T 804 om-06
OFFICIAL TEST METHOD – 1981
REVISED – 1989
REVISED – 1997
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Compression test of fiberboard shipping containers

1. Scope

1.1 This method is used for measuring the ability of corrugated or solid fiber shipping containers to resist external compressive forces.

1.2 The method may be applied in a number of ways. For quality studies, it is usually desirable to test the empty container. For the study of compression resistance where inner packing (corner posts, etc.) is involved, tests may be made with the interior packing in place.

1.3 If overall performance of the entire pack is to be studied, the test can be conducted with the container loaded with its contents and all inner packing. In many packs the contents and inner packing share in carrying a portion of the load.

1.4 The container may be positioned in the machine so as to test the compressive resistance in a direction that is relevant to the container's use including top-to-bottom, end-to-end, or side-to-side.

2. Summary

In essence this method describes how to determine the resistance of a fiberboard shipping container to compressive forces. This is accomplished by placing the container between two flat platens, one of which is mechanically or hydraulically driven to compress the container. A recording device is incorporated to indicate the force and deformation (deflection) required to compress the container.

3. Significance

These compressive forces are related to some of those exerted on containers in stacks or encountered in transportation. The method may be used to compare the compressive resistance of different lots of similar containers or to compare containers of different grades. It may also be used to compare the compression characteristics of containers differing in construction or design. In addition, the information gained may be used to provide an indication of the load that a particular container may be able to withstand in service.

Approved by the Standard Specific Interest Group for this Test Method
TAPPI

4. Apparatus

4.1 *Compression tester*[1], having the following:

4.1.1 Two parallel platens which move together to compress a container placed between them. The platens are of sufficient size so that the test container does not extend beyond the edges of the platens. The platens shall be flat with deviations less than ± 0.5 mm (0.020 in.) from the median plane of the platen. The platens may move no more than 1.3 mm (0.05 in.) in the directions perpendicular to the direction of compression. The platens are either held parallel throughout the test or one platen may be allowed to pivot around its center. If the platens are rigidly held they must remain parallel to within 1 mm (0.04 in.) per 305 mm (1 ft.) in the length and width directions. The fixed platen type of compression testers should be used for all refereed testing. Compression testers with floating or swivel platens provide an alternative to evaluate compression strength from a real world perspective, but may produce different compression values.

4.1.2 Means of driving the movable platen at a uniform speed of 13.0 ± 2.5 mm/min. (0.51 in./min. ± 0.1 in./min.) during the test.

4.1.3 Means of recording or indicating the applied load to within ± 1% of the measured value.

4.1.4 Means of recording or indicating the resultant deformation within ± 2.5% of the measured value or within ± 0.5 mm (0.020 in.), whichever is greater.

4.1.5 Compression testers, like all laboratory testing equipment, need to be calibrated on a regular basis. Obtain a calibration procedure from the compression tester manufacturer, which should be posted at the machine. Prior to performing compression tests for fiberboard shipping containers calibrate the compression tester according to the manufacturer's procedure.

5. Test specimens

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

5.2 Test at least five representative containers for each direction specified. Select only those containers that have not been damaged by previous handling.

6. Sealing

6.1 When this method is used as a quality control test or as a referee test, it is important that a consistent method of flap closure be used to insure consistent results in both average and variability data.

6.2 In preparation for sealing, square the box blank. Avoid distortions and "out-of-squareness," since this will affect the load-bearing ability of the containers.

6.3 The flaps may be bent directly to the sealing position or the flap scorelines may be pre-broken as follows. Bend each of the four bottom flaps backward 180° on the score line until the flap touches its side of the box. Insert a sealing board or place the box over a sealing device, whichever sealing method is used, then fold the inside flaps forward 270° to the normal closed position.

6.4 Up to the review of this test method (1988), the technique for sealing flaps has been very specific. This has consisted of water-based adhesive coverage of 100% of flap areas (more than 13 mm (0.5 in.) away from scores) and holding the flaps in contact with one another until the bond is set. For the purposes of this writing, this sealing technique will be referred to as the classical technique.

