Designation: D 2395 – 02

Standard Test Methods for Specific Gravity of Wood and Wood-Based Materials[1]

This standard is issued under the fixed designation D 2395; 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 Department of Defense.

INTRODUCTION

The specific gravity is the weight of any given volume of a substance divided by the weight of an equal volume of water. As both the weight and volume of wood vary with the amount of moisture contained in the wood, specific gravity as applied to wood is an indefinite quantity unless the conditions under which it is determined are clearly specified. The specific gravity of wood is generally based on the weight when oven-dry, but the volume may be that in the oven-dry, partially dry, or green condition. The amount of moisture retained at any equilibrium condition is proportional to the dry weight of the specimen, and for this reason moisture content is normally expressed as a percent of the oven-dry weight of the wood.

1. Scope

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

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

2. Referenced Documents

2.1 *ASTM Standards:*

D 9 Terminology Relating to Wood[2]

D 4442 Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials[2]

D 4444 Test methods for Use and Calibration of Hand-Held Moisture Meters[2]

3. Summary of Test Methods

3.1 The accuracy of the specific gravity value obtained on a representative specimen will depend upon the accuracy of the measurements made. If the specimens are carefully prepared and regular in shape, the volume determined by Method A can be quite exact. The volume of irregularly shaped specimens can best be determined by immersion in water and if due care is taken to prevent absorption of water, Method B will give results of great precision. Method C is an approximate method but a procedure that can be very useful, particularly as part of a production procedure. Methods D and E are especially adapted to gravity measurements of living trees or of in-place elements and the accuracy of the result is dependent upon the care used in obtaining the specimen. Method F is a specific procedure for wood chips.

3.2 *Conversion of Values*—It may often be desirable to convert the specific gravity obtained at one moisture content to that at some other moisture content condition. This may be approximated by the use of the chart in Fig. 1. The values of specific gravity based on oven-dry volume or volume at the current moisture content, less than the fiber saturation value, are read on the left-hand scale. The specific gravity values based on green volume are plotted on the diagonal lines. All values are based on oven-dry weight.

3.2.1 To illustrate the use of the chart, assume the specific gravity on an oven-dry weight and green volume basis is 0.55 and it is desired to find the specific gravity for a 12 % moisture content condition. Enter the chart at the 12 % moisture content

[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] *Annual Book of ASTM Standards*, Vol 04.10.

