WI 030308.10

T 809

DRAFT NO. 4

DATE June 28, 2006

TAPPI

WORKING GROUP
CHAIRMAN WO Kroeschell

SUBJECT
CATEGORY FISCOTEC

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.

Flat crush of corrugating medium (CMT test)

(Proposed revision of T 809 om-99)

(Lines in text or margins indicate changes since last draft)

1. Scope

This method describes a procedure for measuring the crushing resistance of a laboratory fluted strip of corrugating medium, and provides a means of estimating, in the laboratory, the potential flat crush resistance of a corrugated board. Other grades may not correlate with their potential.

NOTE 1: While the choice of testing instrument does not create significant differences in this test, it should be noted that when the flat crush of the corrugated board is being determined, the rigid support instrument (T 825) gives significantly higher results than the flexible beam instrument (T 808).

2. Significance

Rigidity of the fluted structure is one of the essential characteristics of corrugated board and flat crush resistance (T 825) is necessary to prevent crushing of the flute structure on the corrugator and other converting equipment. The corrugating medium test (CMT) permits the evaluation of corrugating medium before it is fabricated into combined board, and may by consideration of the flat crush of the corrugated board produced as a basis for judgment of fabrication efficiency.

3. Apparatus[1] and materials

3.1 *Medium fluter*[1], consisting of a pair of matched "A"-flute type rolls thermostatically controlled to a temperature of 177 ± 8°C (350 ± 15°F).

The dimensions of the fluting rolls are:

3.1.1 Roll face, 16.0 ± 1.0 mm (0.63 ± 0.04 in.).

3.1.2 Number of teeth, 84.

3.1.3 Depth of teeth, 4.75 ± 0.05 mm (0.2 ± 0.002 in.).

3.1.4 Roll diameter tip to tip, 228.5 ± 0.5 mm (9 ± 0.02 in.).

3.1.5 Radius of teeth at peak, 1.5 ± 0.1 mm (0.06 ± 0.004 in.).

3.1.6 Radius of teeth at base, 2.0 ± 0.1 mm (0.08 ± 0.004 in.).

3.1.7 The force between the rolls is set at 100 ± 10 *N* (22.5 ± 2.25 lbf.).

3.1.8 The speed of the fluting rolls is permanently set at 4.5 r/min ± 1.0 r/min.

3.2 *Rack and comb,* (see figure 1) having the following characteristics:

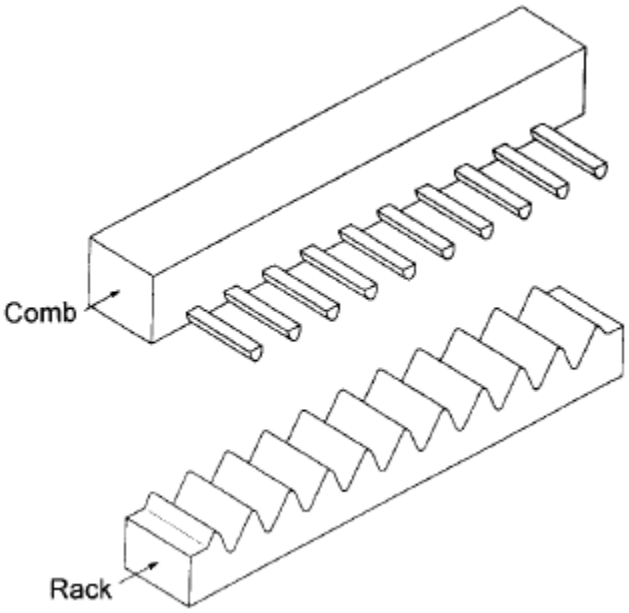

Fig. 1. Drawing of rack and comb.

3.2.1 Rack, 11 teeth, 10 valleys.

[1] Names of suppliers of testing equipment and materials for this method may be found on the Test Equipment Suppliers list in the set of TAPPI Test Methods, or may be available from the TAPPI Quality and Standards Department.

3.2.1.1 Height of teeth, 4.75 ± 0.05 mm (0.2 ± 0.002 in.).

3.2.1.2 Tooth spacing is 8.50 ± 0.05 mm (0. 335 ± 0.002 in.).

3.2.1.3 Width, 19.00 - 0.0 mm (0.75 – 0.0 in.).

3.2.2 Comb, number of prongs, 10.

3.2.2.1 Prong length, at least 19 mm (0.75 in.) wide.Max. prong thickness, 3.4 ± 0.1 mm (0.13 ± 0.004 in.).

3.3 *Pressure sensitive tape*, at least 15 mm (0.6 in.) width.

3.4 *Specimen cutter*, a hand lever operated diecutter. The female portion is 12.7 ± 0.1 mm (0.5 ± 0.004 in.) × 150 to 160 mm (6 to 6.3 in.). The male die is machined to fit the female. The cutting assembly is provided with a specimen delivery slot. The whole is enclosed in a frame to keep out dust.

3.5 *Flexible beam compression or rigid-platen testing machine,* in accordance with TAPPI T 811 "Edgewise Compressive Strength of Corrugated Fiberboard (Short Column Test)."

3.5.1 The surface of the platens shall be provided with some means to prevent slippage of the test piece during compression, for example, by means of a matt finish or being faced with crocus cloth or its equivalent, adhered free of ridges and maintaining parallel surfaces.

4. Test specimens

From each test unit accurately cut at least 10 specimens. Cut the test specimens 12.7 ± 0.1 mm (0.5 ± 0.004 in.) ×150 to 160 mm (6 to 6.3 in.) on the die cutter. Assure that the longer dimension is in the machine direction of the medium.

5. Conditioning

Condition the specimen strips prior to testing in an atmosphere in accordance with TAPPI T 402 "Standard Conditioning and Testing Atmospheres for Paper, Board, Pulp Handsheets and Related Products."

6. Procedure

6.1 Arrange all equipment and supplies to facilitate completing operations in the specified time (see 10.4).

6.2 Perform the fluting operation only after the specimens have reached equilibrium with the specified atmosphere. Heat the fluting rolls to 177 ± 8°C (350 ± 15°F) as shown by the temperature indicator.

6.2.1 Feed the specimen into the guide slot of the fluter, so that the bottom edge of the specimen rides flat on the hot plate. Place the fluted specimen, which emerges on the other side, on the corrugated rack, so that a portion of the specimen is resting on the flat surface at each end of the rack. Place the comb over the fluted specimen, so that it is held firmly into the flutes of the rack, making certain that the specimen is bottomed uniformly in each of the flutes. Exercise care in handling the comb to avoid dropping it. A rolling motion of the comb as it is placed on the specimen aids in forming the specimen onto the rack. Holding the specimen firmly in the rack, place a 130 mm (5 in.) strip of at least 15 mm (0.59 in.) wide pressure sensitive tape, adhesive side down, on the exposed flute tips and stroke down firmly. [If more than 10 flutes are formed, crush the extra flute(s)]. Carefully, slip the comb out of the flutes without damage to the specimen. Then, lift the resulting 10-flute strip straight up from the rack by the edges of the tape to avoid damaging the

flutes. Place the specimen on the lower platen of the compression tester, flutes facing up, and test it for flat crush, applying the force at the prescribed rate, after the platens contact the specimen. The function of the matt or crocus cloth surface on the platen is to prevent leaning failures due to slippage of the specimen.

6.2.2 Perform all of these operations using the same technique and speed for each specimen. Test the specimen immediately after fluting so that the time from complete emergence of the specimen from the fluter to the initial application of the crushing force is 5-8 s.

NOTE 2: Failure to maintain the 5-8 s range may result in low or erratic results.
NOTE 3: See 10.2.

7. Report

Include the following in the report: (1) the average medium flat crush [N(CMT)] value of 10 determinations, to the nearest 5 *N* (1 lbf); (2) the standard deviation of [N(CMT)] values; (3) the type of compression tester used.

