Drop test for fiberboard shipping containers
(Five-year review of Official Method T 802 om-17)
(Changes from Draft 1 incorporated)

1. Scope

1.1 This method describes procedures for determining the ability of fiberboard containers to protect their contents and/or to withstand impact in free-fall drops. These procedures are specifically designed for controlled drop testing of solid fiber or corrugated shipping containers

1.2 They do not apply to cylindrical containers or cans made of fiber.

1.3 This test is not normally used on packages heavier than 68 kg (150 lb).
NOTE 1: Heavier packages may rarely be tested, but are unwieldy and usually undergo other tests such as incline impact or rotational edge/corner/flat drops. These tests are not defined in this method.

1.4 No single procedure is applicable to all handling, transportation and environmental conditions. Alternative test procedures are available in the literature cited in the References section.

2. Summary and significance

2.1 A container, suitably identified as to its elements, is dropped from a constant, predetermined height according to an established, prescribed sequence. At the conclusion of the series of drops, the container and its contents are examined for damage.

2.2 The main objectives of drop tests are:

2.2.1 To measure the ability of the shipping container to withstand rough manual handling.

2.2.2 To measure the ability of a shipping container to withstand small parcel automatic conveyor drops (unknown orientations, and also having unknown packs of various sizes and weights falling onto the pack).

2.2.3 To measure the ability of the package (shipping container and interior packing materials) to protect the contents.

2.3 Use of these procedures permits comparing various package configurations and assists in improving design, method of packing, and blocking or bracing.

2.4 Package testing is complex. The choice of test procedures is critical to relevant package evaluation. Use care to ensure that test procedures and performance levels do not lead to either inadequate protection or less than optimum material usage. The preferred test procedure given here is only one of many that are commonly used. It is not necessarily suitable for every situation. In these instances, the tester must choose another test sequence. Some of the more common procedures are listed under Additional Information. Sources for other test procedures are listed in the References section.

3. Safety precautions

Performing drop tests sometimes requires physical handling of heavy objects. Be sure to use proper lifting techniques when handling such objects. Use a weightlifting belt or similar bracing to support your back when lifting heavy objects and/or making multiple lifts. Packages heavier than 40 lb should be handled by two or more individuals and/or the use of a mechanical lifting device. Drop testing also requires proximity to heavy falling objects. Wear safety shoes or shoe guards when conducting drop tests.
4. Definitions

4.1 The nomenclature for the elements of the most common fiberboard shipping container, the regular slotted container (RSC), is described in 4.2 and illustrated in Fig. 1. A similar nomenclature may be developed for other styles of containers.

![Diagram](image)

*Fig. 1. Identification of faces, edges, and corners.*

4.2 Make identification of the faces, edges, and corners of containers as follows (Fig. 1): Facing one end of the container with the manufacturer's joint on the observer's right, designate the top of the container as 1, the right side as 2, the bottom as 3, the left side as 4, the near end as 5, and the far end as 6. Identify the edges by the numbers of the two faces that form the edge; for example, 1-2 identifies the edge formed by the top and right side, and 2-5 the edge formed by the right side and the near end. Identify the corners by the numbers of the three faces that meet to form that corner; for example, 1-2-5 identifies the corner where the top, the right side, and the near end meet.

5. Apparatus

5.1 *Drop test equipment,* meeting the following requirements:

5.1.1 Permits the container to be placed in a position, prior to release that will ensure correct orientation, within 2° for flat-faced drops and 5° for edge and corner drops, upon impact.

5.1.2 Permits control of the drop from specified heights.

5.1.3 Utilizes lifting devices that will not damage the specimen.

5.1.4 Provides an instantaneous release mechanism that does not impart rotational or angular forces to the test package. If drop leaves are used, the apparatus shall have a spring or other mechanism so that the leaves do not interfere with a free, unobstructed fall.
5.1.5 Provides a rigid and level dropping surface (such as a concrete floor or steel plate) which is integral with a mass that shall be at least 50 times the weight of the dropping container. The dropping surface, firmly anchored to the mass, is a smooth steel plate at least 12.7 mm (approx. 0.5 in.) thick.

