TECHNICAL NOTE NUMBER B-14

UNITED STATES DEPARTMENT OF AGRICULTURE FOREST SERVICE

FOREST PRODUCTS LABORATORY

MADISON 5, WISCONSIN REVISED October 1956

METHODS OF DETERMINING THE SPECIFIC GRAVITY OF WOOD

Next to actual strength tests, the specific gravity of wood affords the best indication of its strength properties. The specific gravity of any piece of wood may easily be determined by the methods described in this note. With the aid of table 1, the strength of the piece as a beam or as a column, its shock-resisting ability, its hardness or wear-resistance, its toughness, its shearing strength, and its value in several other respects may be estimated.

The specific gravity of a substance is its weight divided by the weight of an equal volume of water. As both the weight and volume of wood vary with the amount of moisture in it, specific gravity as applied to wood is an indefinite quantity unless the circumstances under which it is determined are specified. The specific gravity of wood is almost always based on the weight when ovendry, but the volume may be that in the ovendry, air-dry, or green condition. The true specific gravity of wood is, of course, that based on volume when ovendry. For greater convenience in making determinations, however, the U. S. Forest Products Laboratory bases specific gravity on the volume of the specimen when tested and has determined the relation of strength to specific gravity separately for green and air-dry wood.

In using table 1 for estimating the properties of particular timber, therefore, it is necessary to determine specific gravity on the volume of the sample in a green condition or at a moisture content of about 12 percent (air-dry condition). The volume when ovendry may be obtained and converted into the volume when green by means of shrinkage figures.

Specific gravity determinations may be made upon solid specimens that should contain no more than 25 cubic inches. Larger pieces require considerably more time for drying.

After selecting a representative specimen, proceed as follows:

To find specific gravity of wood based upon volume in a green or air-dry condition

1. Find volume of specimen by measurements or by immersion method.
2. Put specimen in oven at 103° C. (plus or minus 2° C.) and dry until constant weight is attained.
3. Weigh specimen.

To find specific gravity of wood based upon volume when ovendry

1. Put specimen in oven at 103° C. (plus or minus 2° C.) and dry until constant weight is attained.
2. Weigh specimen.
3. Find volume of specimen by measurements or by an immersion method.

4. Compute specific gravity, using formula

$$\text{Specific gravity} = \frac{D}{V},$$

where D = weight in grams and V = volume in cubic centimeters.

When weights or measures are not taken in metric units, use the following reduction factors:

Inches x 2.54 = centimeters
Cubic inches x 16.4 = cubic centimeters

Ounces x 28.4 = grams
Pounds x 454 = grams

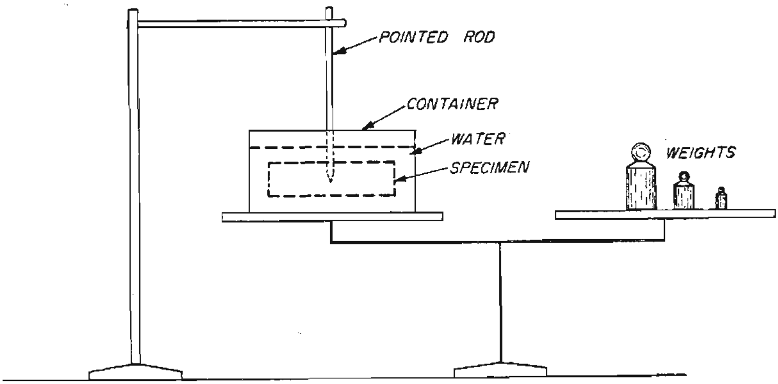
Both the ovendry weight and the volume should be correct to within at least 1/2 of 1 percent.

Determining Volume of Specimens

Lineal measurement method.--The specimen must be regular in shape with right-angle corners for determination of its volume by lineal measurement. It should be measured carefully to determine its length and cross sectional area. Its volume is equal to the product of its length and cross sectional area.

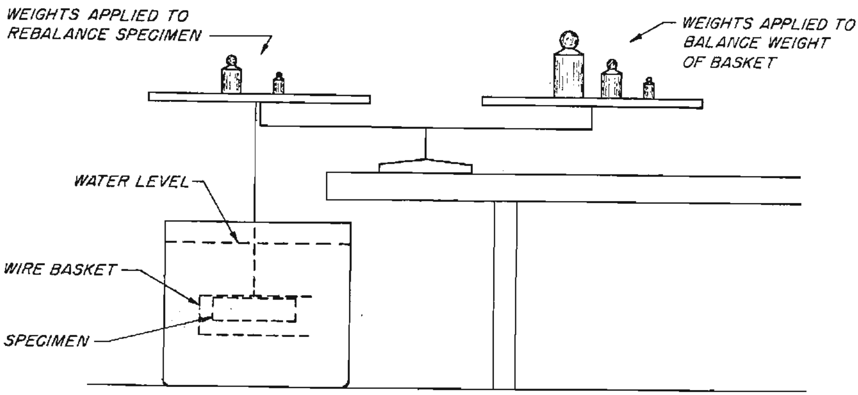
Immersion methods. --The volume of a regular or irregular specimen may be found by determining the weight of water it displaces when immersed. This weight in grams is numerically equal to the volume of the specimen in cubic centimeters.