8. Precision

8.1 For the flexible beam instrument

These data were obtained in a round robin among 29 laboratories, using flexible beam type compression testers

8.1.1 Repeatability (within a laboratory) = 4.5%, 10 specimens/average.

8.1.2 Reproducibility (between laboratories) = 10.0%, 10 specimens/average,.

8.2 For the rigid platen instrument

The following estimates of repeatability and reproducibility are based on results from the CTS Containerboard Interlaboratory Program. The data was drawn from flat crush results from 53 laboratories for two different samples of 26 lb. corrugating medium. The testing was conducted in both 2002 and 2005. Only participants who reported using rigid-platen type instruments and adhering to TAPPI conditioning requirements were included in the calculation of the precision estimates.

8.2.1. Repeatability (within a laboratory) = 5 %, 10 specimens/average

8.2.2 Reproducibility (between laboratories) = 11 %, 10 specimens/average

The precision estimates are based on one test result per lab, per material

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, in accordance with the definitions of these terms in TAPPI T 1200 “Interlaboratory Evaluation of Test Methods to Determine TAPPI Repeatability and Reproducibility.” These estimates may not be valid for different materials or testing conditions

9. Keywords

Corrugating medium, Flat crush tests, Corrugated boards, Compressibility, Compression strength

10. Additional information

10.1 Effective date of issue: to be assigned.

10.2 Another procedure has received wide use. After lifting the composite test piece from the rack, let it condition in the testing atmosphere for 32.5 ± 2.5 min (30 to 35 min) before placing on the lower platen of the compression apparatus, and test it for its flat crush resistance according to the procedure in 6.2. The precision of this procedure is unknown.

10.3 Reflecting the number of equipment units currently in widespread use, the equipment specifications indicated are soft conversions to metric units for the prior specifications of TAPPI T 809 "Flat Crush Potential of Corrugating Medium (CMT Test)."

10.4 For most reliable results, the time for specimen preparation must be maintained within the 5-8 s time limit specified. This is the time interval from the discharge of the fluted specimen from the fluter to the initial application of force in the compression tester. To readily achieve this, the following suggestions have been found convenient:

10.4.1 The compression tester should be equipped with an automatic stop or limit switch to control the initial clearance between the platens to a minimum, convenient for insertion of the specimen.

10.4.2 Mount the test equipment on the laboratory bench top, so that it is in a convenient position. For a right handed tester this would be: left to right facing the equipment, fluter, comb and rack, and compression tester with approximately 250 mm (10 in.) spacing between units.

10.4.3 Precut tape strips to proper length and adhere one end lightly to edge of bench.

10.4.4 Insert medium specimen into fluter with left hand.

10.4.5 Pick up comb with left hand.

10.4.6 Remove fluted specimen from fluter with right hand and place specimen on rack.

10.4.7 Holding comb in left hand, securely position fluted medium in rack.

10.4.8 Apply tape with right hand, using thumb to crush additional flutes at each end of the 10 flute test strip.

10.4.9 Remove comb carefully from taped specimen with left hand, holding specimen in reach with right hand.

10.4.10 Use right hand to insert specimen into compression tester plates.

NOTE 4: For a left handed tester much of the above procedure would be reversed.

10.4.11 Start compression tester with left hand on switch, or use foot pedal if unit is so equipped.

10.4.12 Return compression tester platens to initial position at completion of test.

10.5 Related methods: ISO 7263-1994 (E) two procedures, immediate testing (15 ± 3 s after commencement of fluting), or 30 min reconditioning of fluted sample moisture content prior to compression test.

Appendix A: Calibration

A.1 *Crush tester*. Calibrate the flexible beam instrument in accordance with Appendix A of TAPPI T 808 "Flat Crush Test of Corrugated Board." Calibrate the rigid support instrument in accordance with the manufacturer's instructions.

A.2 *Medium fluter*

A.2.1 *Fluting rolls (Horizontal roll type).* Uniform meshing of fluting rolls can be checked by the use of National Cash Register Tape - CB white NCR paper and CR green tinted NC paper C2R. A 12.7-mm (0.5-in.)-wide strip of each type of paper is run through the fluting rolls. The pressure pattern will appear on the green tinted strip. The pressure lines should be uniform and extend the full 12.7 mm (0.5-in.) width of the strip. If there is more impression at the top or bottom of the rolls, they are not in the same plane. This means that the heating plate has warped, is worn unevenly, or the bearings are worn. In any case, the fluter should go back to the manufacturer for repair.

The rolls should ride flat on the heating plate. If the drive roll is not flat on the heating plate, loosen the collar directly above the bottom bearing housing and tap the roll lightly until it is lying flat. It may be necessary to loosen the bottom bearing also. Make this adjustment only when the fluter is up to normal operating temperature. When the roll is flat, tighten all bolts and set screws. Remove driven roll by taking out the center bolt and lifting the roll up by bolts inserted in the thread holes provided. Inspect the heating plate for wear of chrome plating. If worn, a new heating plate should be installed by the manufacturer. The roll can also be inspected for smoothness and wear on the bottom. The spring-loaded post slide can be checked for freeness of movement and lubricated with powdered graphite, if necessary. When the roll is replaced, powdered graphite should be added to the lubricating hole while the roll is turning. Graphite should be added until the grooves under the roll are completely filled. The same holds true for the drive roll.

A.2.2 *Spring force.* The bar at the front end of the heating plate (on older model fluters) which holds the spring in place can be removed and the spring taken out. By placing the spring upright in the compression tester and applying force until the gage reads 100 *N* (22.5 lbf), the length of the spring at that point can be determined.

The distance from the edge of the heating plate to the base of the slide block should correspond to the spring length at 100 *N* (22.5 lbf) force. Make the measurement with the driven roll in proper contact with the drive roll.

On newer model fluters the spring is under the heating plate and applies force to the roll by leverage so that the spring exerts only 50 *N* (11.25 lbf) of force to give 100 *N* (22.5 lbf) on the roll. This can be checked by the method above, or by pulling the roll back with another spring scale, or by pulling back with a spring scale at the point on the lever where the main spring is located.

A.2.3 *Temperature.* The temperature of the fluting rolls should be 177 ± 8°C (350°F ± 15°F), as checked by a pyrometer or thermocouple. Bring the rolls up to temperature with the cover in place. When the plate and rolls are up to temperature as indicated by the amber light going out, remove the cover and take the temperature of the rolls as near the flute tips as possible. Do this while the fluting rolls are in motion. If the temperature is not correct, adjust the thermostat to bring the rolls to the correct temperature and make a new mark at 177°C (350°F). If the temperature cannot be adjusted, check the heating element under the hot plate with a continuity tester. A new heating element may have to be installed by the manufacturer.

References

1. Long, F. D., and Maltenfort, G. G., "A New Test for Corrugating Medium," *Fibre Containers* **37** (12): (1952).
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8. Gartaganis, P. A., and Ostrowski, H. "Evaluation of the Converting Efficiency of Corrugated Combined Board - Part I," *Tappi* **52** (6): 1059 (1969).

Your comments and suggestions on this procedure are earnestly requested and should be sent to the TAPPI Director of Quality and Standards ■

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April 10, 2006

Dear T 809 SSIG member:

Here is T 809 again. On the last ballot we had one negative vote and this was based on he voter's belief that there was no significant difference between the results for the flexible beam and the rigid platen instruments. We checked and he was right. So we recombined the two methods back in to one and obtained new precision data for the rigid platen instrument, courtesy of Chris Czyryca and the Collaborative Testing Service. The new additions are underlined on this draft. We entered soft conversions of all the dimensions in the apparatus section, eliminated the 26# limit from the scope, removed the data tables estimating flat crush from the CMT, added a section describing the European method of conditioning before testing and took out the paragraph, which said that there were differences. We trust that all of these changes will meet with your approval.

Also, we had thought about separating the rigid support method into a separate method, but that idea has been dropped. So those of you who indicated that you wanted to be on that SSIG, but were not on the SSIG for T 809, have now been added to the T 809 SSIG.

