



Designation: D2395 – 17 (Reapproved 2022)

Standard Test Methods for Density and Specific Gravity (Relative Density) of Wood and Wood-Based Materials¹

This standard is issued under the fixed designation D2395; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 These test methods cover the determination of the density and specific gravity (relative density) of wood and wood-based materials to generally desired degrees of accuracy and for specimens of different sizes, shapes, and moisture content conditions. The test method title is indicative of the procedures used or the specific area of use.

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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.*

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

[D9 Terminology Relating to Wood and Wood-Based Products](#)

[D2555 Practice for Establishing Clear Wood Strength Values](#)

¹ These test methods are under the jurisdiction of ASTM Committee D07 on Wood and are the direct responsibility of Subcommittee D07.01 on Fundamental Test Methods and Properties.

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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.

[D4442 Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials](#)

[D5456 Specification for Evaluation of Structural Composite Lumber Products](#)

[D7438 Practice for Field Calibration and Application of Hand-Held Moisture Meters](#)

[E1547 Terminology Relating to Industrial and Specialty Chemicals](#)

2.2 Other Standards:

[CAN/CSA O86 Engineering Design in Wood](#)³

[ANSI/AWC National Design Specification for Wood Construction](#)⁴

3. Terminology

3.1 Definitions:

3.1.1 For definitions of terms used in this standard, refer to Terminology [D9](#).

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *density*, ρ [kg/m^3 , g/cm^3 or lb/ft^3], n —mass of a unit volume of a specimen at specified moisture content.

NOTE 1—The moisture content is specified for both mass and volume. For further discussion, see [Appendix X3](#).

3.2.1.1 *density at moisture content M*—density based on the mass of a specimen including moisture and its volume at the same moisture content.

NOTE 2—The mass and volume at 12 % moisture content are frequently used.

3.2.1.2 *density, basic or conventional*, ρ_b —density based on the oven-dry mass of a specimen and its green volume.

3.2.1.3 *density, oven-dry or in the absolute dry condition*, ρ_o —density based on the oven-dry mass of a specimen and its oven-dry volume.

3.2.2 *green volume*, n —volume of wood specimen before any shrinkage occurs due to drying to moisture content below the fiber saturation point (about 30 %).

³ Available from CSA Group, 5060 Spectrum Way, Mississauga, ON L4W 5N6, Canada, <http://www.csa.ca>.

⁴ Available from American Wood Council (AWC) 222 Catocin Circle, SE, Suite 201 Leesburg, VA 20175, www.awc.org.

NOTE 3—Green volume may also be obtained by water soaking of partially dry wood specimens until they reach fully swollen condition above the fiber saturation point (for example, see 13.2.3.1). The fiber saturation point of wood averages approximately 30% moisture content, but in individual species and individual pieces of wood it can vary by several percentage points from that value. For further discussion, see Appendix X3.

3.2.3 *moisture content, M [%]*—amount of water contained in a specimen, expressed as a percentage of its oven-dry mass.

3.2.4 *specific gravity (relative density), S , n* —ratio of the oven-dry mass of a specimen to the mass of a volume of water equal to the volume of the specimen at a specified moisture content.

NOTE 4—The volume may be that in the oven-dry, partially dry, or green (fully swollen) condition. Further in this standard, the terms specific gravity and relative density are used interchangeably. For further discussion, see Appendix X3.

3.2.4.1 *specific gravity at moisture content M , n* —specific gravity based on the oven-dry mass of a specimen and its volume at a specified moisture content between the oven-dry condition and the fiber saturation point.

NOTE 5—The volume at 12 % moisture content is frequently used.

3.2.4.2 *specific gravity, basic (or green), S_b , n* —specific gravity based on the oven-dry mass of a specimen and its green volume.

3.2.4.3 *specific gravity, oven-dry or on oven-dry basis, S_0 , n* —specific gravity based on the oven-dry mass of a specimen and its oven-dry volume.

4. Summary of Test Methods

4.1 The precision of test results obtained on a representative specimen depends upon the precision of the measurements made. Test Method A is used for precise measurements when the specimens are carefully prepared and regular in shape. Test Method B is used for precise measurements if the specimens are irregularly shaped and if due care is taken to prevent sorption of water. Test Method C is an approximate test method that is permitted for use as part of a production procedure or in other situations where less precision is acceptable. Test Methods D and E are especially adapted to density or specific gravity measurements of living trees or of in-place elements, and the precision of the result is dependent upon the care used in obtaining the specimen. Test Method F is a specific procedure for wood chips. Test Method G provides a procedure to estimate the overall density or specific gravity of a full-size rectangular member that includes typical growth and manufacturing characteristics.

