.

4.3.1 *Clamps*, upper and lower to secure the test specimen. One side of each clamp must be fixed and so aligned that the test specimen is held exactly perpendicular to the base of the fixture. The moveable side of each clamp is actuated by a spring or springs such that the test specimen is held by a uniform pressure between 27 kPa and 55 kPa (4 and 8 psi) (*7*). The four flat contact surfaces of the clamps must be covered with 120 – 180 grit sandpaper to prevent slippage of the specimen during testing. ("Grit" is a reference to the number of abrasive particles per 6.452 cm^2 (1 $in.^2$).) Each clamp side must be at least 50.8 mm (2.00 in.) wide by 19.8 mm ± 0.25 mm (0.78 in. ± 0.01 in.) tall.

4.3.2 Means to open the jaws against the spring load so as to be able to insert the test specimen (e.g., thumb screws).

4.3.3 *Suspension system*, consisting of frictionless bearings to allow the jaws to move freely up and down. Structure must be of rigid design to guarantee the test load is applied to specimen in an absolute vertical direction relative to the base of the fixture.

5. Sampling

Samples shall be obtained in accordance with TAPPI T 400 "Sampling and Accepting a Single Lot of Paper, Paperboard, Containerboard, or Related Product."

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3.2.1

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Deleted: 3.2.2 *Saw*, circular, equipped with a sharp, no-set (hollow-ground or taper-ground is desirable) saw blade. The saw blade shall be 90° to the table supporting the specimen, and have the ability to consistently hold specimen size to ± 0.8 mm (±0.03 in.).¶

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6. Conditioning

Precondition and condition the samples in accordance with TAPPI T 402 “Standard Conditioning and Testing Atmospheres for Paper, Board, Pulp Hand Sheets, and Related Products.”

7. Test specimens

7.1 From each test unit, accurately cut at least 10 or any other required number of specimens with the knife device described in 4.2. that will cut clean, parallel, and perpendicular edges. If the test specimens are to be taken from corrugated shipping containers, they should be taken from areas away from scorelines, joints, and closures. Specimens should be representative of the material being tested. For example, if roughly 25% of a box is printed, roughly 25% of the specimens should be collected from printed areas.

7.2 The load bearing edges shall be parallel to each other and perpendicular to the axis of the flutes. Cut specimens to a width of 50.8 ± 0.8 mm (2.00 ± 0.03 in.).

7.3 Specimens to be tested using this procedure shall be cut to a height 50.8 ± 0.8 mm (2.00 ± 0.03 in.) for A, B, and C-flute and for all double- and triple-wall board.

NOTE 1: For smaller flute structures, the resulting space between the clamping grips on the fixture may be too large to achieve pure compression using a two inch high sample, depending on the strength and stiffness (thickness) of the combined board materials(8). To achieve pure compression on these structures, an alternate testing approach may be required.

8. Procedure

8.1 Perform all tests in the conditioning atmosphere.

8.2 Using the thumb screws open the upper and lower jaws of the test fixture and place the specimen centrally in the jaws with the flutes oriented in the vertical direction. Allow the fixture to fall into place so that the specimen rests between the fixture’s base and top. Adjust the thumb screws to apply a known, consistent, uniform pressure to the specimen.

NOTE 2: Many clamping fixtures provide a “detent” in the spring loading mechanism to ensure that proper spring loading is achieved. Do not tighten past the detent, or pause, in the loading mechanism.

8.3 Place the test fixture on the machine platen so that the part of the fixture at the top which contacts the upper platen is centered on the upper platen.

8.3.1 Apply a compressive force to the specimen. A test is considered valid when one or both liners have buckled in the center portion of the specimen. Occasionally samples will fail at a loaded edge or along the edge of the clamp. These results may be less than samples buckled in between the jaws. It is recommended that an additional sample be taken.

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Deleted: 7.2 If using a flexible beam compression tester (3.1.2), record the platen movement rate actually used. On most machines this rate of platen movement will be 13-51 mm (0.5 - 2.0 in.) per minute depending on the load range at the beam.¶
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8.4 Record the maximum load in newtons [N] (pounds-force [lbf]), the specimen width, and whether or not the specimen exhibited a valid failure.

9. Report

9.1 For each test unit, report:

9.1.1 Average maximum load per unit width for valid tests calculated from average maximum load from specimen lot (10 specimens) and specimen width in kilonewtons per meter [kN/m] (pounds-force per inch [lbf/in.]).