Yours very truly,

William O. Kroeschell

WI 030308.10

T 809

DRAFT NO. 3

DATE April 10, 2006

TAPPI

WORKING GROUP
CHAIRMAN WO Kroeschell

SUBJECT
CATEGORY FISCOTEC

RELATED
METHODS See "Additional Information"

CAUTION:
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Flat crush of corrugating medium (CMT test)

(Proposed revision of T 809 om-99)

(Lines in text or margins indicate changes since last draft)

1. Scope

This method describes a procedure for measuring the crushing resistance of a laboratory fluted strip of corrugating medium, and provides a means of estimating, in the laboratory, the potential flat crush resistance of a corrugated board. Other grades may not correlate with their potential.

2. Significance

Rigidity of the fluted structure is one of the essential characteristics of corrugated board and flat crush resistance (T 825) is necessary to prevent crushing of the flute structure on the corrugator and other converting equipment. The corrugating medium test (CMT) permits the evaluation of corrugating medium before it is fabricated into combined board, and may by consideration of the flat crush of the corrugated board produced as a basis for judgment of fabrication efficiency.

3. Apparatus[1] and materials

3.1 *Medium fluter*[1], consisting of a pair of matched "A"-flute type rolls thermostatically controlled to a temperature of 175 ± 8°C (350 ± 15°F).

The dimensions of the fluting rolls are:

3.1.1 Roll face, 16.0 ± 1.0 mm (0.63 ± 0.04 in.).

3.1.2 Number of teeth, 84.

3.1.3 Depth of teeth, 4.75 ± 0.05 mm (0.2 ± 0.002 in.).

3.1.4 Roll diameter tip to tip, 228.5 ± 0.5 mm (9 ± 0.02 in.).

3.1.5 Radius of teeth at peak, 1.5 ± 0.1 mm (0.06 ± 0.004 in.).

3.1.6 Radius of teeth at base, 2.0 ± 0.1 mm (0.08 ± 0.004 in.).

3.1.7 The force between the rolls is set at 100 ± 10 *N* (22.5 ± 2.25 lbf.).

3.1.8 The speed of the fluting rolls is permanently set at 4.5 r/min ± 1.0 r/min.

3.2 *Rack and comb,* (see figure 1) having the following characteristics:

3.2.1 Rack, 11 teeth, 10 valleys.

3.2.1.1 Height of teeth, 4.75 ± 0.05 mm (0.2 ± 0.002 in.).

3.2.1.2 Tooth spacing is 8.50 ± 0.05 mm (0. 335 ± 0.002 in.).

3.2.1.3 Width, 19.00 - 0.0 mm (0.75 – 0.0 in.).

3.2.2 Comb, number of prongs, 10.

3.2.2.1 Prong length, at least 19 mm (0.75 in.) wide.

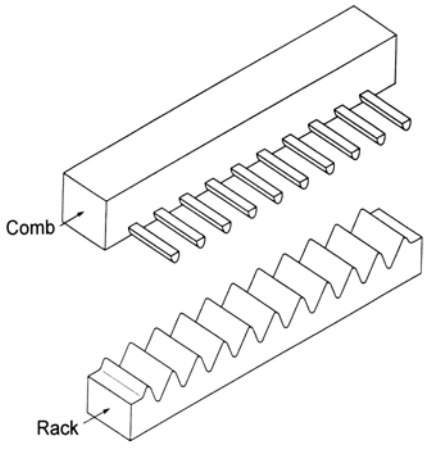

Figure 1. Drawing of rack and comb

3.2.2.2 Max. prong thickness, 3.4 ± 0.1 mm (0.13 ± 0.004 in.).

[1] Names of suppliers of testing equipment and materials for this method may be found on the Test Equipment Suppliers list in the set of TAPPI Test Methods, or may be available from the TAPPI Quality and Standards Department.

3.3 *Pressure sensitive tape,* at least 15 mm (0.6 in.) width.

3.4 *Specimen cutter,* a hand lever operated diecutter. The female portion is 12.7 ± 0.1 mm (0.5 ± 0.004 in.) × 150 to 160 mm (6 to 6.3 in.). The male die is machined to fit the female. The cutting assembly is provided with a specimen delivery slot. The whole is enclosed in a frame to keep out dust.

3.5 *Flexible beam compression or rigid-platen testing machine,* in accordance with TAPPI T 811 "Edgewise Compressive Strength of Corrugated Fiberboard (Short Column Test)."

3.5.1 The surface of the platens shall be provided with some means to prevent slippage of the test piece during compression, for example, by means of a matt finish or being faced with crocus cloth or its equivalent, adhered free of ridges and maintaining parallel surfaces.

4. Test specimens

From each test unit accurately cut at least 10 specimens. Cut the test specimens 12.7 ± 0.1 mm (0.5 ± 0.004 in.)× 150 to 160 mm (6 to 6.3 in.) on the die cutter. Assure that the longer dimension is in the machine direction of the medium.

5. Conditioning

Condition the specimen strips prior to testing in an atmosphere in accordance with TAPPI T 402 "Standard Conditioning and Testing Atmospheres for Paper, Board, Pulp Handsheets and Related Products."

6. Procedure

6.1 Arrange all equipment and supplies to facilitate completing operations in the specified time (see 10.4).

6.2 Perform the fluting operation only after the specimens have reached equilibrium with the specified atmosphere. Heat the fluting rolls to 175 ± 8°C (350 ± 15°F) as shown by the temperature indicator.

6.2.1 Feed the specimen into the guide slot of the fluter, so that the bottom edge of the specimen rides flat on the hot plate. Place the fluted specimen, which emerges on the other side, on the corrugated rack, so that a portion of the specimen is resting on the flat surface at each end of the rack. Place the comb over the fluted specimen, so that it is held firmly into the flutes of the rack, making certain that the specimen is bottomed uniformly in each of the flutes. Exercise care in handling the comb to avoid dropping it. A rolling motion of the comb as it is placed on the specimen aids in forming the specimen onto the rack. Holding the specimen firmly in the rack, place a 130 mm (5 in.) strip of at least 15 mm (0.59 in.) wide pressure sensitive tape, adhesive side down, on the exposed flute tips and stroke down firmly. (If more than 10 flutes are formed, crush the extra flute(s)). Carefully, slip the comb out of the flutes without damage to the specimen. Then, lift the resulting 10-flute strip straight up from the rack by the edges of the tape to avoid damaging the flutes. Place the specimen on the lower platen of the compression tester, flutes facing up, and test it for flat crush, applying the force at the prescribed rate, after the platens contact the specimen. The function of the matt or crocus cloth surface on the platen is to prevent leaning failures due to slippage of the specimen.

6.2.2 Perform all of these operations using the same technique and speed for each specimen. Test the specimen immediately after fluting so that the time from complete emergence of the specimen from the fluter to the initial application of the crushing force is 5-8 s.

NOTE 1: Failure to maintain the 5-8 s range may result in low or erratic results.

NOTE 2: See 10.2.

7. Report

Include the following in the report: (1) the average medium flat crush [N(CMT)] value of 10 determinations, to the nearest 5 *N* (1 lbf); (2) the standard deviation of [N(CMT)] values; (3) the type of compression tester used.

8. Precision

8.1 For the flexible beam instrument

These data were obtained in a round robin among 29 laboratories, using flexible beam type compression testers

8.1.1 Repeatability (within a laboratory) = 4.5%, 10 specimens/average.

8.1.2 Reproducibility (between laboratories) = 10.0%, 10 specimens/average,.

8.2 For the rigid platen instrument

The following estimates of repeatability and reproducibility are based on results from the CTS Containerboard Interlaboratory Program. The data was drawn from flat crush results from 53 laboratories for two different samples of 26 lb. corrugating medium. The testing was conducted in both 2002 and 2005. Only participants who reported using rigid-platen type instruments and adhering to TAPPI conditioning requirements were included in the calculation of the precision estimates.