5.2 Two kinds of equipment meet these requirements:

5.2.1 *Dropping table*, consisting of a frame with a single or double trap door which drops vertically and folds back out of the way so that the door does not interfere with a free, unobstructed fall, the top being adjustable in height.

5.2.1.1 An alternative to the trap door dropping table is a frame with a lifting platform that rises from and falls vertically into recesses in the floor. The dropping surface is the concrete floor that surrounds the recessed area. A steel plate at least 6.3 mm (0.25 in.) thick may be placed on the lifting platform to support the container and act as the dropping surface.

5.2.2 *Hoist*, electrically or manually operated, provided with slings, quick release device, and hooks, which can suspend the box in the desired orientation and position.

6. **Sampling and test specimens**

6.1 Select at least three, but preferably five, containers as nearly as possible typical of the lot, style or construction to be evaluated, in accordance with TAPPI T 400 “Sampling and accepting a single lot of paper, paperboard, containerboard, or related product.

6.2 When evaluating the protective ability of the container, pack it with specimens of the actual material(s) or items for which the container is designed.

6.3 When evaluating the ability of the container itself to withstand rough handling, a dummy load, simulating the actual contents in weight, shape, size and resilience, may be used; however, since so many factors of a product affect its ability to withstand and transmit shock loads, use of the actual product is highly recommended. Use dummy or simulated loads only in limited circumstances.

7. **Conditioning**

7.1 Condition the specimens and test them in an atmosphere in accordance with TAPPI T 402 “Standard Conditioning and Testing Atmospheres for Paper, Board, Pulp Handsheets, and Related Products.”

**NOTE 2:** In many cases customers wish to test at ambient conditions or harsher conditions (high temperature and/or high or low humidity) and do not want their packages conditioned according to TAPPI T 402. Take the customer’s wishes into account before conditioning.

7.2 During the conditioning of empty boxes, open the flaps of one-piece boxes and separately expose the parts of boxes composed of two or more pieces. Allow the conditioning atmosphere to have free access to all the
surfaces of empty boxes or their component parts, and to all outer surfaces when filled.

7.3 Securely close and reinforce the flaps in the same manner as that used in preparing it for shipment. If an aqueous adhesive is used, recondition the box after closing.

8. Procedure

8.1 Properly position the first specimen in the drop test apparatus at the chosen height, determined as follows: The height from which containers are dropped depends upon the purpose of the test. In some instances the height and number of drops are prescribed in the specifications for the container. For end points based upon obvious damage, choose the height of drop as a height judged to be sufficient to cause failure to any of the containers of a comparison series in less than 10 falls. If the approximate drop resistance of the containers is unknown, determine this height by preliminary test. If the end point is a prescribed number of drops, then choose the height of drop by consideration of the expected shipment hazard.

8.2 Drop the specimen upon its corner, edge, or face in the following sequence:

8.2.1 A corner drop on the 2-3-5 corner, or the most fragile corner, if known.
8.2.2 An edge drop on the shortest edge radiating from that corner.
8.2.3 An edge drop on the next longer edge radiating from that corner.
8.2.4 An edge drop on the longest edge radiating from that corner.
8.2.5 A flatwise drop on one of the smallest faces.
8.2.6 A flatwise drop on the opposite smallest face.
8.2.7 A flatwise drop on one of the intermediate faces.
8.2.8 A flatwise drop on the opposite intermediate face.
8.2.9 A flatwise drop on one of the largest faces.
8.2.10 A flatwise drop on the opposite largest face.

8.3 Depending on the desired end point of the test (section 8.4), additional drop cycles may be appropriate either with a fresh specimen or continuing with the initial specimen. Start the second cycle of ten drops with a drop on the 1-4-6 corner, which is diagonally opposite to the corner on which the first drop was made, and complete in the sequence described above. Start the succeeding cycles of ten drops each at the following corners and complete in the same sequence:

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Corner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Third</td>
<td>1-2-5</td>
</tr>
<tr>
<td>Fourth</td>
<td>3-4-6</td>
</tr>
<tr>
<td>Fifth</td>
<td>3-4-5</td>
</tr>
<tr>
<td>Sixth</td>
<td>1-2-6</td>
</tr>
<tr>
<td>Seventh</td>
<td>1-4-5</td>
</tr>
<tr>
<td>Eighth</td>
<td>2-3-6</td>
</tr>
</tbody>
</table>
NOTE 3: When using a dropping table, the box may be properly oriented for corner or edge drops by balancing it on the corner or edge and by sighting down a suitably positioned plumb line.

