Designation: D2395 – 17 (Reapproved 2022)

Standard Test Methods for Density and Specific Gravity (Relative Density) of Wood and Wood-Based Materials[1]

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.

	Section
Test Method A—Volume by Measurement	8
Test Method B—Volume by Water Immersion	9
Test Method C—Flotation Tube	10
Test Method D—Forstner Bit	11
Test Method E—Increment Core	12
Test Method F—Chips	13
Test Method G—Full-Size Members	14

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

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_0*—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 %).

[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.

[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 Catoctin 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 ±0.3 % or less, and the mass shall be determined to a precision of ±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 °C ± 2 °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_0)*—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

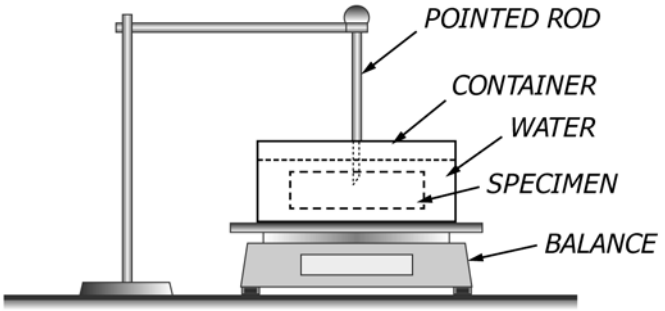

FIG. 1 Diagrammatic Sketch of Apparatus Used to Measure Volume of Specimens by Test Method B (Mode II)

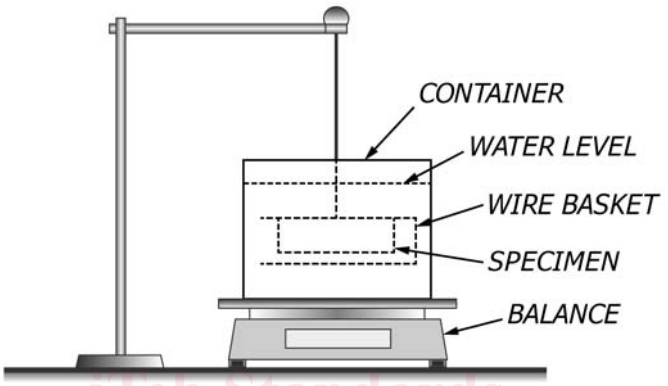

FIG. 2 Diagrammatic Sketch of Apparatus Used to Measure Volume of Specimens by Test Method B (Mode III)

reaching the equilibrium, the mass reading on the balance, if the specimen is lighter than water, plus the mass of the specimen in air equals the volume of water displaced. If the specimen is heavier than water, subtract the mass reading on the balance from the mass of the specimen in air to determine the volume of water displaced.

9.2.2.4 *Mode IV*—Immerse the specimen, of an elongated shape, in a graduated tube having a cross section only slightly larger than that of the specimen as shown in Fig. 3. Read the water level in the tube, preferably to an even graduation mark, before immersing the specimen. Immerse the specimen, hold it submerged with a slender pointed rod if necessary, and determine the water level again. The difference in water level is equal to the volume of the specimen.

9.2.2.5 *Surface Treatment of Specimen*—Partially dry or oven-dry specimens shall be dipped in hot paraffin wax before making volume determinations. After the wax dip, weigh the specimen again and use this mass in conjunction with the immersed mass for determining volume in Mode II and Mode III (9.2.2.2 and 9.2.2.3).

NOTE 9—Specimens of green wood may be briefly immersed in water without appreciable absorption that will affect volume determinations.

9.2.3 *Oven-dry Mass (m_0)*—Oven-dry mass of the test specimen shall be determined by drying to practical equilibrium in accordance with 6.2.

9.2.4 *Moisture Content*—Determine the moisture content (M) of the specimen in accordance with 7.1.1.

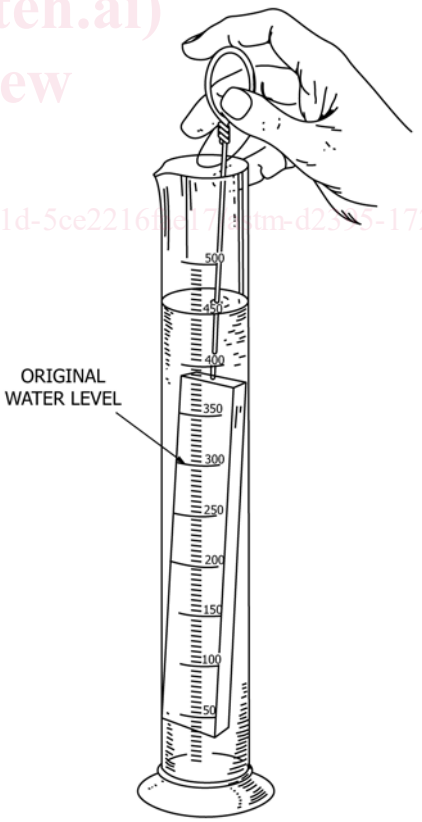

FIG. 3 Measuring Volume of Elongated Specimens Using a Graduated Tube by Test Method B (Mode IV)