8.2.1. Repeatability (within a laboratory) = 5 %, 10 specimens/average

8.2.2 Reproducibility (between laboratories) = 11 %, 10 specimens/average

The precision estimates are based on one test result per lab, per material

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, in accordance with the definitions of these terms in TAPPI T 1200 “Interlaboratory Evaluation of Test Methods to Determine TAPPI Repeatability and Reproducibility.” These estimates may not be valid for different materials or testing conditions

9. Keywords

Corrugating medium, Flat crush tests, Corrugated boards, Compressibility, Compression strength

10. Additional information

10.1 Effective date of issue: to be assigned.

10.2 Another procedure has received wide use. After lifting the composite test piece from the rack, let it condition in the testing atmosphere for 32.5 ± 2.5 min (30 to 35 min) before placing on the lower platen of the compression apparatus, and test it for its flat crush resistance according to the procedure in 6.2. The precision of this procedure is unknown.

10.3 Reflecting the number of equipment units currently in widespread use, the equipment specifications indicated are soft conversions to metric units for the prior specifications of TAPPI T 809 "Flat Crush Potential of Corrugating Medium (CMT Test)."

10.4 For most reliable results, the time for specimen preparation must be maintained within the 5-8 s time limit specified. This is the time interval from the discharge of the fluted specimen from the fluter to the initial application of force in the compression tester. To readily achieve this, the following suggestions have been found convenient:

10.4.1 The compression tester should be equipped with an automatic stop or limit switch to control the initial clearance between the platens to a minimum, convenient for insertion of the specimen.

10.4.2 Mount the test equipment on the laboratory bench top, so that it is in a convenient position. For a right handed tester this would be: left to right facing the equipment, fluter, comb and rack, and compression tester with approximately 250 mm (10 in.) spacing between units.

10.4.3 Precut tape strips to proper length and adhere one end lightly to edge of bench.

10.4.4 Insert medium specimen into fluter with left hand.

10.4.5 Pick up comb with left hand.

10.4.6 Remove fluted specimen from fluter with right hand and place specimen on rack.

10.4.7 Holding comb in left hand, securely position fluted medium in rack.

10.4.8 Apply tape with right hand, using thumb to crush additional flutes at each end of the 10 flute test strip.

10.4.9 Remove comb carefully from taped specimen with left hand, holding specimen in reach with right hand.

10.4.10 Use right hand to insert specimen into compression tester plates.

NOTE 3: For a left handed tester much of the above procedure would be reversed.

10.4.11 Start compression tester with left hand on switch, or use foot pedal if unit is so equipped.

10.4.12 Return compression tester platens to initial position at completion of test.

10.5 Related methods: ISO 7263-1994 (E) two procedures, immediate testing (15 ± 3s after commencement of fluting), or 30 min reconditioning of fluted sample moisture content prior to compression test.

Appendix A: Calibration

A.1 *Crush tester*. Calibrate the flexible beam instrument in accordance with Appendix A of TAPPI T 808 "Flat Crush Test of Corrugated Board." Calibrate the rigid support instrument in accordance with the manufacturer's instructions.

A.2 *Medium fluter*

A.2.1 *Fluting rolls (Horizontal roll type).* Uniform meshing of fluting rolls can be checked by the use of National Cash Register Tape - CB white NCR paper and CR green tinted NC paper C2R. A 12.7-mm (0.5-in.)-wide strip of each type of paper is run through the fluting rolls. The pressure pattern will appear on the green tinted strip. The pressure lines should be uniform and extend the full 12.7 mm (0.5-in.) width of the strip. If there is more impression at the top or bottom of the rolls, they are not in the same plane. This means that the heating plate has warped, is worn unevenly, or the bearings are worn. In any case, the fluter should go back to the manufacturer for repair.

The rolls should ride flat on the heating plate. If the drive roll is not flat on the heating plate, loosen the collar directly above the bottom bearing housing and tap the roll lightly until it is lying flat. It may be necessary to loosen the bottom bearing also. Make this adjustment only when the fluter is up to normal operating temperature. When the roll is flat, tighten all bolts and set screws. Remove driven roll by taking out the center bolt and lifting the roll up by bolts inserted in the thread holes provided. Inspect the heating plate for wear of chrome plating. If worn, a new heating plate should be installed by the manufacturer. The roll can also be inspected for smoothness and wear on the bottom. The spring-loaded post slide can be checked for freeness of movement and lubricated with powdered graphite, if necessary. When the roll is replaced, powdered graphite should be added to the lubricating hole while the roll is turning. Graphite should be added until the grooves under the roll are completely filled. The same holds true for the drive roll.

A.2.2 *Spring force.* The bar at the front end of the heating plate (on older model fluters) which holds the spring in place can be removed and the spring taken out. By placing the spring upright in the compression tester and applying force until the gage reads 100 *N* (22.5 lbf.), the length of the spring at that point can be determined.

The distance from the edge of the heating plate to the base of the slide block should correspond to the spring length at 100 *N* (22.5 lbf.) force. Make the measurement with the driven roll in proper contact with the drive roll.

On newer model fluters the spring is under the heating plate and applies force to the roll by leverage so that the spring exerts only 50 *N* (11.25 lbf.) of force to give 100 *N* (22.5 lbf.) on the roll. This can be checked by the method above, or by pulling the roll back with another spring scale, or by pulling back with a spring scale at the point on the lever where the main spring is located.

A.2.3 *Temperature.* The temperature of the fluting rolls should be 175 ± 8°C (350°F ± 15°F), as checked by a pyrometer or thermocouple. Bring the rolls up to temperature with the cover in place. When the plate and rolls are up to temperature as indicated by the amber light going out, remove the cover and take the temperature of the rolls as near the flute tips as possible. Do this while the fluting rolls are in motion. If the temperature is not correct, adjust the thermostat to bring the rolls to the correct temperature and make a new mark at 175°C (350°F). If the temperature cannot be adjusted, check the heating element under the hot plate with a continuity tester. A new heating element may have to be installed by the manufacturer.

References

1. Long, F. D., and Maltenfort, G. G., "A New Test for Corrugating Medium," *Fibre Containers* **37** (12): (1952).
2. Long, F. D., and Maltenfort, G. G., "Some Aspects of the Concora Medium Test," *Tappi* **39** (9): 88A (1956).
3. Maltenfort, G. G., "New Model Concora Medium Fluter," *Paperboard Packaging* **46** (6): 60 (1961).
4. Long, F. D., "Automatic Concora Medium Fluter," *Paperboard Packaging **46*** (7): 56 (1961).
5. Container Laboratories, "Quality Evaluation and Research Group 1961 Clinic, Preliminary Report on Effect of New CMIT Formulas."
6. Maltenfort, G. G., "The Effect of Sample Preparation on Concora Medium Test (CMT): A Survey," *Tappi* **47** (12): 176A (1964).
7. McKee, R. C., and Whitsit, W. J., "Relationship Between Combined Board Flat Crush and Concora Flat Crush," *Tappi* **50** (9): 79A (1967).
8. Gartaganis, P. A., and Ostrowski, H. "Evaluation of the Converting Efficiency of Corrugated Combined Board - Part I," *Tappi* **52** (6): 1059 (1969).

Your comments and suggestions on this procedure are earnestly requested and should be sent to the TAPPI Director of Quality and Standards ■

William O. Kroeschell
272 Mooring Line Drive
Naples, Fl 34102-4741
(239) 262-6639

November 3, 2005

TO : SSIG for T 809

We decided to rewrite T 809 to take in all of the comments on the first draft in the following way: (Additions are underlined, eliminations struck through)
We eliminated the rigid support tester from this draft. Don't worry. We have already rewritten the new method for the rigid support tester and are in the process of developing a precision statement from the CTS data. It should be out shortly. Then there will be two methods just as we have for flat crush and many other methods.

We took out the limit for 26 pound in the Scope and added a note about the European method, where they condition for 30 minutes before testing. We couldn't do more with this because the precision is not known.

Finally we took out the tables relating the results to flat crush. After all there was a disclaimer in 10.3 for this data anyway and it really didn't contribute to the test method. I tried to get this out years ago.

We trust that these changes still meet with your approval.