5. Significance and Use

5.1 Density and specific gravity are cornerstone terms that help define many useful properties of wood and wood-based materials. These terms designate concepts that have distinct definitions though they relate to the same characteristic (mass in a unit volume). Generally, in the US and Canada, density of wood is measured in terms of *specific gravity*, or *relative density*. In the wood-based composites industry and internationally the term density is often preferred.

5.2 The *basic density* and *basic specific gravity* of wood are used in the forestry industry for calculating the oven-dry weight of wood fiber contained in a known wood volume of various wood species. Thus, it serves as an indicator of the amount of wood pulp that could be produced, the workability of the material or its shipping weight. This information is referenced in various resources, including Wood Handbook.⁵ Note that specific gravity varies within a tree, between trees, and between species. Since the specific gravity of wood cell wall substance is practically constant for all species (approximately 1.53), it is apparent that individual specific gravity value is indicative of the amount of wood cell wall substance present. It affords a rapid and valuable test method for selection of wood for specific uses. In US and Canadian building codes, the *oven-dry specific gravity* is correlated to various strength characteristics of wood products (for example, compression perpendicular to grain, shear strength and fastener holding capacity).

5.3 It is often desirable to know the density or specific gravity of a living tree, a structural member already in place, a log cross section, a segment of a research element, or the earlywood or latewood layer. Therefore, it is possible that specimens will be large or small, regular or irregular in shape, and at a variety of moisture contents. These test methods give procedures that include all of these variables and provides for calculation of density and specific gravity values to degrees of precision generally needed.

5.4 In the wood-based composites industry, the product density or specific gravity also provides an important indicator of potential product attributes. For wood-based materials, the same test methods are used; however, the measurements typically combine the mass from the wood substance with any resin, wax, or other solid additives present in the material. These properties are not to be confused with *equivalent specific gravity* of structural composite lumber used to characterize its fastener-holding capacity determined in accordance with Specification D5456.

6. Test Specimens

6.1 The test specimens shall be fully representative of the material from which they are taken. The specimen size shall be such that accurate measurements of mass and volume are easy to attain. Where other standards specify the location and size of test specimens, these requirements shall be carefully followed. With the exception of Test Method G, the specimens shall be carefully cut from the larger element to ensure clean-cut surfaces. All loose fibers shall be carefully removed before the specimen is weighed and measured. The specimen shall be free from knots, and if pitch or other infiltrates are present, this shall be noted in the report or they shall be extracted before taking measurements and weighing. The specimens for Test Method G shall be full-size rectangular members. When Test Method G is used with solid wood lumber, the specimens shall be permitted to include knots, wane, edge easing, pitch, or other typical growth or manufacturing characteristics.

⁵ Forest Products Laboratory General Technical Report FPL-GTR-190, *Wood Handbook: Wood as Engineering Material*, Forest Products Society, 2010.

6.2 Measurements—The dimensions of test specimens shall be measured to a precision of $\pm 0.3\%$ or less, and the mass shall be determined to a precision of $\pm 0.2\%$ or less. Where drying of specimens is required, this shall be done in a forced convection oven that can be maintained at $103\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ throughout the drying chamber for the time required to dry the specimen to reach practical equilibrium. The oven shall be vented to allow the evaporated moisture to escape.

NOTE 6—For most specimens of wood and structural composite lumber 1 in. (25 mm) in length parallel to grain, drying for 24 h in an oven having good air circulation and exchange will be sufficient to reach practical equilibrium (no more than 0.2% mass change over 8 h period of drying). For other wood-based materials, the drying time should be established by test. For further discussion, see [Appendix X3](#).

7. Moisture Content

7.1 The moisture content (M) of the specimens shall be measured to identify the basis on which the density or specific gravity is determined. The method of determination of the moisture content depends on the size of the specimen and the purpose of the test.

