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Standard Test Method for Bulk Density And Specific Gravity of Plastic Lumber and Shapes by Displacement[1]

This standard is issued under the fixed designation D 6111; 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 covers the determination of the bulk density and specific gravity of plastic lumber and shapes in their "as manufactured" form. As such, this is a test method for evaluating the properties of plastic lumber or shapes as a product and not a material property test method.

1.2 This test method is suitable for determining the bulk specific gravity or bulk density by immersion of the entire item or a representative cross section in water. This test method involves the weighing of a one piece specimen in water, using a sinker with plastics that are lighter than water. This test method is suitable for products that are wet by, but otherwise not affected by water for the duration of the test.

1.3 Plastic lumber and plastic shapes are currently made predominately from recycled plastics. However, this test method would also be applicable to similar manufactured plastic products made from virgin resins where the product is non-homogeneous in the cross-section.

1.4 The values stated in SI units are to be regarded as ~~the~~ 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.*

NOTE ~~1—There is no similar or equivalent ISO standard.~~ 1—There is no known ISO equivalent to this test method.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D 618 Practice for Conditioning Plastics for Testing
D 883 Terminology Relating to Plastics
D 1622 Test Method for Apparent Density of Rigid Cellular Plastics
D 1898 Practice for Sampling of Plastics[3]
D 5033 Guide for ~~the~~ Development of ASTM Standards Relating to ~~the Proper~~ Recycling and Use of Recycled Plastics
D 6108 Test Method for Compressive Properties of Plastic Lumber and Shapes
E 1 Specification for ASTM Liquid-in-Glass Thermometers
E 12 Terminology Relating to Density and Specific Gravity of Solids, Liquids, and Gases[0]
E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 *Definitions:*

3.1.1 *density, bulk*—the weight per unit volume of a material including voids inherent in material as tested. (See Terminology D 883.)

3.1.1.1 *Discussion*—Specific gravity at 23/23°C can be converted to density 23°C, g/cm^3, as follows:

$$D^{23C}, \text{g/cm}^3 = \text{sp gr } 23/23°\text{C} \times 0.9976 \quad (1)$$

3.1.2 *plastic lumber*, *n*—a manufactured product composed of more than 50 weight percent resin, and in which the product generally is rectangular in cross-section and typically supplied in board and dimensional lumber sizes, may be filled or unfilled,

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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* ~~, Vol 08.01,~~ volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Withdrawn.

***A Summary of Changes section appears at the end of this standard.**

and may be composed of single or multiple resin blends.

3.1.3 *plastic shape*, *n*—a manufactured product composed of more than 50 weight percent resin, and in which the product generally is not rectangular in cross-section, may be filled or unfilled, and may be composed of single or multiple resin blends.

3.1.4 *resin*, *n*—a solid or pseudosolid organic material often of high molecular weight, which exhibits a tendency to flow when subjected to stress, usually has a softening or melting range, and usually fractures conchoidally. (See Terminology D 883.)

3.1.4.1 *Discussion*—In a broad sense, the term is used to designate any polymer that is a basic material for plastics.

3.1.5 *specific gravity, bulk (of solids)*—the ratio of the weight in air of a unit volume of a permeable material (including both permeable and impermeable voids normal to the material) at a stated temperature to the weight in air of equal density of an equal volume of gas-free distilled water at a stated temperature. The form of expression shall be the following:

$$\text{bulk specific gravity } x/y°\text{C} \quad (2)$$

where:

x = temperature of the material, and

y = temperature of the water.

3.1.5.1 *Discussion*—The accuracy of bulk density determinations is so low that corrections for air buoyancy and variations in the value for the acceleration of gravity are not warranted. Hence, this definition is based on weights in air. (See Terminology E 12.)

3.2 Additional definition of terms applying to this test method appear in Terminology D 883 and Guide D 5033.

4. Summary of Test Method

4.1 Determine the weight of a specimen of the plastic lumber or shape in air. The specimen is then immersed in water, its weight upon immersion is determined, and its bulk specific gravity calculated.

5. Significance and Use

5.1 The specific gravity or density of a solid is a property that can be measured conveniently to follow physical changes in a sample, to indicate degree of uniformity among different sampling units or specimens, or to indicate the average density of a large item.

5.2 ~~V~~It is possible that variations in density of a particular plastic lumber or shapes specimen ~~may~~will be due to changes in crystallinity, loss of plasticizer/solvent content, differences in degree of foaming, or to other causes. ~~Portions~~ It is possible that portions of a sample ~~may~~will differ in density because of difference in crystallinity, thermal history, porosity, and composition (types or proportions of resin, plasticizer, pigment, or filler).

NOTE 2—Reference is made to Test Method D 1622.

5.3 Density is useful for calculating strength to weight and cost to weight ratios.

5.4 If the cross-sectional area of the specimen is required for future testing on a particular sample, it ~~may be determined~~ is acceptable to determine it from a specific gravity measurement, see ~~Note 10 (Eq 5).~~ Eq 5.

6. Apparatus

6.1 *Balance*—A balance large enough to accommodate the specimen conveniently, with a precision within 1.0 mg, accuracy within 0.05 % relative (that is 0.05 % of the weight of the specimen in air), and equipped with a means of support for the immersion cage. ~~Note3—Assurance that the balance meets the performance requirements should be provided by frequent checks on adjustments of zero point and sensitivity and by periodic calibration for absolute accuracy, using standard masses.~~

6.1.1 Calibrate the balance at least annually in accordance with the manufacturer's instructions for zero point, sensitivity, and absolute accuracy.

6.2 *Immersion Cage:*

6.2.1 *Wire*—A corrosion-resistant wire for suspending the cage.