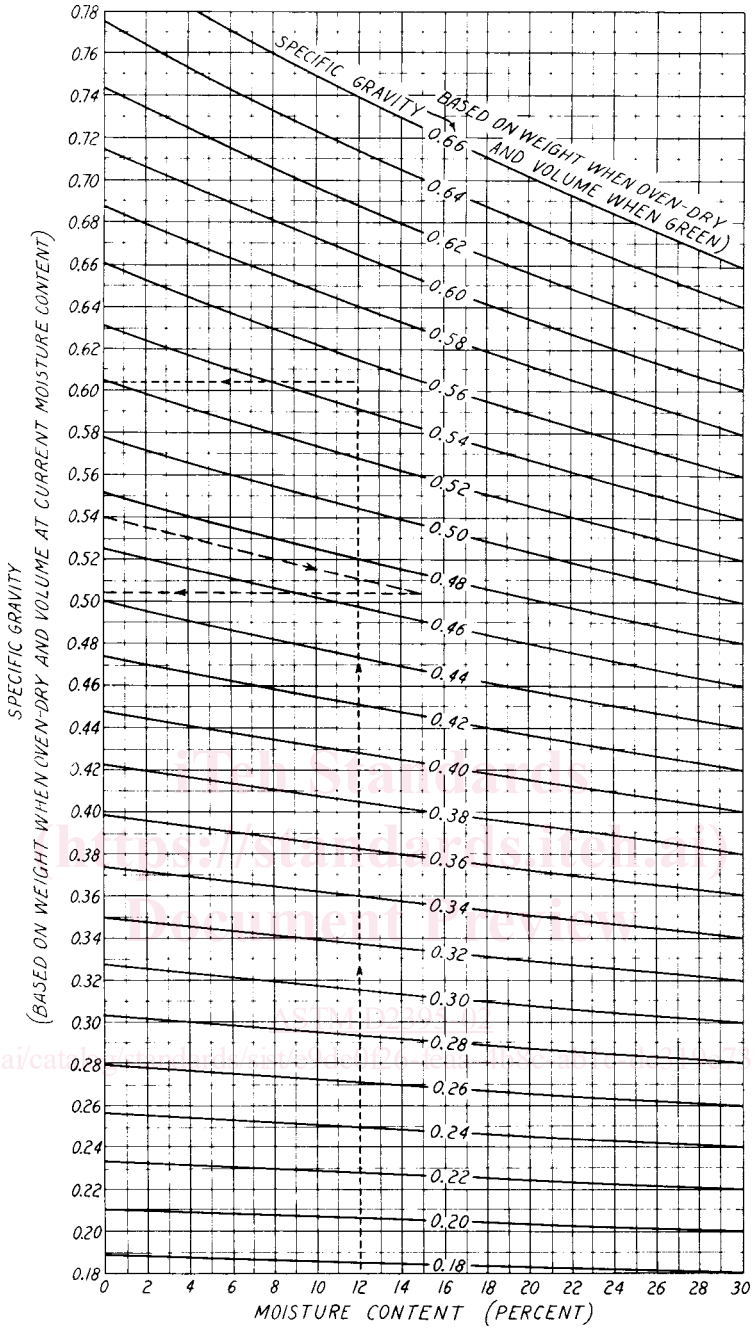

FIG. 1 Relation of Specific Gravity and Moisture Content

and move vertically to the point where this line intersects the 0.55 specific gravity value (between diagonals 0.54 and 0.56) and move horizontally to the left-hand scale to read the specific gravity value 0.60. If the specific gravity on an oven-dry weight and volume basis is 0.54 and the specific gravity at 15 % moisture content is desired, enter the chart at 0.54 on the left-hand scale and move parallel to the diagonals to an intersection with the 15 % moisture content line, then move horizontally to the left-hand scale to read 0.50. If the specific gravity at 8 % moisture content is 0.45 and the value at 15 % moisture content is desired, enter the chart with 8 % moisture content on the lower scale and 0.45 on the left-hand scale; from this intersection move parallel to the diagonal lines to an intersection with the 15 % moisture content line and then horizontally to the left-hand scale to read 0.44.

4. Significance and Use

4.1 The specific gravity of wood gives an excellent measure of the amount of wood substance present in a sample. Thus, it may serve as a valuable indicator of the amount of wood pulp that could be produced, the workability of the material, or the strength characteristics of a specimen or a species. It should be recognized that specific gravity varies between trees, within a tree, and between species. Since the specific gravity of wood substance is practically constant for all species (approximately 1.53), it is apparent that individual specific gravity values are

indicative of the amount of wood substance present. It affords a rapid and valuable method for selection of wood for specific uses.

4.2 It may be desirable to know the 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. The specimen thus may be large or small, regular or irregular, and at a variety of moisture contents. These test methods give procedures that include all of these variables and provides for calculation of specific gravity values to degrees of accuracy generally needed.

5. Test Specimens

5.1 The specific gravity specimens shall be fully representative of the material from which they are taken. The specimen size shall be such that accurate measurements of weight and volume are easy to attain. Where other standards specify the location and size of specific gravity specimens, these requirements shall be carefully followed. 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 specific gravity values are obtained.

5.2 *Measurements*—The dimensions of test specimens shall be measured to a precision of ±0.3 % or less, and the weight shall be determined to a precision of ±0.2 % or less. Where drying of specimens is required, this shall be done in an oven maintained at 103 ± 2°C. (For most panel materials and wood specimens 1 in. (25 mm) in length parallel to grain, drying for 48 h in an oven having good air circulation and exchange will be sufficient to reach constant weight.)