Method A. --A container holding enough water to completely submerge the specimen is placed on one pan of a balance scale. The combined weight of the container and water is then balanced with weights added to the other scale pan. By means of a sharp pointed rod, the specimen is held completely submerged without touching the container while the scales are again balanced. The weight that is added to restore balance is the weight of water displaced by the specimen.



METHOD A

Method B. --A container holding enough water to completely submerge the specimen is placed below one pan of a balance scale from which a wire basket is suspended of sufficient weight to hold the specimen submerged. (See sketch.) The weight of the basket is balanced with weights added to the other scale pan. The specimen is first weighed in air and then placed in the basket and held completely submerged without touching the water container while the scales are again balanced. If the specimen has a tendency to float, the weight that is added to restore balance is added to the weight of the specimen in air to give the weight of an equal volume of water. Conversely, if the specimen has a tendency to sink, the weight that is added to restore balance is subtracted from the weight of the specimen in air to determine the volume. In this case, the weights added to restore balance are added to the same pan as the weight applied to balance the weight of the wire basket.



METHOD B

Green specimens may usually be immersed for volume determinations in the condition in which they are selected. The determination of volume should be made as quickly as possible after immersion of the specimen, because any absorption of water by the specimens directly affects the accuracy of the result. To prevent ovendry specimens from taking up water when they are immersed, they may be dipped in hot paraffin wax. After the paraffin dip, the specimen should be weighed again before immersion and this second weight used in connection with the immersed weight for determining the volume of the specimen.

A quicker method of treating specimens to prevent water absorption, which is suitable only for softwoods and for hardwoods with small pores, is to dip them in a solution of paraffin wax in carbon tetrachloride (1 gram of paraffin in 150 cubic centimeters of carbon tetrachloride). Allow a few minutes for the carbon tetrachloride to evaporate and then determine the volume by one of the immersion methods. The gain in weight due to the thin film of wax is negligible and may be ignored. An advantage of this method of treating the specimen is that it may be used satisfactorily to determine the volume of air-dried specimens, since the thin film of wax does not appear to affect the subsequent shrinkage of specimens when ovendried.

Rapid Method for Determining Specific Gravity

The flotation method is a rapid method of determining specific gravity directly, but it is less accurate than the other methods described. A long piece of regular cross section is floated on end in a narrow vessel of water. The submerged portion of the piece, expressed as a decimal fraction of the total length, is numerically equal to the specific gravity of the specimen, based on weight and volume at the moisture condition when tested.

Determination of Moisture Content

If the specimen is weighed immediately when obtained as well as after ovendrying, the moisture content may be computed, thus affording both moisture and specific gravity determinations on the same piece.

$$\text{Moisture content (percent)} = \frac{\text{green weight - ovendry weight x 100}}{\text{ovendry weight}}$$

Weight per Cubic Foot

The weight per cubic foot of a specimen at the current moisture condition may be determined quite easily from the specific gravity, based on ovendry weight and volume at test, by the following relationship:

$$\text{Weight per cubic foot} = \text{Specific gravity} \times 62.4 \times (100 + \text{moisture content at test})$$

Table 1.--Specific gravity-strength relations among different species[1]

Property	Unit	Moisture condition	
		Green	Air-dry (12-percent moisture content)
Static bending:			
Fiber stress at proportional limit	Pounds per square inch	$10,200G^{1.25}$	$16,700G^{1.25}$
Modulus of rupture	do.	$17,600G^{1.25}$	$25,700G^{1.25}$
Work to maximum load	Inch-pounds per cubic inch	$35.6G^{1.75}$	$32.4G^{1.75}$
Total work	do.	$103G^{2}$	$72.7G^{2}$
Modulus of elasticity	1,000 pounds per square inch	2,360G	2,800G
Impact bending:			
Fiber stress at proportional limit	Pounds per square inch	$23,700G^{1.25}$	$31,200G^{1.25}$
Modulus of elasticity	1,000 pounds per square inch	2,940G	3,380G
Height of drop	Inches	$114G^{1.75}$	$94.6G^{1.75}$
Compression parallel to grain:			
Fiber stress at proportional limit	Pounds per square inch	5,250G	8,750G
Maximum crushing strength	do.	6,730G	12,200G
Modulus of elasticity	1,000 pounds per square inch	2,910G	3,380G
Compression perpendicular to grain:			
Fiber stress at proportional limit	Pounds per square inch	$3,000G^{2.25}$	$4,630G^{2.25}$
Hardness:			
End	Pounds	$3,740G^{2.25}$	$4,800G^{2.25}$
Side	do.	$3,420G^{2.25}$	$3,770G^{2.25}$

[1] The values listed in this table are to be read as equations. For example, modulus of rupture for green material is $17,600G^{1.25}$, where G represents the specific gravity, ovendry, based on volume at moisture condition indicated.

Z M 28990 F