This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: D4577 – 19 (Reapproved 2023)

Standard Test Method for Compression Resistance of a Container Under Constant Load[1]

This standard is issued under the fixed designation D4577; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method is designed to determine the resistance of a shipping container to a vertically applied constant load for either a specified time or to failure. The test method may also be used for palletized or unitized load configurations.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements, see Section 6.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D642 Test Method for Determining Compressive Resistance of Shipping Containers, Components, and Unit Loads

D685 Practice for Conditioning Paper and Paper Products for Testing

D996 Terminology of Packaging and Distribution Environments

D4332 Practice for Conditioning Containers, Packages, or Packaging Components for Testing

D4442 Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials

E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process

2.2 *TAPPI Standard*[3]

T412 Moisture in pulp, paper and paperboard

3. Terminology

3.1 *Definitions*—General definitions for the packaging and distribution environments are found in Terminology D996.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *load*—the force applied to a body, lbf or N.

3.2.2 *constant load*—a load that is invariable or unchanging

3.2.3 *static load*—an imposed stationary force, constant in magnitude, direction, and sense

4. Significance and Use

4.1 In the distribution system for many products there is a phase wherein the packaged product may be stored for a period of time in a manner such that one or more containers are superimposed one upon the other. Failure can occur in any layer[4] (see Fig. 1 and Fig. 3).

4.2 This test method subjects a container, empty or filled, to a predetermined static load, and to specified atmospheric conditions, if required.

5. Apparatus

5.1 The testing apparatus shall be capable of imposing a constant load on the test specimen and may be hydraulically, pneumatically, or mechanically activated. A test apparatus employing dead weights to impose the constant load may be used, as in Fig. 1 and Fig. 2. Compression machines may also be used, as in Fig. 3 and Fig. 4, and shall contain two platens, or suitable framework and fixturing, one stationary and one movable in the vertical direction. The movable platen may be swiveled (floating) or fixed and should have proper mechanical, pneumatic, or hydraulic linkages to permit top-to-bottom loading. If the floor where the test is to be conducted is subject to severe vibration, it may be necessary to vibration-isolate the test apparatus. The test device should have a timer

[1] This test method is under the jurisdiction of ASTM Committee D10 on Packaging and is the direct responsibility of Subcommittee D10.21 on Shipping Containers and Systems - Application of Performance Test Methods.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from Technical Association of the Pulp and Paper Industry (TAPPI), 15 Technology Parkway South, Norcross, GA 30092, http://www.tappi.org.

[4] Frank, B., Gilgenbach, M., and Maltenfort, M., "Compression Testing to Simulate Real-World Stresses," *Packaging Technology and Science*, 2010; 23: 275-282.

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FIG. 1 Containers Under Constant Load of Dead Weights Imposed by Other Containers

for measuring the period of time required to cause container failure and means such as a dial indicator to measure box deformation (inches or millimetres) while under load, or an autographic recording device that records load and deformation over a period of time.

5.2 *Closing Equipment for Fiberboard Boxes*—When empty boxes are to be tested, suitable closing facilities such as sealing boards and proper adhesive for closing the flaps of box specimens shall be used. See Test Method D642.

5.3 *Conditioning Apparatus*—Adequate facilities shall be provided to maintain a conditioned atmosphere of temperature and humidity as required for the purpose of the test.

5.4 *Miscellaneous Equipment*—Drying oven, scales, knife, saws, etc., for use in determination of the moisture content or for making other supplementary tests of the materials from which the containers are made. When testing unit loads, it is recommended that an empty pallet be placed on top of the unit load test specimen to achieve conditions similar to actual use.

6. Safety Precautions

6.1 Performance of a test should never be considered without regard to safety. Some apparent precautions against injuries are:

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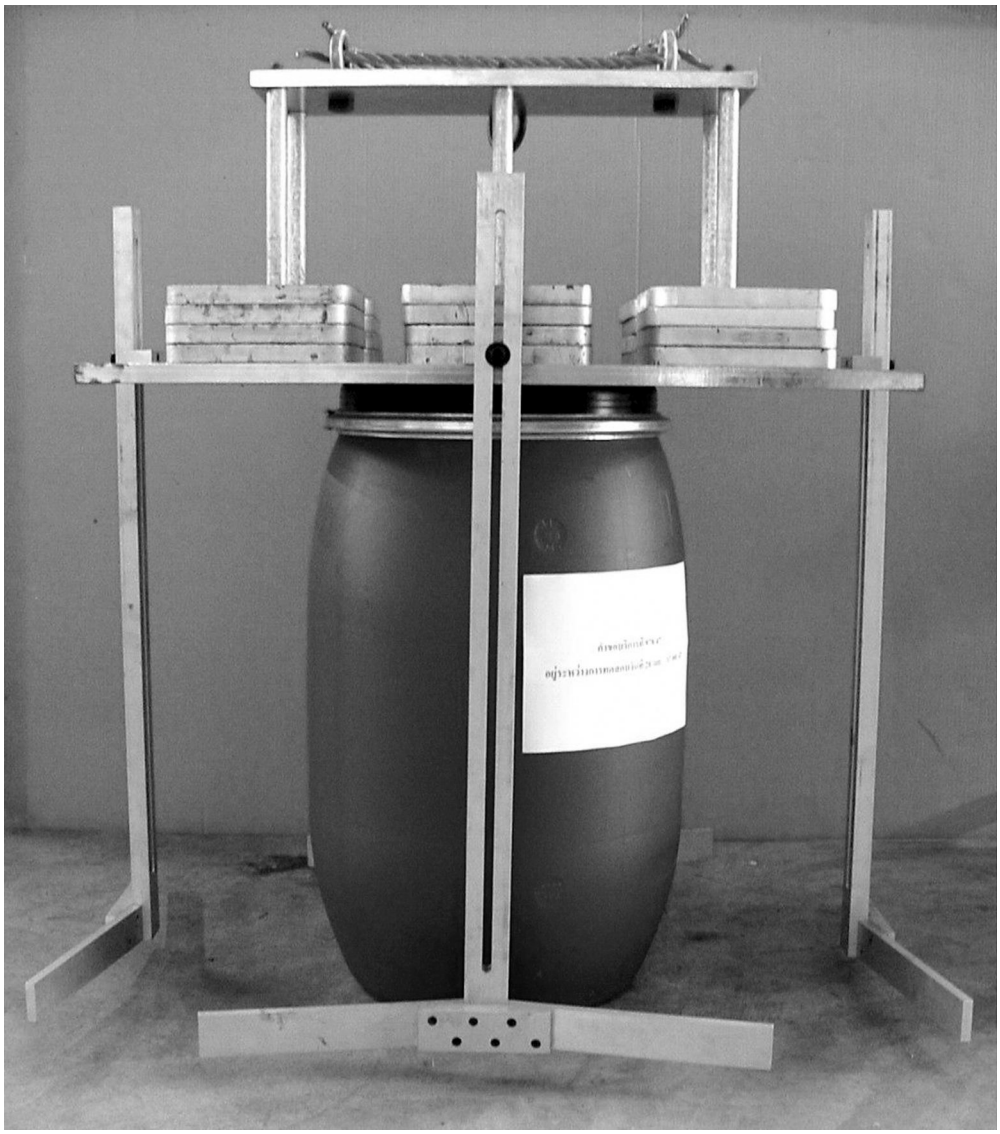

FIG. 2 Container Under Constant Load of Dead Weights

6.1.1 Care and caution should be observed while placing the shipping container filled or unfilled on the testing apparatus.

6.1.2 The testing apparatus should have load arrestors or safety interlocks to prevent complete crushing of the container after initial failure.

6.1.3 When using dead weights, caution should be taken when loading and unloading the weights from the apparatus.

7. Test Specimens and Number of Tests

7.1 The containers being tested shall be complete in all respects. Depending on the purpose of the test, interior packing may or may not be included. No related bracing material within the boxes that will give false results as to sample behavior shall be used. Tests may be made on containers with or without contents as prescribed. Packed containers should be closed and secured in the same manner as will be used in preparing them for shipment (for example, tape, strapping).

7.2 Performance normally should be based on tests of not fewer than five representative replicates of a given size and type of container. For large production runs, lot sampling is advised. Application of Practice E122 is suggested.

7.3 For testing unitized loads, multiple unitized load specimens are recommended but a single unitized load specimen is permissible.

8. Closing Fiberboard Containers Using Adhesive

8.1 Close the box specimen so as to avoid distortions that may affect its loadbearing ability. The method of preparing the test specimen as described in the Annex of Test Method D642 will accomplish this, but any method that will produce the same results may be used.

9. Conditioning

9.1 When required, the container should be conditioned for the static load test by exposure to fixed or controlled variable conditions of temperature and humidity.

9.1.1 Where applicable, a special atmosphere selected from those specified in Practice D4332 may be used.

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