Yours very truly,

William O. Kroeschell

WI 030308.10

T 809

DRAFT NO. 2

DATE November 3, 2005

TAPPI

WORKING GROUP
CHAIRMAN WO Kroeschell

SUBJECT
CATEGORY FISCOTEC

RELATED
METHODS See "Additional Information"

Flat crush of corrugating medium (CMT test)

(flexible beam tester)

(Five-year review of T 809 om-99)

(lines in text or margins indicate changes since last draft)

1. Scope

This method describes a procedure for measuring the crushing resistance of a laboratory fluted strip of corrugating medium, and provides a means of estimating, in the laboratory, the potential flat crush resistance of a corrugated board. Other grades may not correlate with their potential.

2. Significance

Rigidity of the fluted structure is one of the essential characteristics of corrugated board and flat crush resistance is necessary to prevent crushing of the flute structure on the corrugator and other converting equipment. The corrugating

medium test (CMT) permits the evaluation of corrugating medium before it is fabricated into combined board, and may also be used as a basis for judgment of fabrication efficiency.

3. Apparatus[1] and materials

3.1 *Medium fluter*[1], consisting of a pair of matched "A"-flute type rolls thermostatically controlled to a temperature of 175 ± 8°C (350 ± 15°F).

The dimensions of the fluting rolls are:

3.1.1 Roll face, 16.0 ± 1.0 mm.

3.1.2 Number of teeth, 84.

3.1.3 Depth of teeth, 4.75 ± 0.05 mm.

3.1.4 Roll diameter tip to tip, 228.5 ± 0.5 mm.

3.1.5 Radius of teeth at peak, 1.5 ± 0.1 mm.

3.1.6 Radius of teeth at base, 2.0 ± 0.1 mm.

3.1.7 The force between the rolls is set at 100 ± 10 *N*.

3.1.8 The speed of the fluting rolls is permanently set at 4.5 r/mm ± 1.0 r/mm.

3.2 *Rack and comb,* (see figure 1) having the following characteristics:

3.2.1 Rack, 11 teeth, 10 valleys.

3.2.1.1 Height of teeth, 4.75 ± 0.05.

3.2.1.2 Tooth spacing is 8.50 ± 0.05 mm.

3.2.1.3 Width, 19.00 - 0.0 mm.

3.2.2 Comb, number of prongs, 10.

3.2.2.1 Prong length, at least 19 mm wide.

3.2.2.2 Max. prong thickness, 3.4 ± 0.1 mm.

3.3 *Pressure sensitive tape,* at least 15 mm width.

3.4 *Specimen cutter,* a hand lever operated diecutter. The female portion is 12.7 ± 0.1 mm × 150 to 160 mm. The male die is machined to fit the female, 12.7 ± 0.1 mm × 150 to 160 mm. The cutting assembly is provided with a specimen delivery slot. The whole is enclosed in a frame to keep out dust.

3.5 *Compression testing machine*[1], in accordance with TAPPI T 811 "Edgewise Compressive Strength of Corrugated Fiberboard (Short Column Test)."

3.5.1 The surface of the platens shall be provided with some means to prevent slippage of the test piece during compression, for example, by means of a matt finish or being faced with crocus cloth or its equivalent and should be adhered free of ridges and maintaining parallel.

[1] Names of suppliers of testing equipment and materials for this method may be found on the Test Equipment Suppliers list in the bound set of TAPPI Test Methods, or may be available from the TAPPI Quality and Standards Department.

4. Test specimens

From each test unit accurately cut at least 10 specimens. Cut the test specimens 12.7 ± 0.1 mm × 150 to 160 mm on the die cutter. Align the longer dimension in the machine direction of the medium.

5. Conditioning

Condition the specimen strips prior to testing in an atmosphere in accordance with TAPPI T 402 "Standard Conditioning and Testing Atmospheres for Paper, Board, Pulp Handsheets and Related Products."

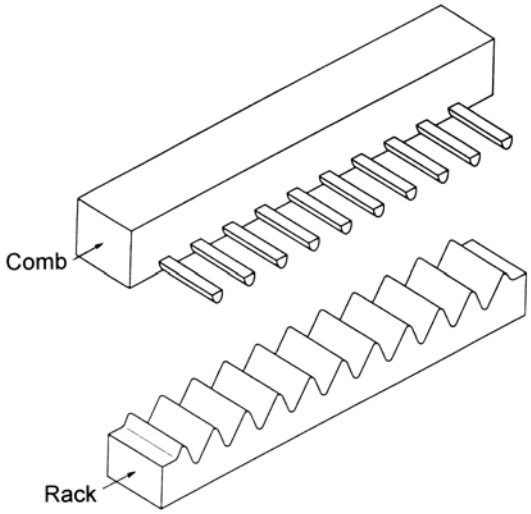

Figure 1. Drawing of rack and comb

6. Procedure

6.1 Arrange all equipment and supplies to facilitate completing operations in the specified time (see 10.4).

6.2 Perform the fluting operation only after the specimens have reached equilibrium with the specified atmosphere. Heat the fluting rolls to 175 ± 8°C (350 ± 15°F) as shown by the temperature indicator.

6.2.1 Feed the specimen into the guide slot on the left side of the fluter, so that the bottom edge of the specimen rides flat on the hot plate. Place the fluted specimen, which emerges on the other side, on the corrugated rack, so that a portion of the specimen is resting on the flat surface at each end of the rack. Place the comb over the fluted specimen, so that it is held firmly into the flutes of the rack, making certain that the specimen is bottomed uniformly in each of the

flutes. Exercise care in handling the comb to avoid dropping it. A rolling motion of the comb as it is placed on the specimen aids in forming the specimen onto the rack. Holding the specimen firmly in the rack, place a 130-mm strip of at least 15 mm wide pressure sensitive tape, adhesive side down, on the exposed flute tips and stroke down firmly. (If more than 10 flutes are formed, crush the extra flute(s)). Carefully, slip the comb out of the flutes without damage to the specimen. Then, lift the resulting 10-flute strip straight up from the rack by the edges of the tape to avoid damaging the flutes. Place the specimen on the lower platen of the compression tester, flutes facing up, and test it for flat crush, applying the force at the prescribed rate, after the platens contact the specimen. The function of the matt or crocus cloth surface on the platen is to prevent leaning failures due to slippage of the specimen.

6.2.2 Perform all of these operations using the same technique and speed for each specimen. Test the specimen immediately after fluting so that the time from complete emergence of the specimen from the fluter to the initial application of the crushing force is 5-8 s.

NOTE 1: Failure to maintain the 5-8 s range may result in low or erratic results.

NOTE 2: See 10.2.

7. Report

Include the following in the report: (1) the average medium flat crush [N(CMT)] value of 10 determinations, to the nearest 5 *N* (1 lbf); (2) the standard deviation of [N(CMT)] values; (3) the type of compression tester used.

8. Precision

8.1 Repeatability (within a laboratory) = 4.5%, 10 specimens/average.

8.2 Reproducibility (between laboratories) = 10.0%, 10 specimens/average, in accordance with the definitions of these terms in TAPPI T 1206 “Precision Statement for Test Methods.”

8.3 These data were obtained in a round robin among 29 laboratories, using flexible beam type compression testers.

8.4 Data contained in Reports 278 and 279 of the Collaborative Reference Program for Containerboard indicate that the Rigid Platen Type Compression Testers yield results that are 1% higher than results obtained on Flexible Beam Type instruments. The results from tests on 26 lb medium were averaged using data from twenty (20) laboratories with Rigid Platen Testers and compared to data from thirty (30) laboratories with Flexible Beam Testers.

9. Keywords

Corrugating medium, Flat crush tests, Corrugated boards, Compressibility, Compression strength

10. Additional information

10.1 Effective date of issue: to be assigned.

10.2 Another procedure has received wide use. After lifting the composite test piece from the rack, let it condition in the testing atmosphere for 32.5 ± 2.5 min (30 to 35 min) before placing on the lower platen of the compression apparatus, and test it for its flat crush resistance according to the procedure in 6.2. The precision of this procedure is unknown.

10.3 Reflecting the number of equipment units currently in widespread use, the equipment specifications indicated are soft conversions to metric units for the prior specifications of TAPPI T 809 "Flat Crush Potential of Corrugating Medium (CMT Test)."