7.1.1 Oven Drying—The moisture content shall be determined using the oven-dry procedures of Test Method [D4442](#). With small specimens of convenient size that can be oven-dried within a reasonable timeframe, the entire piece shall be used for the moisture content determination. With larger specimens that cannot be conveniently oven-dried, at least one representative segment shall be cut from the full-size specimen for the moisture content determination. In this case, the moisture content specimens shall be as large as can be practically dried in a reasonable timeframe and cut away from the member ends, wherever possible.

7.1.2 Moisture Meter—Where a large solid wood specimen cannot be cut to secure a moisture content segment for oven drying, an approximate moisture content shall be permitted to be obtained through the use of a moisture meter in accordance with Practice [D7438](#). The meter readings shall be corrected for temperature and species. The use of moisture meters shall not be permitted for materials other than solid wood.

NOTE 7—Since the moisture content value obtained with moisture meter is approximate, it should be recognized that the density and specific gravity values obtained using this method are approximate. To improve accuracy, the oven-drying method of moisture content determination should be used whenever possible.

8. Test Method A—Volume by Measurement

8.1 Applicability:

8.1.1 This procedure is adaptable to any size of clear wood specimen at any moisture content. The specimen shall be regular in shape with right-angle corners for determination of volume by linear measurement. If the surfaces of the specimen are smooth and sufficient measurements are taken, the volume can be obtained with high precision. Special care shall be taken in measurement of very small or thin specimens. Volume of irregular or rough-surfaced specimens shall be obtained by Test Method B.

8.2 Procedures:

8.2.1 Volume—Measure the length, width, and thickness of the specimen in accordance with [6.2](#) in a sufficient number of places to ensure a precise indication of volume.

8.2.2 Initial Mass, (m_M)—Determine the initial mass of the specimen at the time of test in accordance with [6.2](#).

8.2.3 Oven-dry Mass (m_o)—Oven-dry mass of the specimen shall be determined by drying to practical equilibrium in accordance with [6.2](#) or by calculation in accordance with [15.1.2](#) if a moisture meter is used ([7.1.2](#)).

8.2.4 Moisture Content—Determine the moisture content (M) of the specimen in accordance with [7.1](#).

9. Test Method B—Volume by Water Immersion

9.1 Applicability:

9.1.1 This procedure is particularly adaptable to clear wood specimens of irregular shape or having a rough surface.

NOTE 8—Limitations on specimen size are based primarily on size of immersion tanks available. In small size specimens, less than 1 cm^3 in volume, air bubbles adhering to the specimen surface can result in considerable error in volume measurement and thus in the computed density or specific gravity value. Freshly cut green wood will not absorb appreciable quantities of water during the brief immersion period. If any drying has taken place, the surface of the specimen needs to be sealed before immersion in water or else the volumetric displacement of the specimen will be in error in an amount equal to the volume of water absorbed by the wood.

9.2 Procedures:

9.2.1 Initial Mass (m_M)—Determine the initial mass of the specimen at time of test in accordance with [6.2](#).

9.2.2 Volume—Determine the volume of the specimen by measuring the volume or the mass of the water displaced by the specimen using one of the following modes. The mass of water in grams is numerically equal to its volume in cubic centimeters. Unless the volume is determined on a specimen of green wood, the surfaces of the specimen shall be adequately sealed (see [9.2.2.5](#)).

9.2.2.1 Mode I—Place the specimen in a tank of known volume and add sufficient water to fill the tank with the specimen being fully submerged. Then remove the specimen and determine the volume of water remaining. The tank volume less the volume of water remaining is equal to the volume of the specimen. The relationship between specimen volume and tank volume shall be such that the precision of specimen volume measurement is adequate to the purpose of the test.

9.2.2.2 Mode II—Place a container holding enough water to completely submerge the specimen on a balance as shown in [Fig. 1](#). Then tare the balance to the combined mass of the container and water. Using a sharp, pointed, slender rod, place the specimen in the container so that it is completely submerged in the water without touching the sides of the container. After reaching the equilibrium, the reading on the balance is equal to the mass of water displaced by the specimen.

9.2.2.3 Mode III—Place a container holding enough water to completely submerge the specimen on a balance as shown in [Fig. 2](#). The container shall be sufficiently large so that immersion of the specimen causes no significant change in water level. Suspend a wire basket of sufficient mass to keep the specimen submerged and immerse it in the water. Tare the balance to the mass of the basket when freely immersed. Weigh the specimen in air. Place the specimen in the basket and hold it completely submerged without touching the container. After