6.2.2 *Cage*—A device large enough to support the bottom of the specimen and when weighted will transfer the sinker force to the specimen to keep it from floating. Refer to the sample immersion cage diagrammed in Fig. 1.

6.2.3 *Sinker*—A sinker for use with specimens of plastics that have specific gravities less than 1.000. The sinker shall: be corrosion-resistant; have a specific gravity of not less than 7.0; have smooth surfaces and a regular shape; and be slightly heavier than necessary to sink the ~~specimen, and should~~specimen. It is important that the sinker be easily attached to the cage.

6.3 *Immersion Vessel*—A beaker, bucket, or other wide-mouthed vessel for holding the water and immersed cage.

6.4 *Thermometer*—A thermometer having not fewer than four divisions per °C over a temperature range of not less than 5°C above and below the standard temperature, and having an ice point for calibration. A thermometer short enough to be handled inside the balance case will be found convenient. ASTM Thermometer 23C (see Specification E 1) and Anschütz-type thermometers have been found satisfactory for this purpose.

7. Materials

7.1 *Water*—The water shall be distilled, deionized, or demineralized.

8. Sampling

8.1 The sampling units used for the determination of specific gravity shall be representative of the quantity of product for which

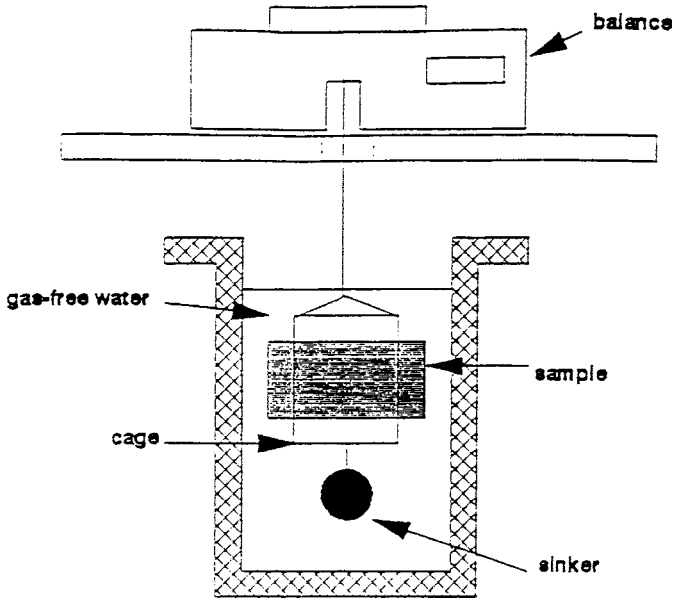

FIG. 1 Typical Configuration of Test Apparatus

the data are required, in accordance with Practice D 1898.

8.2 Plastic lumber and shapes are typically foamed, layered or hollow, varying in material properties over the cross section. To establish the overall specific gravity for a section, complete unmachined elements or representative cross sections of these elements shall be used.

9. Test Specimens

9.1 Test specimens for determining the bulk specific gravity or bulk density of plastic lumber and shapes shall be cut from the "as manufactured" profile. Plastic lumber is generally non-uniform through the cross-section; no machining operations other than those required to provide flat, parallel ends shall be conducted. Care must be taken in cutting specimens to avoid changes in density resulting from compressive stresses or frictional heating.

9.2 The standard test specimen shall be in the form of a right cylinder or prism where height is twice its minimum cross-section or diameter.

NOTE ~~4—Expect~~ 3—Expect for specified tolerances, the specimen requirements given in 9.1 and 9.2 above are the same for Test Method D 6108. ~~Specimens~~ It is acceptable, therefore, to use specimens prepared in accordance with Test Method D 6108 ~~may, therefore, be used~~ to determine bulk specific gravity or density prior to being subjected to the destructive compression tests.

~~9.3In such cases where~~ 9.3 When the cross section of the ~~cross section~~ material being tested is known or suspected to be porous, hollow, or contain voids, or both, seal the cut ends ~~should be sealed~~ to prevent ~~the~~ ingress of water from producing false results. ~~Note5—Nominal 0.05 mm thick, unreinforced plastic packaging tape~~

9.3.1 Unreinforced plastic packaging tape that is nominally 0.05 mm in thickness has been found suitable for sealing the cut ends. ~~Considering~~Because the weight of the tape is small compared to the weight of the ~~specimen, as well as the relative density~~ specimens, use of the ~~tape, use of this~~ plastic tape ~~to seal the cut ends~~ will have a negligible effect on the final density and specific gravity calculations. Use of a different type of tape or any other method to seal the cut ends ~~may, however,~~will require correction factors for accurate results.

9.4 The specimen shall be free from oil, grease, and other foreign matter.

10. Conditioning

10.1 *Conditioning*—Unless otherwise specified by the customer or product specifications, condition the test specimens at 23 ± 2°C and 50 ± 5 % relative humidity for not less than 40 hours prior to test in accordance with Procedure A of Practice D 618. In cases of disagreement, the tolerances shall be ±1°C and ±2 % relative humidity.

10.2 *Test Conditions*—Unless otherwise specified by the customer or product specification, conduct tests in the standard laboratory atmosphere of 23 ± 2°C and 50 ± 5 % relative humidity. In cases of disagreement, the tolerances shall be ±1°C and ±2 % relative humidity.

11. Procedure

11.1 Weigh the specimen in air to the nearest 1.0 mg. Record this as *a*, the weight of the specimen in air. ~~Note6—The specimen may be weighed in air after hanging from the wire. In this case, record the weight of the specimen,~~