10.4 For most reliable results, the time for specimen preparation must be maintained within the 5-8 s time limit specified. This is the time interval from the discharge of the fluted specimen from the fluter to the initial application of force in the compression tester. To readily achieve this, the following suggestions have been found convenient:

10.4.1 The compression tester should be equipped with an automatic stop or limit switch to control the initial clearance between the platens to a minimum, convenient for insertion of the specimen.

10.4.2 Mount the test equipment on the laboratory bench top, so that it is in a convenient position. For a right handed tester this would be: left to right facing the equipment, fluter, comb and rack, and compression tester with approximately 250 mm (10 in.) spacing between units.

10.4.3 Precut tape strips to proper length and adhere one end lightly to edge of bench.

10.4.4 Insert medium specimen into fluter with left hand.

10.4.5 Pick up comb with left hand.

10.4.6 Remove fluted specimen from fluter with right hand and place specimen on rack.

10.4.7 Holding comb in left hand, securely position fluted medium in rack.

10.4.8 Apply tape with right hand, using thumb to crush additional flutes at each end of the 10 flute test strip.

10.4.9 Remove comb carefully from taped specimen with left hand, holding specimen in reach with right hand.

10.4.10 Use right hand to insert specimen into compression tester plates.

NOTE 3: For a left handed tester much of the above procedure would be reversed.

10.4.11 Start compression tester with left hand on switch, or use foot pedal if unit is so equipped.

10.4.12 Return compression tester platens to initial position at completion of test.

10.5 Related methods: ISO 7263-1994 (E) two procedures, immediate testing (15 ± 3s after commencement of fluting), or 30 min reconditioning of fluted sample moisture content prior to compression test.

Appendix A: Calibration

A.1 *Crush tester*. Calibrate the flexible beam instrument in accordance with Appendix A of TAPPI T 808 "Flat Crush Test of Corrugated Board." Calibrate the rigid support instrument in accordance with manufacturer's instructions.

A.2 *Medium fluter*

A.2.1 *Fluting rolls (Horizontal roll type).* Uniform meshing of fluting rolls can be checked by the use of National Cash Register Tape - CB white NCR paper and CR green tinted NC paper C2R. A 12.7-mm (0.5-in.)-wide strip of each type of paper is run through the fluting rolls. The pressure pattern will appear on the green tinted strip. The pressure lines should be uniform and extend the full 12.7 mm (0.5-in.) width of the strip. If there is more impression at the top or bottom of the rolls, they are not in the same plane. This means that the heating plate has warped, is worn unevenly, or the bearings are worn. In any case, the fluter should go back to the manufacturer for repair.

The rolls should ride flat on the heating plate. If the drive roll is not flat on the heating plate, loosen the collar directly above the bottom bearing housing and tap the roll lightly until it is lying flat. It may be necessary to loosen the bottom bearing also. Make this adjustment only when the fluter is up to normal operating temperature. When the roll is flat, tighten all bolts and set screws. Remove driven roll by taking out the center bolt and lifting the roll up by bolts inserted in the thread holes provided. Inspect the heating plate for wear of chrome plating. If worn, a new heating plate should be installed by the manufacturer. The roll can also be inspected for smoothness and wear on the bottom. The spring-loaded post slide can be checked for freeness of movement and lubricated with powdered graphite, if necessary. When the roll is replaced, powdered graphite should be added to the lubricating hole while the roll is turning. Graphite should be added until the grooves under the roll are completely filled. The same holds true for the drive roll.

A.2.2 *Spring force.* The bar at the front end of the heating plate (on older model fluters) which holds the spring in place can be removed and the spring taken out. By placing the spring upright in the compression tester and applying force until the gage reads 100 *N* (22.5 lb), the length of the spring at that point can be determined.

The distance from the edge of the heating plate to the base of the slide block should correspond to the spring length at 100 *N* (22.5 lb) force. Make the measurement with the driven roll in proper contact with the drive roll.

On newer model fluters the spring is under the heating plate and applies force to the roll by leverage so that the spring exerts only 50 *N* (11.25 lb) of force to give 100 *N* (22.5 lb) on the roll. This can be checked by the method above, or by pulling the roll back with another spring scale, or by pulling back with a spring scale at the point on the lever where the main spring is located.

A.2.3 *Temperature.* The temperature of the fluting rolls should be 175 ± 8°C (350°F ± 15°F), as checked by a pyrometer or thermocouple. Bring the rolls up to temperature with the cover in place. When the plate and rolls are up to temperature as indicated by the amber light going out, remove the cover and take the temperature of the rolls as near the flute tips as possible. Do this while the fluting rolls are in motion. If the temperature is not correct, adjust the thermostat to bring the rolls to the correct temperature and make a new mark at 175°C (350°F). If the temperature cannot be adjusted, check the heating element under the hot plate with a continuity tester. A new heating element may have to be installed by the manufacturer.

References

1. Long, F. D., and Maltenfort, G. G., "A New Test for Corrugating Medium," *Fibre Containers* **37** (12): (1952).
2. Long, F. D., and Maltenfort, G. G., "Some Aspects of the Concora Medium Test," *Tappi* **39** (9): 88A (1956).
3. Maltenfort, G. G., "New Model Concora Medium Fluter," *Paperboard Packaging* **46** (6): 60 (1961).
4. Long, F. D., "Automatic Concora Medium Fluter," *Paperboard Packaging **46*** (7): 56 (1961).
5. Container Laboratories, "Quality Evaluation and Research Group 1961 Clinic, Preliminary Report on Effect of New CMIT Formulas."
6. Maltenfort, G. G., "The Effect of Sample Preparation on Concora Medium Test (CMT): A Survey," *Tappi* **47** (12): 176A (1964).
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8. Gartaganis, P. A., and Ostrowski, H. "Evaluation of the Converting Efficiency of Corrugated Combined Board - Part I," *Tappi* **52** (6): 1059 (1969).

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

WI 030308.10

T 809

DRAFT NO. 1

DATE August 21, 2003

TAPPI

WORKING GROUP
CHAIRMAN to be assigned

SUBJECT
CATEGORY FISCOTEC

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.

Flat crush of corrugating medium (CMT test)

(Five-year review of T 809 om-99)

1. Scope

This method describes a procedure for measuring the crushing resistance of a laboratory fluted strip of 26 pound corrugating medium, and provides a means of estimating, in the laboratory, the potential flat crush resistance of a corrugated board. Other grades may not correlate with their potential.

2. Significance

Rigidity of the fluted structure is one of the essential characteristics of corrugated board and flat crush resistance is necessary to prevent crushing of the flute structure on the corrugator and other converting equipment. The corrugating medium test (CMT) permits the evaluation of corrugating medium before it is fabricated into combined board, and may also be used as a basis for judgment of fabrication efficiency.

3. Apparatus[1] and materials

3.1 *Medium fluter*[1], consisting of a pair of matched "A"-flute type rolls thermostatically controlled to a temperature of 175 ± 8°C (350 ± 15°F).

The dimensions of the fluting rolls are:

3.1.1 Roll face, 16.0 ± 1.0 mm.

3.1.2 Number of teeth, 84.

3.1.3 Depth of teeth, 4.75 ± 0.05 mm.

3.1.4 Roll diameter tip to tip, 228.5 ± 0.5 mm.

3.1.5 Radius of teeth at peak, 1.5 ± 0.1 mm.

3.1.6 Radius of teeth at base, 2.0 ± 0.1 mm.

3.1.7 The force between the rolls is set at 100 ± 10 *N*.

3.1.8 The speed of the fluting rolls is permanently set at 4.5 r/mm ± 1.0 r/mm.

3.2 *Rack and comb,* (see figure 1) having the following characteristics:

3.2.1 Rack, 11 teeth, 10 valleys.

3.2.1.1 Height of teeth, 4.75 ± 0.05.

3.2.1.2 Tooth spacing is 8.50 ± 0.05 mm.

3.2.1.3 Width, 19.00 - 0.0 mm.

3.2.2 Comb, number of prongs, 10.

3.2.2.1 Prong length, at least 19 mm wide.

3.2.2.2 Max. prong thickness, 3.4 ± 0.1 mm.

3.3 *Pressure sensitive tape,* at least 15 mm width.