6.5 The procedure for sealing boxes according to the classical technique is outlined in Appendix A.

6.6 Other sealing techniques are acceptable.

6.6.1 In top-to-bottom testing, the primary concern is to insure that the minor and major flaps are fastened to each other by some means. The means may include hot melt adhesive, stitches or clips. The important factor is that the flaps not be allowed to freely sink into the depth of the box during the compression test.

6.6.2 The compression testing of empty boxes with unsealed flaps can be acceptable as long as it is understood that this is the procedure being used. There is evidence that the testing of empty boxes with unsealed flaps can at times

[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.

result in higher average test values than testing the same boxes with sealed flaps.

6.6.3 When testing boxes end to end or side to side, the placement of and action of the flaps during the compression test become even more critical to the average test value attained. When testing boxes end to end or side to side, one should use either the classical flap sealing technique or a technique that simulates the manner in which the flaps will be closed in actual field use.

7. Conditioning

7.1 Condition in accordance with TAPPI T 402 "Standard Conditioning and Testing Atmospheres for Paper, Board, Pulp Handsheets, and Related Products," precondition the test specimens so as to approach the equilibrium moisture content at standard conditions from a drier state and then condition for a minimum of 24 h.

NOTE 1: The criterion for the conditioning period for other than regular grade, single-wall boxes is that there should be less than a 0.1% change in their weight between successive weighings taken at intervals of at least 2 h.

7.2 If water based adhesive is used in sealing the flaps, allow the boxes to dry for 24 h after sealing to permit the adhesive to dry. The boxes should be preconditioned and conditioned to insure that the boxes have the same moisture content.

7.3 If conditioning is impractical in special instances, determine the moisture content of the boxes in accordance with TAPPI T 412 "Moisture in Paper and Paperboard" immediately after the test.

8. Procedure

8.1 Test each box in the conditioned environment. If this is not possible, test each box immediately upon removing it from the conditioned room.

8.2 Center the test container on the bottom platen of the compression machine. Adjust the load indicator to zero, i.e., counterbalance or compensate by adjustment for the gross weight of the box including the sealing board or its contents. Select the lowest load range of the machine compatible with the greatest anticipated test load. Apply a preload to the specimen (see 8.2.1) and set the deformation point to zero, or begin the deformation measurement at zero at this point. The preload ensures definite platen contact and in most instances levels off any irregularities of the box.

8.2.1 Initial preload should be 5% of the maximum compression resistance or a value agreed upon by the parties engaged in testing. Examples of preloads that been used are: (a) single-wall boxes, 223 *N* (50 lbf); (b) double-wall boxes, 446 *N* (100 lbf); (c) triple-wall boxes, 2230 *N* (500 lbf).

8.2.2 Apply the test load at a rate of 13.0 ± 2.5 mm/min. (0.51 in./min. ± 0.1 in./min.). Record the load applied and the deformation until failure of the container. Failure may be determined either by reduction in the load supported or by deformation. The typical value for a decrease in load is 10%. See 12.4 for generally used critical deformations. Take readings at each 2.5 mm (0.1 in.) deformation if a recording device is not used.

9. Report

9.1 As a minimum, report the following:

9.1.1 Dimensions of container, style, flute, flute direction, grade of material, and type of manufacturer's joint. If the container was tested with interior parts, or contents, describe these.

9.1.2 Method of closure.

9.1.3 The orientation in which the containers were tested, e.g., T-B, E-E, or S-S.

9.1.4 Number of specimens tested.

9.1.5 A graph or tabulation of the loads sustained and corresponding deformations. A summary usually consists of the average of the highest loads at or below the critical deformation, the critical deformations used, the average of maximum loads, the average of the deformation at the maximum loads, and the standard deviation (see 12.4).