9.1.2 Standard deviation among valid determinations in kilonewtons per meter [kN/m] (pounds-force per inch [lbf/in.]).

9.1.3 Number of valid test determinations.

9.1.4 A description of material tested.

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

10. Precision

10.1 Repeatability (within a laboratory) = 3.1%.

10.2 Reproducibility (between laboratories) = 13.5%.

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.

10.3 The estimates of repeatability and reproducibility listed above are based on data from the CTS Containerboard and Paper, Paperboard & Corrugated Fiberboard Interlaboratory Programs from monthly testing conducted on three sets of ECT samples (ECT 8, ECT9, ECT10) from December 2014 through December 2017. Outliers and labs that reported not using TAPPI standard conditions were excluded. On average, 34 labs were included each month, with results for repeatability and reproducibility averaged over the 37 months in the testing period. There were no trends in the data with material.

10.3.1 The prior precision statement, showing a repeatability of 3% and a reproducibility of 16%, covered testing in 2005 through 2007. That data included 12 rounds of testing on 6 different samples of "C" flute corrugated board in either 42-26-42 or 35-26-35 board combinations. Between lab reproducibility is a little tighter in the present estimate, but there is a good bit of variation from cycle to cycle and so the prior value is not unreasonable. As well, in the 2005-7 assessment, data was taken from a program where more than one ECT method was in use, and some comingling of data between labs may have occurred if a lab misidentified their testing approach.

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11. Keywords

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Corrugated boards, Edge crush resistance

12. Additional information

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12.1 Effective date of issue: To Be Assigned.

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12.2 Related Methods

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12.2.1 TAPPI T 811, TAPPI T 838, FEFCO Test Method No. 8, ISO 3037, and ISO 13821 provide alternate procedures requiring different specimen dimensions, specimen geometry, or specimen support techniques to evaluate Edgewise Compressive Strength. This method differs in that a test holding fixture is used, a single specimen size is used for all board constructions, and the test specimen's edges are not reinforced nor is the sample necked down. The various listed procedures will not necessarily yield the same results as this test method (*9-13*), nor are the results simply scaleable between test methods. For example, if fabrication of the sample material is excellent, one might expect the results from this method to be higher than those from the T 811 method, while if the sample is significantly crushed, one might expect the T 811 method to produce higher results than this method (*14*).

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12.2.2 In some testing protocols (e.g. compliance with National Motor Freight Classification item 222), a method of evaluating Edgewise Compressive Strength is specifically indicated. Given that the various methods do not necessarily yield the same results, the specified method (which may be different that this method) must be used in those cases to comply with the testing protocol.

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12.3 *Revisions*

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12.3.1 The 2008 revision of this method fixed the numbering of section 3, updated the precision statement, and clarified required equipment accuracy (3.1.5) and specimen sampling procedure (6.1). References were also added and updated. Most critically, the redundant and confusing specification of the clamping fixture by both spring constant and applied pressure was changed to specify only the pressure, and the specified clamping pressure (3.3.1) was reduced from 55–83 kPa to 27–55 kPa (8–12 psi to 4–8 psi). These changes bring the test into range where artificially lower test results arising due to sample damage from the clamping fixture itself are less likely. The new clamping pressure range is also in line with the original work developing this method as well as the actual pressures applied to most C-flute board by much of the equipment on the market (*7*). As such, this change effectively brings the test method in line with equipment in common use, and is not expected to significantly impact testing results or shift data from historical averages.

Moved down [2]: 11.3.1 The 2018 revision made minor editorial changes, added Note1 and Note 2, and updated the precision statement.¶

Moved down [1]: 11.3.2 The 2012 revision of this method made minor editorial changes to sections 3.2.2, 7.3, and 7.4.¶

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12.3.2 The 2012 revision of this method made minor editorial changes to sections 3.2.2, 7.3, and 7.4.

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12.3.3 The 2018 revision made minor editorial changes, added Note1 and Note 2, and updated the precision statement.

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Moved (insertion) [2]

12.3.4 The principle change for the 2023 revision is to remove the use of the Flexible Beam Tester and references to its use. Also, a Safety Precautions statement was added, "Literature Cited" Reference 13 was updated, and Section numbering was changed, where needed, to reflect text changes. In addition, typos and grammatical

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changes were made to Sections 5 and 6.1, with Sections 11.2.1 through 11.2.3 and new Section 12.3.4 (added to highlight the current changes) re-arranged to be put in chronologic order.

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