3.4 *Specimen cutter,* a hand lever operated diecutter. The female portion is 12.7 ± 0.1 mm × 150 to 160 mm. The male die is machined to fit the female, 12.7 ± 0.1 mm × 150 to 160 mm. The cutting assembly is provided with a specimen delivery slot. The whole is enclosed in a frame to keep out dust.

3.5 *Compression testing machine*[1], in accordance with TAPPI T 811 "Rigid Support Compression Tester or Flexible Beam Compression Tester."

3.5.1 The surface of the platens shall be provided with some means to prevent slippage of the test piece during compression, for example, by means of a matt finish or being faced with crocus cloth or its equivalent and should be adhered free of ridges and maintaining parallel.

[1] Names of suppliers of testing equipment and materials for this method may be found on the Test Equipment Suppliers list in the bound set of TAPPI Test Methods, or may be available from the TAPPI Quality and Standards Department.

4. Test specimens

From each test unit accurately cut at least 10 specimens. Cut the test specimens 12.7 ± 0.1 mm × 150 to 160 mm on the die cutter. Align the longer dimension in the machine direction of the medium.

5. Conditioning

Condition the specimen strips prior to testing in an atmosphere in accordance with TAPPI T 402 "Standard Conditioning and Testing Atmospheres for Paper, Board, Pulp Handsheets and Related Products."

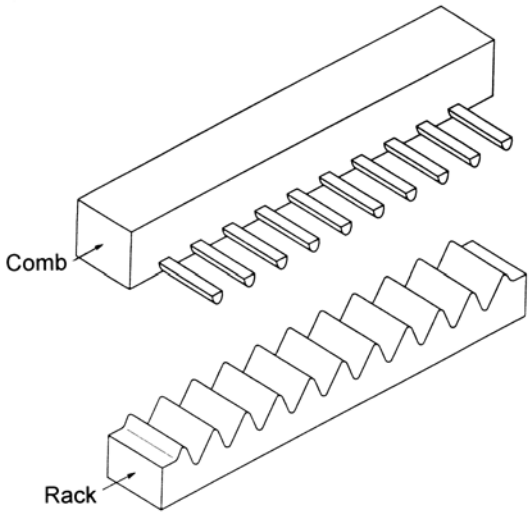

Figure 1. Drawing of rack and comb

6. Procedure

6.1 Arrange all equipment and supplies to facilitate completing operations in the specified time (see 10.4).

6.2 Perform the fluting operation only after the specimens have reached equilibrium with the specified atmosphere. Heat the fluting rolls to 175 ± 8°C (350 ± 15°F) as shown by the temperature indicator.

6.2.1 Feed the specimen into the guide slot on the left side of the fluter, so that the bottom edge of the specimen rides flat on the hot plate. Place the fluted specimen, which emerges on the other side, on the corrugated rack, so that a portion of the specimen is resting on the flat surface at each end of the rack. Place the comb over the fluted specimen, so that it is held firmly into the flutes of the rack, making certain that the specimen is bottomed uniformly in each of the flutes. Exercise care in handling the comb to avoid dropping it. A rolling motion of the comb as it is placed on the specimen aids in forming the specimen onto the rack. Holding the specimen firmly in the rack, place a 130-mm strip of at least 15 mm wide pressure sensitive tape, adhesive side down, on the exposed flute tips and stroke down firmly. (If

more than 10 flutes are formed, crush the extra flute(s)). Carefully, slip the comb out of the flutes without damage to the specimen. Then, lift the resulting 10-flute strip straight up from the rack by the edges of the tape to avoid damaging the flutes. Place the specimen on the lower platen of the compression tester, flutes facing up, and test it for flat crush, applying the force at the prescribed rate, after the platens contact the specimen. The function of the matt or crocus cloth surface on the platen is to prevent leaning failures due to slippage of the specimen.

6.2.2 Perform all of these operations using the same technique and speed for each specimen. Test the specimen immediately after fluting so that the time from complete emergence of the specimen from the fluter to the initial application of the crushing force is 5-8 s.

NOTE 1: Failure to maintain the 5-8 s range may result in low or erratic results.

7. Report

Include the following in the report: (1) the average medium flat crush [N(CMT)] value of 10 determinations, to the nearest 5 *N* (1 lbf); (2) the standard deviation of [N(CMT)] values; (3) the type of compression tester used.

8. Precision

8.1 Repeatability (within a laboratory) = 4.5%, 10 specimens/average.

8.2 Reproducibility (between laboratories) = 10.0%, 10 specimens/average, in accordance with the definitions of these terms in TAPPI T 1206 "Precision Statement for Test Methods."

8.3 These data were obtained in a round robin among 29 laboratories, using flexible beam type compression testers.

8.4 Data contained in Reports 278 and 279 of the Collaborative Reference Program for Containerboard indicate that the Rigid Platen Type Compression Testers yield results that are 1% higher than results obtained on Flexible Beam Type instruments. The results from tests on 26 lb medium were averaged using data from twenty (20) laboratories with Rigid Platen Testers and compared to data from thirty (30) laboratories with Flexible Beam Testers.

9. Keywords

Corrugating medium, Flat crush tests, Corrugated boards, Compressibility, Compression strength

10. Additional information

10.1 Effective date of issue: to be assigned.

10.2 Reflecting the number of equipment units currently in widespread use, the equipment specifications indicated are soft conversions to metric units for the prior specifications of TAPPI T 809 "Flat Crush Potential of Corrugating Medium (CMT Test)."

10.3 Table I and Table II, while not intended to be a part of the test procedure, are furnished for information and reference for facilitating the conversion of corrugating medium test results to combined board flat crush statistics, based on initial data and U. S. industry experience. In specific cases, users may wish to develop their own conversion formulas. Depending on corrugating equipment, operating practices, medium runnability quality, etc., the correlation between CMT and the flat crush values given in Tables I and II can vary considerably.

10.4 For most reliable results, the time for specimen preparation must be maintained within the 5-8 s time limit specified. This is the time interval from the discharge of the fluted specimen from the fluter to the initial application of force in the compression tester. To readily achieve this, the following suggestions have been found convenient:

10.4.1 The compression tester should be equipped with an automatic stop or limit switch to control the initial clearance between the platens to a minimum, convenient for insertion of the specimen.

10.4.2 Mount the test equipment on the laboratory bench top, so that it is in a convenient position. For a right handed tester this would be: left to right facing the equipment, fluter, comb and rack, and compression tester with approximately 250 mm (10 in.) spacing between units.

10.4.3 Precut tape strips to proper length and adhere one end lightly to edge of bench.

10.4.4 Insert medium specimen into fluter with left hand.

10.4.5 Pick up comb with left hand.

10.4.6 Remove fluted specimen from fluter with right hand and place specimen on rack.

10.4.7 Holding comb in left hand, securely position fluted medium in rack.

10.4.8 Apply tape with right hand, using thumb to crush additional flutes at each end of the 10 flute test strip.

10.4.9 Remove comb carefully from taped specimen with left hand, holding specimen in reach with right hand.

10.4.10 Use right hand to insert specimen into compression tester plates.

NOTE 2: For a left handed tester much of the above procedure would be reversed.

10.4.11 Start compression tester with left hand on switch, or use foot pedal if unit is so equipped.

10.4.12 Return compression tester platens to initial position at completion of test.

10.5 Related methods: ASTM D-2806 (technically identical); ISO 7263-1994 (E) two procedures, immediate testing (15 ± 3s after commencement of fluting), or 30 min reconditioning of fluted sample moisture content prior to compression test.

Table 1. Corrugating medium test (CMT) values (N/10 flutes) versus predicted flat crush values (kPa) (method T 808).