9.1.6 A statement identifying the type of compression apparatus used as having fixed or floating platens.

9.1.7 A statement to the effect that all tests were made in compliance with this method including preconditioning or that the method was used with certain specific exceptions.

NOTE 2: Further desirable information in the report includes any observations that may assist in interpreting the results of the tests, such as the nature and cause of failure, any auxiliary tests made, presence of printing on the container, etc.

9.2 Report the moisture content of the container board as soon as possible after making the compression test.

10. Precision

10.1 The values for repeatability and reproducibility have been calculated from the results of a round robin which is discussed in detail in Appendix B. The average and variability data reported by each laboratory were based on 10 individual compression tests. The repeatability and reproducibility reported below were calculated for comparisons of averages of 5 compression tests. This was done since 5 tests is the most common number used in establishing the compression value of an order.

10.2 Repeatability (within a laboratory) = 7.0%.

10.3 Reproducibility (between laboratories) = 10.6%. This is true when the two laboratories use the same method of sealing the containers.

10.4 Repeatability and reproducibility represent the agreement which is expected 95% of the time when two test results are compared. Refer to TAPPI T 1200 "Interlaboratory Evaluation of Test Methods to Determine TAPPI Repeatability and Reproducibility" for complete definitions of these terms.

11. Keywords

Containers, Compression tests, Fiberboards, Compressibility, Compression strength.

12. Additional information

12.1 Effective date of issue: September 13, 2006.

12.2 This method was first published in 1945 as a Tentative Standard, became an Official Standard in 1967 and was revised in 1975.

12.3 For special purposes or studies (non-referee tests), this method may be used as described at conditions such as high humidity, low temperatures, and other specially prescribed conditions. Such special procedures used must be specifically stated in the report.

12.4 Common practice is to give particular consideration to the highest load attained up to the point of critical deformation. The critical deformation is the deformation beyond which the contents might be forced to carry a significant part of the load. The critical deformations generally used in the industry for A- or C-flute, single-wall, regular slotted containers are: (a) top-to-bottom, 19 mm (0.75 in.); (b) end-to-end, 13 mm (0.5 in.); (c) side-to-side, 13 mm (0.5 in.).

12.4.1 The maximum load and the deformation at maximum load are also recorded even if they occur above these critical deformations. Deformation is the reduction in height which the specimen undergoes, measured in terms of reduced platen separation, as measured from the preload.

12.5 Related methods: ASTM D 642 "Standard Test Method for Determining Compressive Resistance of Shipping Containers, Components, and Unit Loads," American Society for Testing and Materials, Philadelphia, PA; APPITA P 800 "Compression Resistance of Fiberboard Boxes (Cases)," Technical Association of the Australian and New Zealand Pulp and Paper Industry, Parkville, Australia.

Appendix A: Classical technique for sealing flaps

A.1 *Sealing equipment*, consists of the following:

A.1.1 A means of clamping the inner and outer flaps together, after the adhesive has been applied and the flaps have been closed, and for holding the flaps flat and in good contact.

NOTE A1: The adhesive may be any water based case-sealing glue.

A.1.2 Sealing board used for the purpose should be wooden boards thick enough to apply the sealing pressure uniformly, and with dimensions about 38 mm (1.5 in.) to a maximum of 102 mm (4 in.) smaller than the inside container, so that the board left in the container will not influence the test. See A.3 for suggested methods of clamping.

A.2 Apply a uniform film of adhesive to the inner flaps. Keep the adhesive approximately 13 mm (0.5 in.) but not more than 25 mm (1 in.) away from all the score lines. Close the outer flaps and square them, and, with the sealing equipment, apply firm pressure to assure complete and flat contact of the flaps. Do this quickly to prevent undue drying of the adhesive before contact is made. After the adhesive has been dried sufficiently to prevent disturbing the bond, remove the pressure.

A.3 When the box is to be tested empty, the flaps may be sealed by one of the following methods or an equivalent one which will ensure a firm seal without damage to the container.

A.3.1 The bottom flaps may be clamped by one of these devices:

A.3.1.1 A spring loaded bottom sealer which clamps the flaps between two flat platens.