10. Test Method C—Flotation Tube

10.1 *Applicability:*

10.1.1 This procedure provides a rapid means for obtaining an approximate density or specific gravity for an elongated clear wood specimen of uniform cross section and known moisture content.

NOTE 10—Estimates of density to the nearest 1 lb/ft^3 (0.02 g/cm^3) or specific gravity to the nearest 0.02 can be readily made.

10.2 *Procedures:*

10.2.1 *Specimen Preparation*—The specimen shall be slender and of uniform cross section, preferably approximately 1 in. (25 mm) on a side and 10 in. (25 cm) long.

10.2.2 *Measurement*—Place the specimen in a slender cylinder filled with water and allow it to float in as nearly a vertical position as possible (Fig. 4). The cylinder diameter shall be slightly larger than the specimen cross section, and the specimen shall not touch the cylinder wall until immersed as far as it will go. With the specimen floating in an upright position, quickly note the water level on the specimen to avoid excessive absorption of water by the specimen.

10.2.3 *Moisture Content*—Determine the moisture content (*M*) of the specimen in accordance with 7.1.

NOTE 11—Precautions should be used to minimize the influence of the water immersion on the measurement of the moisture content.

11. Test Method D—Forstner Bit

11.1 *Applicability:*

11.1.1 This procedure is particularly adaptable for determining the density or specific gravity of logs, timbers, or any in-place elements from which it would be difficult to saw a more conventional sample. The volume of the hole formed by the lead screw of a Forstner bit is negligible; therefore, the volume of the specimen can be calculated from the diameter of the bit and the depth of the hole. Care shall be taken to collect all of the shavings.

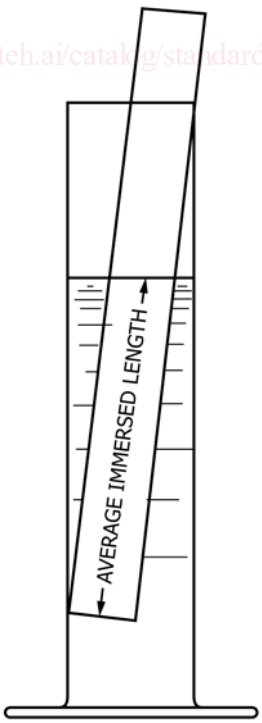

FIG. 4 Cylinder and Specimen Used in Flotation Tube Test Method (Method C)

11.2 *Procedures:*

11.2.1 *Volume*—Obtain the volume of specimen material by boring a hole into the element in question with a Forstner-type bit. The diameter of hole and depth of boring shall be such that an adequate sample is obtained without damage to the element. Accurately measure the diameter of the bit and depth of the hole. Use these dimensions to calculate the specimen volume.

11.2.2 *Initial Mass (m_M)*—Carefully collect all of the chips obtained by boring and immediately weigh them to determine the initial mass.

11.2.3 *Oven-dry Mass (m_0)*—Oven-dry mass of the chips shall be determined by drying to practical equilibrium in accordance with 6.2.

NOTE 12—Drying chips in a forced convection oven should be done with care: as the chips dry, small particles may be blown away from dishes and lost for the oven-dry mass measurements.

11.2.4 *Moisture Content*—Determine the moisture content (*M*) in accordance with 7.1.1.

12. Test Method E—Increment Cores

12.1 *Applicability:*

12.1.1 This procedure is particularly adaptable for obtaining specimens to determine the density or specific gravity of standing trees but is also suitable for use on logs, poles, piles, or other structural elements. Since only a pencil-sized hole is made in the member in question, it has no material effect on the properties of the member and can be easily sealed.

12.2 *Procedures:*

12.2.1 *Volume*—Obtain the specimen material by extracting a core from the member by means of a standard increment borer. Obtain the volume from the diameter of the cutting edge of the increment borer and measure the length of the core immediately after it is removed from the member. Handle the core carefully to prevent damage or loss of any portion.

12.2.2 *Initial Mass (m_M)*—When the moisture content of the element is desired, weigh the increment core immediately after the length is measured in order to obtain the initial mass. If the immediate weighing is impractical, the core shall be protectively wrapped to prevent loss of moisture.