10 flute specimen, tested immediately after fluting. Controlled atmosphere 23 + 1.0°C (73 ± 3°F)

Predicted flat crush value Kpa				*Predicted flat crush value kPa*				*Predicted flat crush value kPa*			
CMT test N/10 flutes	*A*	*B*	*C*	*CMT test, N/10 flutes*	*A*	*B*	*C*	*CMT test N/10 flutes*	*A*	*B*	*C*
200	159	239	198	300	224	340	280	400	288	441	362
205	163	244	203	305	227	345	285	405	291	447	367
210	166	249	207	310	230	350	289	410	294	452	371
215	169	254	211	315	233	355	293	415	297	457	375
220	172	259	215	320	236	361	297	420	301	462	379
225	175	264	219	325	240	366	301	425	304	467	383
230	179	269	223	330	243	371	305	430	307	472	387
235	182	274	227	335	246	376	309	435	310	477	391
240	185	280	231	340	249	381	313	440	313	482	395
245	188	285	235	345	252	386	317	445	317	487	399
250	191	290	239	350	256	391	321	450	320	492	403
255	195	295	244	355	259	396	326	455	323	497	408
260	198	300	248	360	262	401	330	460	326	502	412
265	201	305	252	365	265	406	334	465	329	507	416
270	204	310	256	370	268	411	338	470	333	512	420
275	207	315	260	375	272	416	342	475	336	517	424
280	211	320	264	380	275	421	346	480	339	522	428
285	214	325	268	385	278	426	350	485	342	527	432
290	217	330	272	390	281	431	354	490	346	533	436
295	220	335	276	395	285	436	358	495	349	538	440

A flute:

$$FC_m = 30.93 + 0.642\ CMT_m$$

B flute:

$$FC_m = 36.66 + 1.012\ CMT_m$$

C flute:

$$FC_m = 34.475 + 0.820\ CMT_m$$

where

FC_m = flat crush value, kPa for a 64.5-cm² specimen

CMT_m = CMT test value, NC flute:

Table 2. Corrugating Medium Test (CMT) Values (lb/10 Flutes) Versus Predicted Flat Crush Values (lb 10 sq. in.) (method T 808).

10 flute sample, tested immediately after fluting. Controlled atmosphere 23 ± 1°C (73 ± 3°F)

lbf CMT test	Predicted flat crush value lb/10 sq in A	B	C	CMT test	Predicted flat crush value lb/10 sq in A	B	C	lbf CMT test	Predicted flat crush value lb/10 sq in A	B	C	lbf CMT test	Predicted flat crush value lb/10 sq in A	B	C
24	144	210	177	55	272	412	341	86	400	615	505	116	525	811	664
25	148	216	182	56	276	419	346	87	405	621	510	117	529	817	669
26	152	223	188	57	281	425	352	88	409	628	516	118	533	824	674
27	157	230	193	58	285	432	357	89	413	634	521	119	537	830	680
28	160	236	198	59	289	438	362	90	417	641	526	120	541	837	685
29	165	243	203	60	293	445	368	91	421	647	532	121	545	843	690
30	169	249	209	61	297	452	373	92	425	654	537	122	549	850	696
31	173	256	214	62	301	458	378	93	429	661	542	123	553	856	701
32	177	262	219	63	305	465	383	94	434	667	547	124	558	863	706
33	181	269	225	64	310	471	389	95	438	674	553	125	562	870	712
34	185	275	230	65	314	478	394	96	442	680	558	126	566	876	717
35	190	282	235	66	318	484	399	97	446	687	563	127	570	883	722
36	194	288	241	67	322	491	405	98	450	693	569	128	574	889	727
37	198	295	246	68	326	497	410	99	454	700	574	129	578	896	733
38	202	301	251	69	330	504	415	100	458	706	579	130	582	902	738
39	206	308	256	70	334	510	420	101	462	713	584	131	587	909	743
40	210	314	262	71	338	517	426	102	467	719	590	132	591	915	749
41	214	321	267	72	343	523	431	103	471	726	595	133	595	922	754
42	219	327	272	73	347	530	436	104	475	732	600	134	599	928	759
43	223	334	278	74	351	536	442	105	479	739	606	135	603	935	764
44	227	341	283	75	355	543	447	106	483	745	611	136	607	941	770
45	231	347	288	76	359	550	452	107	487	752	616	137	611	948	775
46	235	354	293	77	363	556	457	108	491	759	622	138	615	954	780
47	239	360	299	78	367	563	463	109	496	765	627	139	620	961	786
48	243	367	304	79	372	569	468	110	500	772	632	140	624	968	791
49	247	373	309	80	376	576	473	111	504	778	637	141	628	974	796
50	252	380	315	81	380	582	479	112	508	785	643	142	632	981	801
51	255	386	320	82	384	589	484	113	512	791	648	143	636	987	807
52	260	393	325	83	388	595	489	114	516	798	653	144	640	994	812
53	264	399	330	84	392	602	495	115	520	804	659	145	644	1000	817
54	268	406	336	85	396	608	500								

A flute-FCc = 4.486 = 0.414 CMTc, B flute-FCc = 5.317 + 0.653 CMTc, C flute-FCc = 5.00 + 0.529 CMTc where FCc = flat crush valve, lbf/in² per 10 in² specimen. CMTc = CMT test valve, lbf

Appendix A: Calibration

A.1 *Crush tester*. Calibrate the flexible beam instrument in accordance with Appendix A of TAPPI T 808 "Flat Crush Test of Corrugated Board." Calibrate the rigid support instrument in accordance with manufacturer's instructions.

A.2 *Medium fluter*

A.2.1 *Fluting rolls (Horizontal roll type).* Uniform meshing of fluting rolls can be checked by the use of National Cash Register Tape - CB white NCR paper and CR green tinted NC paper C2R. A 12.7-mm (0.5-in.)-wide strip of each type of paper is run through the fluting rolls. The pressure pattern will appear on the green tinted strip. The pressure lines should be uniform and extend the full 12.7 mm (0.5-in.) width of the strip. If there is more impression at the top or bottom of the rolls, they are not in the same plane. This means that the heating plate has warped, is worn unevenly, or the bearings are worn. In any case, the fluter should go back to the manufacturer for repair.

The rolls should ride flat on the heating plate. If the drive roll is not flat on the heating plate, loosen the collar directly above the bottom bearing housing and tap the roll lightly until it is lying flat. It may be necessary to loosen the bottom bearing also. Make this adjustment only when the fluter is up to normal operating temperature. When the roll is flat, tighten all bolts and set screws. Remove driven roll by taking out the center bolt and lifting the roll up by bolts inserted in the thread holes provided. Inspect the heating plate for wear of chrome plating. If worn, a new heating plate should be installed by the manufacturer. The roll can also be inspected for smoothness and wear on the bottom. The

spring-loaded post slide can be checked for freeness of movement and lubricated with powdered graphite, if necessary. When the roll is replaced, powdered graphite should be added to the lubricating hole while the roll is turning. Graphite should be added until the grooves under the roll are completely filled. The same holds true for the drive roll.

A.2.2 *Spring force.* The bar at the front end of the heating plate (on older model fluters) which holds the spring in place can be removed and the spring taken out. By placing the spring upright in the compression tester and applying force until the gage reads 100 *N* (22.5 lb), the length of the spring at that point can be determined.

The distance from the edge of the heating plate to the base of the slide block should correspond to the spring length at 100 *N* (22.5 lb) force. Make the measurement with the driven roll in proper contact with the drive roll.

On newer model fluters the spring is under the heating plate and applies force to the roll by leverage so that the spring exerts only 50 *N* (11.25 lb) of force to give 100 *N* (22.5 lb) on the roll. This can be checked by the method above, or by pulling the roll back with another spring scale, or by pulling back with a spring scale at the point on the lever where the main spring is located.

A.2.3 *Temperature.* The temperature of the fluting rolls should be 175 ± 8°C (350°F ± 15°F), as checked by a pyrometer or thermocouple. Bring the rolls up to temperature with the cover in place. When the plate and rolls are up to temperature as indicated by the amber light going out, remove the cover and take the temperature of the rolls as near the flute tips as possible. Do this while the fluting rolls are in motion. If the temperature is not correct, adjust the thermostat to bring the rolls to the correct temperature and make a new mark at 175°C (350°F). If the temperature cannot be adjusted, check the heating element under the hot plate with a continuity tester. A new heating element may have to be installed by the manufacturer.

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