8.4 Choice of end point. In conducting drop tests, use either of two types of end points:
8.4.1 Continue the test until obvious damage occurs, or
8.4.2 Conduct the test as a specified number of drops or cycles followed by the examination of the resulting damage to the contents or the container, depending upon which objective is being considered (see also 3.1.1 and 3.1.2)

NOTE 4: Usually, if the proper height is chosen when evaluating the ability of the container to withstand rough handling, and always when performing the prescribed number of drops to simulate expected shipment hazards, halt the drop sequence at or before completion of the first series of ten drops.

8.5 Inspect both the package and the product. Failure is evidenced either by damage to the product or by damage to the container such that it can either no longer contain or no longer afford reasonable protection to the product. Further guidance regarding failure criteria may be found in ASTM D4169, “Standard Practice for Performance Testing of Shipping Containers and Systems”.

9. Report

9.1 Report the number of drops up to the point of failure (safe drops) or, if the test is terminated prior to failure, report the number of drops made.

9.2 Include: the dimensions of the container under test; its complete structural specifications; description and specifications for blocking and cushioning, if used; spacing, size, and kind of fasteners; method of closing and reinforcing, if any; and the tare and gross weights. Additionally describe the testing environmental conditions (per 7.1 and Note 2), the contents of the container; the test equipment and special instrumentation, if used; the procedure or prescribed sequence used; the height of drop; and the number of specimens tested per sample.

9.3 The report should include a detailed record of tests on each container, including damage to the container and contents, together with any other observation which may assist in correctly interpreting the results or aid in improving the design of the container or the method of packing, blocking, or bracing. It also includes the method, if any, on conditioning the container, the moisture content if determined; and the results of supplementary tests of the materials from which the container is made; and a statement to the effect that all tests were made in full compliance with this method, and designation of procedure employed.

10. Precision

Due to the subjective and qualitative nature of this test, a precision statement is not applicable.
11. **Keywords**

Boxes, Corrugated boxes, Fiberboards, Impact tests.

12. **Additional information**

12.1 Effective date of issue: To be assigned.

12.2 Drop height is frequently chosen to simulate expected shipment hazards and is sometimes prescribed as follows:

<table>
<thead>
<tr>
<th>Weight of packaged product</th>
<th>Drop height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 9.1 kg (20 lb)</td>
<td>762 mm (30 in.)</td>
</tr>
<tr>
<td>More than 9.1 kg (20 lb), but less than or equal to 18.1 kg (40 lb)</td>
<td>610 mm (24 in.)</td>
</tr>
<tr>
<td>Greater than 18.1 kg (40 lb), but less than or equal to 27.2 kg (60 lb)</td>
<td>457 mm (18 in.)</td>
</tr>
<tr>
<td>Greater than 27.2 kg (60 lb), but less than or equal to 45.4 kg (100 lb)</td>
<td>305 mm (12 in.)</td>
</tr>
<tr>
<td>Greater than or equal to 45.4 kg (100 lb) but less than 68 kg (150 lb)</td>
<td>200 mm (8 in.)</td>
</tr>
</tbody>
</table>

**NOTE 5:** Weight is not the only determining factor for drop height; others are product value, fragility, volume, importance of reliability, image quality, mode of transport, warehousing, availability, density, and acceptable loss percentage. In addition, customer specifications may supersede all other factors.

12.3 This test best assesses the protective nature of the packaging when comparing a new or different container to a container of known performance.

12.3.1 *Comparison series.* In a comparison series where a number of different samples are to be compared, use the following procedures: test one of the specimens of the first sample, chosen at random, followed by the testing of a randomly chosen specimen of each of the other samples until one specimen from each sample has been tested. Follow the same procedure with the remaining specimens of the various samples until obvious damage occurs.

12.4 *Additional procedures.* Different procedures from those specified may be used in special circumstances for comparison of two or more packages within a laboratory or between laboratories by prior agreement. Some typical procedures are as follows.