12.2.3 *Oven-dry Mass (m_0)*—Oven-dry mass of the specimen shall be determined by drying to practical equilibrium in accordance with 6.2.

12.2.4 *Moisture Content*—When necessary, determine the moisture content (*M*) in accordance with 7.1.1.

NOTE 13—For example, when determining the basic density or specific gravity of a standing tree, the determination of the moisture content may not always be necessary.

13. Test Method F—Chips[6]

13.1 *Applicability:*

[6] Additional information on this test method may be obtained from TAPPI 258 om-06, Basic Density and Moisture Content of Pulpwood. Available from Technical Association of the Pulp and Paper Industry (TAPPI), 15 Technology Parkway South, Norcross, GA 30092, http://www.tappi.org.

13.1.1 This procedure is specifically designed to determine the basic density or basic specific gravity of wood chips, although the values at any other moisture content can also be obtained.

13.2 *Procedures:*

13.2.1 *Specimen*—Select a representative sample of chips weighing approximately 0.66 lb to 0.77 lb (approximately 300 g to 350 g) for test. Remove sawdust and undersized chips by shaking on a three-mesh sieve.

13.2.2 *Initial Mass (m_M)*—Obtain the initial mass of the chips in accordance with 6.2.

13.2.3 *Volume:*

13.2.3.1 Submerge the chips in water at room temperature for at least 1 h to ensure that they are at their green volume and will not absorb water during volume measurement. Then remove the chips from the water, allow them to drain in a wire-mesh basket, and place them in the centrifuge basket. Centrifuge the chips from 800 to 1200 r/min for 1 to 4 min.

13.2.3.2 Place a container holding enough water to freely submerge the chip holder on a balance. Submerge the empty chip holder, except for its wire handle, in the water container. The chip holder must not touch the sides or bottom of the container. Tare the balance. Transfer the chips to the chip holder and slowly lower them into the container of water, being careful to remove any entrapped air. After reaching the equilibrium, the balance reading represents the volume of water equal to the volume of chips (V).

13.2.4 *Oven-dry Mass (m_0)*—Oven-dry mass of the chips shall be determined by drying to practical equilibrium in accordance with 6.2.

13.2.5 *Moisture Content*—When necessary, determine the moisture content (M) in accordance with 7.1.1.

NOTE 14—For example, when determining the basic density or specific gravity of chips, the determination of the moisture content may not always be necessary.

14. Test Method G—Full-Size Members

14.1 *Applicability:*

14.1.1 This procedure is adaptable to full-size rectangular wood or wood-based material members at any moisture content. The tested members shall be permitted to include typical non-rectangular geometric irregularities (that is, edge easing, wane, checks, etc.) and other growth (that is, knots, pitch pockets, holes, etc.) or manufacturing characteristics. The specimens shall be representative of the materials to be tested, regular in shape, and with near right-angle corners for determination of volume by linear measurement.

14.2 *Procedures:*

14.2.1 *Volume*—Measure the length, width, and thickness of the specimen in accordance with 6.2 in at least one location for each dimension. If multiple measurements are taken for any of these dimensions, the average values shall be used in calculations. The linear measurements taken shall be typical of the full product dimension and not adjusted to account for edge easing, holes, wane, checks or other volume reductions.

14.2.2 *Initial Mass, (m_M)*—Determine the mass of the full-length specimen at the time of test in accordance with 6.2.

14.2.3 *Moisture Content*—Determine the moisture content (M) of the specimen in accordance with 7.1.

NOTE 15—It is preferable to use the oven-dry moisture content method of 7.1.1 for all wood and wood based materials. For further discussion, see X3.8.1. However, use of an approximate moisture content determined with a moisture meter is permitted for solid wood materials in accordance with 7.1.2.

14.2.4 *Oven-Dry Mass (m_0)*—Oven-dry mass of the specimen shall be determined by calculation (15.1.2).

15. Calculation

15.1 *Moisture Content (M) or Oven-Dry Mass (m_0):*

15.1.1 If Test Method D4442 is used with Test Methods A-F, the moisture content is calculated as follows:

$$M = \frac{m_M - m_0}{m_0} \times 100 \quad (1)$$

where:

M = moisture content of specimen at the time of test, percent,
m_M = initial mass, and
m_0 = oven-dry mass.

15.1.2 If Test Method G or if Practice D7438 is used with Test Methods A or C, the oven-dry mass is estimated as follows:

$$m_0 = \frac{m_M}{1 + 0.01M} \quad (2)$$

where:

m_0 = oven-dry mass,
m_M = initial mass, and
M = moisture content determined by 7.1.