5.3 *Report*—The report shall identify the material as completely as possible, the method of selecting the specific gravity sample, the procedure used in determining the specific gravity, and the conditions under which the volume and weight were determined.

METHOD A—VOLUME BY MEASUREMENT

6. Applicability

6.1 *Shape of Specimen*—The specimen must be regular in shape with right-angle corners for determination of volume by lineal measurement. The procedure is adaptable to any size of specimen or to specimens of any moisture content. If the surfaces of the specimen are smooth and sufficient measurements are taken, the volume can be obtained with considerable accuracy. Special care must be taken in measurement of very small or thin specimens. Volume of irregular or rough-surfaced specimens should be obtained by Method B.

7. Procedures

7.1 *Measurement*—Measure the length (*L*), width (*w*), and thickness (*t*) of the specimen in accordance with 5.2 in a sufficient number of places to ensure an accurate indication of volume. In small specimens, uniform in size, one or two measurements of each dimension will suffice; in larger specimens the number of measurements will depend on the uniformity of the specimen, but at least three measurements of each dimension will be required.

7.2 *Weight*—Determine the weight (*W*) of the specimen at the time of observation or test in accordance with 5.2.

7.3 *Moisture Content*—Determine the moisture content (*M*) of the specimen to permit description of the basis on which the specific gravity is computed. Test Methods D 4442 and D 4444 indicate procedures that should be used.

7.3.1 *Small Specimens*—The entire specimen may be used for determination of moisture content.

7.3.2 *Intermediate Specimens*—When the specimen is of a size that is unsuitable for moisture content determinations (the time to oven-dry to constant weight would be excessive), a segment may be cut from the specimen for a moisture content specimen. Select this segment so that its moisture content is representative of that of the larger specimen. Where possible in solid wood elements, the moisture content specimen shall be of full cross-sectional dimensions and 1 in. (25 mm) in length (parallel to grain). In sheet materials the specimen shall be equal in thickness to the thickness of the material and 3 by 6 in. (76 by 122 mm) in size.

7.3.3 *Structural Elements*—In full-sized members, determine the moisture content from a segment cut from the member. It shall be of full cross-sectional dimensions and 1 in. (25 mm) in length (parallel to grain), and shall be selected from a representative area of the member. To avoid the effects of end drying, cut the specimen at least 18 in. (457 mm) in from the end of the member.

7.3.4 *Special Situations*—Where the specimen or element cannot be cut to secure a moisture content segment, an approximate moisture content may be obtained through the use of a moisture meter which is used in accordance with the manufacturer's recommendations. Since the moisture content value is approximate, it should be recognized that the specific gravity value obtained will also be approximate.

7.3.5 *Specimen Preparation*—When the moisture content specimen is a portion of the element, remove all loose particles from the specimen and determine the initial weight (*I*) in accordance with 5.2.

7.4 *Drying*—Oven-dry the moisture content specimen to constant weight in accordance with 5.2, and determine the oven-dry weight (*F*).

8. Calculation

8.1 *Moisture Content*—Calculate the moisture content of the specimen as follows:

$$\text{Moisture content, \%} = 100\,[(I - F)/F] \quad (1)$$

where:
I = initial weight, and
F = final weight (oven-dry).

8.2 *Specific Gravity*—Calculate the specific gravity as follows:

$$\text{sp gr} = KW/[1 + (M/100)]Lwt \quad (2)$$

where:
W = weight of specimen,
M = moisture content of sample, %,

$W/[1 + (M/100)]$ = calculated oven-dry weight of specimen,
L = length of specimen,
w = width of specimen,
t = thickness of specimen, and
K = a constant;
K = 27.68 when weight is in lb and volume is in $in.^3$
K = 453.59 when weight is in lb and volume is in cm^3
K = 453 590 when weight is in lb and volume is in mm^3
K = 0.061 when weight is in g and volume is in $in.^3$
K = 1 when weight is in g and volume is in cm^3
K = 1000 when weight is in g and volume is in mm^3

8.2.1 The specific gravity calculated is based on oven-dry weight and volume at test.

8.2.2 If the term [1 + (*M*/100)] were removed from the formula, the specific gravity value would be based on weight and volume when tested, or at the moisture content when measured. If the measured moisture content were above the fiber saturation point, the specific gravity would be based on the green volume.