12.4.1 *Progressive height drop test.* The procedure for the progressive height drop test consists of dropping the test package a specified number of drops (or a specified cycle) from several progressively increasing heights until the end point is reached.
12.4.1.1 Properly position the first specimen in the drop tester at the chosen first height of drop. Drop the specimen repeatedly from this height for the required number of drops or through the required cycle of drops. Then increase the height of drop by an increment previously chosen, at which height subject the same specimen to the same number of drops as given at the first height. Continue the drops or cycles at progressively increasing heights until the end point is reached.

12.4.1.2 Example: Drop the packages upon a surface for 10 consecutive drops from a height of 305 mm (12 in.) in the drop tester. Then increase the height by an increment of 76.2 mm (3 in.) to permit a height drop of 381 mm (15 in.). After ten drops at this height, increase the height by an increment of 76.2 mm (3 in.) and make 10 additional drops, etc., until obvious damage to the contents results. An alternative method is to drop the package once (instead of 10 times) from each increased height.

12.4.2 Safe drop height - infinite number of drops. This procedure consists essentially of repeated applications of the constant height drop test procedure with the difference that a different height of drop is chosen for each specimen of the sample, which height is dependent on the results of the tests of the previous specimens. The height of drop is determined which will not cause failure until the specimen package has been subjected to a very large number of drops. The data obtained in this manner are plotted on a graph with the number of drops (or cycles) to failure as the abscissa and the corresponding height of drop as the ordinate. This plot will give a curve which can be considered to approximate a hyperbola. The ordinate of the horizontal asymptote of this curve may be interpreted as representing the height of drop below which failure will not occur after an infinite number of drops. In practice, this can be estimated from inspection of the curve. This procedure may be used with many methods which have obvious damage end points.

12.4.3 Single-drop test. The single-drop test consists of finding the failure zone determined by the lowest height of drop that will cause failure in a single drop and the greatest height of drop that will not cause failure in a single drop. The average of these two heights is defined as the mean drop height of the failure zone. The safe single-drop height is the height immediately below the failure zone. This procedure may be used whenever an end point of obvious damage is applicable.

12.4.3.1 To determine the mean drop height of the failure zone and the safe single-drop height, properly position the first specimen in the drop tester at a height estimated to cause failure on the first drop. If the first specimen does not fail as a result of the drop from the selected height, drop the second specimen from an arbitrarily chosen greater height. If the second specimen fails as a result of a single drop from the greater height, select an intermediate height for the drop of the third specimen. Depending on whether the third specimen does or does not fail when dropped from the intermediate height, either decrease or increase the intermediate height for the drop of the fourth specimen. Likewise, the choice of the height of drop for each subsequent test depends on the results of the preceding drop. Thus, with a few specimens, a narrow zone of height can be established from which some specimens of a specific sample will fail while others will not fail. The width of the failure zone depends largely on the total variability. Determine the mean drop height of the failure zone by taking the average of the lowest height of drop which caused failure and the greatest height of drop which did not cause failure in single drop.

12.4.3.2 The safe single-drop height is the height immediately below the failure zone.

12.5 Dropping on only one member. In some instances, as in 12.4, a laboratory may choose to make all
drops on a single element of the container. This can be a single face, corner, or edge until failure or to complete a prescribed number of drops. Alternatively, the drops can be made on each of the faces in sequence or on the corners as follows (in this procedure, several members of the package are under test in that the package is dropped upon all corners):

12.5.1 Drop the package cornerwise in the following sequence of drops: 1-2-5, 3-4-6, 2-3-5, 1-4-6, 3-4-5, 1-2-6, 1-4-5, and 2-3-6. These eight cornerwise drops constitute one cycle.

12.6 This method was first published in 1944 as a Tentative Standard, was revised in 1967, and became an Official Method in 1975.

12.6.1 Significant changes in the 2007 revision include: an increase in the heaviest package weight from 100 to 150 lbs (45 to 68 kg); a description of an alternative to the trap door dropping table in part 5.2.1.1; and a new section 3 on safety precautions to take during testing.

12.6.2 Changes in the 2012 revision include additions to the safety precaution regarding heavy packages and clarification of the end points of the weight ranges in 12.2.


12.7.1 Shock testing machines may also be used to do similar testing.

References


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