A.3.1.2 A flat surface of a bench on which the container is placed after the bottom flaps have been closed, a board of proper size inserted inside and further by:

A.3.1.2.1 Placing a weight on the board, or

A.3.1.2.2 Hanging a weight on the board by means of a hook through a slot in the bench, or

A.3.1.2.3 Passing a long carriage bolt through a hole in the board, the flaps, and the bench, and drawing tight with a wing nut.

A.3.1.3 A sealing board on the inside and outside with a carriage bolt extended through a hole in the inside board, the flap and the outside board, drawn tight with a wing nut or toggle clamp.

A.3.2 The top flaps may be clamped as follows:

A.3.2.1 Inserting the sealing board in the container,

A.3.2.2 Inverting the container on the bench, and

A.3.2.3 Hanging a weight on the board as in A.3.1.2.2 above, or

A.3.2.4 Using a long bolt and wing nut as in A.3.1.2.3 above or

A.3.2.5 Using a sealing board outside as in A.3.1.3 above.

A.4 When the adhesive has set, release the clamping device and permit the inner sealing board to fall loose, holding the box upright so that the board falls flat and does no damage. If the box has interior dividers or contents, that are capable of supporting the inner flaps, use a board and weight to hold the top flaps in place while the glue sets.

A.5 Make sure that the sealing board is in such a position that it will not offer any support to the box during the test.

Appendix B: A discussion of the repeatability and reproducibility data

B.1 These precision data are based on tests conducted for TAPPI in 12 laboratories in 1988.

B.2 All the corrugated board in this study was taken from one position off the corrugator and was made at a constant speed over approximately a two-minute period. These sheets were run in order through a flexo folder gluer at a constant speed over about a 3-minute period. The boxes were numbered in order of production off the flexo. A random numbers table was used to select the sets of boxes for testing at each laboratory. The board used in the test was 200 pound test C-flute. The boxes were tested top to bottom.

B.3 The results for repeatability and reproducibility were compared in the following ways:

B.3.1 Only three of the 12 laboratories were equipped to run the test using the classical sealing method. These three laboratories tested groups of boxes according to the classical sealing method and the hot melt adhesive sealing method, which was the most common.

B.3.2 Seven laboratories tested using the hot melt adhesive sealing technique. Repeatability and reproducibility were determined for those 7 laboratories.

B.3.3 Repeatability and reproducibility were determined for all 12 laboratories. Methods of Sealing were: 7 - Hot Melt; 1 - PVA; 1 - Clipped; 1 - Stitched; 1 - Tape, Clipped; 1 - Bottom Stitched, Top Clipped and Taped.

B.3.4 The results:

Technique method	*Number of laboratories*	*Compression average, lbs*	*Repeatability*	*Reproducibility*
Classic	3	810	7.1%	9.3%
Hot melt	3	805	7.5%	8.5%
Hot melt	7	818	7.0%	10.6%
Results for laboratories described in B.3.3	12	840	6.5%	16.2%

Repeatability and reproducibility are for averages of 5 samples.

B.4 Reproducibility is about 10% when the two laboratories follow this procedure and use the same flap fastening method. Comparing compression averages when two different flap fastening methods have been used adds to the uncertainty of the comparison.

Appendix C

C.1 Some pieces of compression test equipment can be altered to enable the user to allow the top platen to float or to swivel. This means that the top platen is not always parallel to the bottom platen. As the test proceeds the top platen is allowed to seek the weakest point on the horizontal plane of the test surface. This is a good technique to use when seeking the weak link in a stacking pattern as might be experienced in a warehouse stacking situation.

C.2 The floating platen technique is likely to yield different test results from the fixed platen technique. If the floating platen technique is used, it should be highlighted in the test report. If the purpose of the testing being conducted is to gather quality assurance data on individual boxes or to gather comparative data for a referee situation, it is highly recommended that the fixed platen technique be used.

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