15.2 *Density (ρ)* (see Appendix X3):

15.2.1 For Test Methods A, B, D, E, F, and G density is calculated using the following formulae:

15.2.1.1 *Density at moisture content M:*

$$\rho_M = \frac{m_M}{V_M} \quad (3)$$

15.2.1.2 *Oven-dry density:*

$$\rho_0 = \frac{m_0}{V_0} \quad (4)$$

15.2.1.3 *Basic density:*

$$\rho_b = \frac{m_0}{V_{max}} \quad (5)$$

where:

m_0 = oven-dry mass of specimen as determined in 15.1,
V_M = volume of specimen at moisture content M,
V_0 = oven-dry volume of specimen, and
V_{max} = green volume of specimen.

15.2.2 For Test Method C, density of the specimen at moisture content M is calculated using Eq 6, which yields the value numerically equal to the density in g/cm^3:

$$\rho_M = \frac{L_i}{L} \quad (6)$$

where:

L_i = immersed length of specimen, and
L = total length of specimen.

15.2.3 *Conversion of Values*—It is often desirable to convert the density of wood obtained at one moisture content to that at some other moisture content condition. Relations between the density and moisture content are presented in Appendix X1.

15.3 *Specific Gravity (S)* (see Appendix X3)*:*

15.3.1 For Test Methods A, B, D, E, F, and G specific gravity is calculated using the following formulae (see notation in 15.2):

15.3.1.1 *Specific gravity at moisture content M:*

$$S_M = \frac{Km_0}{V_M} \tag{7}$$

15.3.1.2 *Oven-dry specific gravity:*

$$S_0 = \frac{Km_0}{V_0} \tag{8}$$

15.3.1.3 *Basic specific gravity:*

$$S_b = \frac{Km_0}{V_{max}} \tag{9}$$

where:

K = constant determined by the units used to measure mass and volume:
= 27.680 $in.^3$/lb when mass is in lb and volume is in $in.^3$,
= 453.59 cm^3/lb when mass is in lb and volume is in cm^3,
= 453 590 mm^3/lb when mass is in lb and volume is in mm^3,
= 0.061024 $in.^3$/g when mass is in g and volume is in $in.^3$,
= 1.000 cm^3/g when mass is in g and volume is in cm^3,
= 1000 mm^3/g when mass is in g and volume is in mm^3.

15.3.2 For Test Method C, specific gravity of the specimen at moisture content M is calculated using the following formula (see notation in 15.1, 15.2.2 and Note 14):

$$S_M = \frac{L_i}{L(1 + 0.01\,M)} \tag{10}$$

NOTE 16—The term $(1 + 0.01M)$ accounts for the mass of moisture in the specimen. For oven-dry specimens it equals unity.

15.3.3 *Conversion of Values*—It is often desirable to convert the specific gravity of wood obtained at one moisture content to that at some other moisture content condition. Relations between the specific gravity and moisture content are presented in Appendix X2.

15.4 *Relations between specific gravity and density*—Relations between the values of specific gravity and density are expressed as follows (see Note 17).

15.4.1 *Values at moisture content M:*

$$S_M = \frac{\rho_M}{\rho_w(1 + 0.01\,M)} \tag{11}$$

15.4.2 *Oven-dry values:*

$$S_0 = \frac{\rho_0}{\rho_w} \tag{12}$$

15.4.3 *Basic values:*

$$S_b = \frac{\rho_b}{\rho_w} \tag{13}$$

where:

ρ_w = density of water (see Appendix X3), and
M = moisture content of specimen, percent.

NOTE 17—If the values of density are expressed in g/cm^3, oven-dry specific gravity and oven-dry density are numerically equal, as well as the values of basic specific gravity and basic density. However, the values of specific gravity and density at moisture content M are not equal. For example, for a specimen with density $\rho_{12} = 0.45$ g/cm^3, the corresponding specific gravity is $S_{12} = 0.45/[1.00\times(1 + 0.01\times12)] = 0.40$. Similarly, for a specimen with specific gravity $S_{12} = 0.45$, the corresponding density is $\rho_{12} = 0.45\times [1.00\times(1 + 0.01\times12)] = 0.50$ g/cm^3.

16. Report

16.1 *Report*—The report shall identify the material as completely as possible, the method of selecting test specimens, the test procedure used, and the conditions under which the volume and mass were determined.

16.2 The basis for calculating the density or specific gravity shall be clearly referenced as shown in Section 15.

17. Precision and Bias

17.1 The precision and bias of these test methods have not been established.

18. Keywords

18.1 chips; density; Forstner bit; full-size members; increment cores; moisture content; small specimens; specific gravity; volume by immersion; volume by measurement