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Standard Test Methods for Transmitted Shock Characteristics of Foam-in-Place Cushioning Materials[1]

This standard is issued under the fixed designation D 4168; 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.

ϵ^1 NOTE—Sections 2 and 3.1 were updated editorially in April 2008.

1. Scope

1.1 These test methods determine the shock-absorbing characteristics of foam-in-place packaging materials.

1.2 *Test Method A* uses a free-fall package drop test apparatus.

1.3 *Test Method B* uses a shock-test apparatus.

~~1.4~~

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.5 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ~~*ASTM Standards:*~~

~~D996Terminology of Packaging and Distribution Environments~~

~~D1596Test Method for Dynamic Shock Cushioning Characteristics of Packaging Material~~ ASTM Standards: [2]

D 996 Terminology of Packaging and Distribution Environments

D 3332 Test Methods for Mechanical-Shock Fragility of Products, Using Shock Machines

~~D4332Practice for Conditioning Containers, Packages, or Packaging Components for Testing~~

D 5276 Test Method for Drop Test of Loaded Containers by Free Fall

D 5487~~Test Method for Simulated Drop of Loaded Containers by Shock Machines~~

~~E122Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process~~ Test Method for Simulated Drop of Loaded Containers by Shock Machines

3. Terminology

~~3.1*Definitions:*~~

~~3.1.1~~

3.1 General definitions for packaging and distribution environments are found in Terminology D 996.

3.2 *Definitions:*

3.2.1 *acceleration*—the rate of change of velocity of a body with respect to time, measured in inches per second per second (metres per second per second).

~~3.1.2~~

3.2.2 *velocity*—the rate of change of position of a body in a specified direction with respect to time, measured in inches per second (metres per second).

~~3.2~~3.3 *Definitions of Terms Specific to This Standard:*

~~3.2.1~~3.3.1 *equivalent free-fall height*—the calculated height of free fall in a vacuum required for a falling body to attain a measured or given impact velocity.

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[1] These test methods are under the jurisdiction of ASTM Committee D10 on Packaging and are the direct responsibility of Subcommittee D10.13 on Interior Packaging.

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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.

~~3.2.2~~

3.3.2 *foam-in-place cushioning material*—a material that is formed by dispensing chemical components which react and expand to produce a foam cushioning material in a container or mold.

~~3.2.3~~

3.3.3 *free rise core density*—the density of a foam sample taken from the interior of a bun of foam (without skin) that was produced under unrestricted (free-rise) conditions in pounds per cubic foot (kilograms per cubic metre).

~~3.2.4~~

3.3.4 *static loading*—the applied mass in pounds (kilograms) divided by the area, measured in square inches (square metres) to which the mass is applied in pounds per squares inches (kilograms per square metre).

~~3.2.5~~

3.3.5 *velocity change*—the sum of the impact velocity and any rebound velocity.

~~3.3~~

3.4 *Symbols:Symbols*:

~~3.3.1~~

3.4.1 *g*—symbol for the acceleration due to the effects of the earth's gravitational pull. While somewhat variable, it is usually considered a constant of value 386 in./s/s (9.8 m/s/s).

4. Summary of Test Methods

4.1 The test methods consist of using the cushioning material to be tested to support a weighted test block inside a package. The complete package is subjected to drops or controlled shocks and the accelerations transmitted to the test block are measured.

4.2 Either Test Method A or B may be used. However, the two methods will not necessarily give the same result.

5. Significance and Use

5.1 Data obtained by these methods may be used to determine the transmitted shock cushioning characteristics of foam-in-place packaging materials. These data allow design of cushioning systems that can provide adequate and efficient use of foam for protection of goods during a distribution life-cycle.

5.2 These methods, in contrast to other methods that usually test only the cushioning foam, are designed to evaluate foam-in-place cushioning materials in a manner in which the foam-in-place packaging material is used. In particular, the method includes simultaneous use of a plastic film, the foam, and the box usually used in this method of packaging. See Fig. 1.

6. Apparatus

6.1 *Test Method A*:

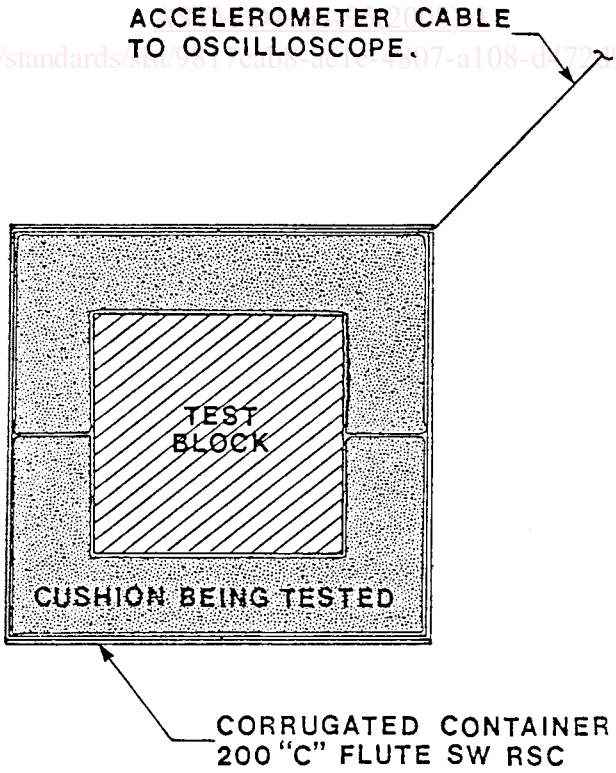

FIG. 1 Specimen Ready For Test

6.1.1 The free-fall drop test apparatus shall conform to the requirements as described in Test Method D 5276.

6.2 *Test Method B*:

6.2.1 The shock test apparatus shall conform to the requirements as described in Test Method D 5487.

6.3 *Instrumention and Shock Sensors* —Accelerometers, signal conditioners, and data storage apparatus are required to monitor acceleration versus time histories at various points on the test apparatus and test specimen. The instrumentation systems shall have the following minimum properties:

6.3.1 Frequency response range from 2 Hz or less to at least 1000 Hz.

6.3.2 Accuracy of reading to be within ±5 % of the actual value.

6.3.3 Cross-axis sensitivity less than 5 % of full scale.

6.4 *Test Block*:

6.4.1 The test block shall have a rigid square bottom face of not less than 8 in. (203 mm) on a side. Its height shall be a minimum of half the bottom square dimension and a maximum of the full bottom square dimension.

6.4.2 The test block shall include provisions for firmly mounting ballast weight to adjust its total weight to a desired value.

6.4.3 An accelerometer mounting attachment shall be provided near the center of gravity of the block. The block shall be designed and constructed to be as rigid as possible and to minimize motion of the various components.

6.4.4 A recommended configuration is shown in Fig. 2. Also, it is suggested that the box weight be evenly distributed about the center of the bottom face of the test block.

6.4.5 Ballast weights are added or removed to achieve the desired static loading on the cushioning material. The accelerometer shall be considered as a portion of the ballast weight.

6.5 *Outer Container*, shall be a regular, slotted container (RSC) corrugated box fabricated with 200 psi (1380 kPa) test "C" flute fiberboard.

7. Sampling

7.1 Because users form their own cushioning materials, it is very important that accurate records be prepared of all physical data pertaining to those materials for later identification. In addition, the specific characteristics of the film used with the cushion shall be recorded. Care must be taken to ensure that samples are of representative quality. It is recommended that all samples be allowed to cure and stabilize after being poured for a minimum period of 24 h before they are tested.

7.2 *Specimens*—If any of the requirements of Sections 7 and 8 are not met, the container and cushioning material shall be discarded and the procedure repeated with new material. Fig. 1 shows a typical specimen assembled and ready for test.

8. Preparation of Test Specimens

8.1 *Modified Free-Rise Bottom Cushion Fabrication (Option 1)*:

8.1.1 Dispense a layer of the foam-in-place cushioning material into the bottom of the box. Place the barrier film over the foam; then position the test block such that the foam will rise to a depth equal to the thickness to be tested. Alternatively, a dummy test block jig referenced to the top of the box may be used to ensure the correct position of the test block. The sides of the foam cushion

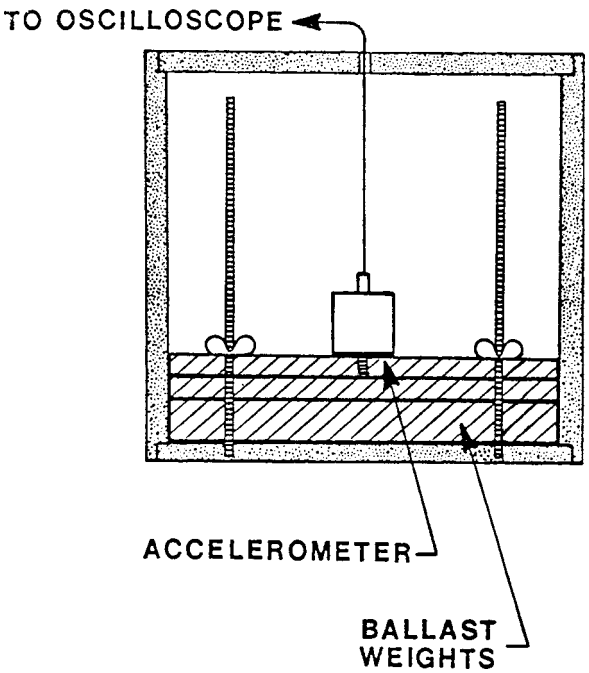

FIG. 2 Test Block