METHOD B—VOLUME BY WATER IMMERSION

9. Applicability

9.1 *Type of Specimen*—This procedure is particularly adaptable to specimens of irregular shape or having a rough surface. 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 to the computed specific gravity value. Freshly cut green wood will not absorb appreciable quantities of water during the brief immersion period. As soon as any drying of the wood has taken place however, the surface must be sealed before immersion in water or else the volumetric displacement of the wood specimen will be in error in an amount equal to the volume of water absorbed by the wood.

10. Procedures

10.1 *Weight*—Determine the initial weight (*I*) of the specimen at time of test in accordance with 5.2.

10.2 *Volume*—Determine the volume of the specimen by one of the following modes. Volume may be determined in the "as received" condition if the specimen is green; or in the "as received" condition if the specimen is partially dry or after oven-drying if the pores are adequately sealed (see 10.2.5). Determine the volume of the specimen by measuring the volume of water displaced or by determining the weight of the water displaced. The weight in grams is numerically equal to the volume in cubic centimetres.

10.2.1 *Mode I*—Place the specimen in a tank of known volume and add sufficient water to fill the tank. 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 high.

10.2.2 *Mode II*—Place a container holding enough water to completely submerge the specimen on one pan of a balance as shown in Fig. 2. Then balance the combined weight of the container and water with weights added to the other pan. Hold the specimen so that it is completely submerged without touching the sides of the container by means of a sharp, pointed, slender rod and balance the scales again. The weight added to restore balance is equal to the weight of water displaced by the specimen. Alternatively, an automatic balance may be used and will greatly facilitate the speed of such measurements. If very small specimens are used, the accuracy of resulting data is likely to be low.

10.2.3 *Mode III*—Place a container holding enough water to completely submerge the specimen below one pan of a balance as shown in Fig. 3. The container shall be sufficiently large so that immersion of the specimen causes no material change in water level. Suspend a wire basket of sufficient weight to hold the specimen submerged from this same pan and immerse it in the water. Balance the weight of the basket when freely immersed with weights added to the other scale pan. Weigh the specimen in air. Place the specimen in the basket and hold it completely submerged without touching the container while balancing the scales again. The weight added to restore

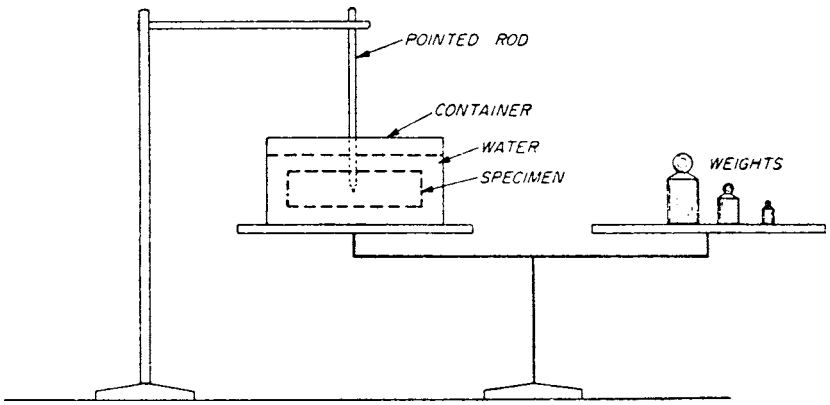

FIG. 2 Diagrammatic Sketch of Apparatus Used to Measure Volume of Specimens by Method B-II