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Standard Practice for Sampling Forest Trees for Determination of Clear Wood Properties¹

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INTRODUCTION

The everyday use of wood for many different purposes creates a continual need for data on its mechanical properties. Small clear specimen testing to characterize a species has historically been employed for such property determination, and related methods of test are outlined in Test Methods [D143](#).

Because wood is a biological material, its mechanical properties are subject to considerable natural variation. Thus, the results of tests to evaluate the mechanical properties of a species depend to a great extent upon how the forest trees are sampled for test material. Ideally, if the results of mechanical property evaluations are to be representative of the forest sampled, probability sampling of materials such as outlined in Practice [E105](#) must be used. However, true probability sampling of the forest trees for determination of mechanical properties can be extremely complex and expensive because of the broad geographic range and topographic conditions under which a tree species grows. In some instances, direct probability sampling may be impractical, necessitating the need for alternative sampling procedures.^{2,3}

1. Scope

1.1 This practice offers two alternative physical sampling procedures: cruciform sampling and random sampling. The choice of procedure will depend upon the intended use for the test results, the resources available for sampling and testing, and the availability of existing data on the mechanical properties and specific gravity of the species of interest.

1.2 A third procedure, double sampling, is included primarily by reference. This procedure applies the results of cruciform or random samples through correlation to improve or update property values.

1.3 *Units*—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *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.

1.5 *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*:⁴

- [D9 Terminology Relating to Wood and Wood-Based Products](#)
- [D143 Test Methods for Small Clear Specimens of Timber](#)
- [D1038 Terminology Relating to Veneer, Plywood, and Wood Structural Panels](#)
- [D2555 Practice for Establishing Clear Wood Strength Values](#)
- [E105 Guide for Probability Sampling of Materials](#)

3. Terminology

3.1 *Definitions*:

¹ This practice is under the jurisdiction of ASTM Committee [D07](#) on Wood and is the direct responsibility of Subcommittee [D07.08](#) on Forests.

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² Bendtsen, B. A., Freese, F., and Ethington, R. L., “A Forest Sampling Method for Wood Strength,” *Forest Products Journal*, Vol 20, No. 11, 1970, pp. 38–47.

³ Pearson, R. G., and Williams, E. J., “A Review of Methods for Sampling of Timber,” *Forest Products Journal*, Vol 8, No. 9, 1958, pp. 263–268.

⁴ 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.

3.1.1 For definitions of terms used in this standard, refer to Terminologies **D9** and **D1038**.

4. Significance and Use

4.1 This practice covers procedures of sampling for obtaining small, clear wood specimens which, when tested in accordance with Test Methods **D143** and, in conjunction with full-size product tests, will provide mechanical properties for use in deriving design properties for lumber, panels, poles, house logs, and other products.

4.2 Data obtained by testing specimens sampled in accordance with these methods also provide information on the influence on mechanical properties of such factors as density, locality of growth, position in cross section, height in the tree, and moisture content.

4.3 Cruciform sampling is of principal value when information is desired on the influence on mechanical properties of height in the tree; of age or radial position in the tree; of rate of growth; the change from sapwood to heartwood; the relationships between mechanical properties and factors such as specific gravity; and making general comparisons between species for purposes of rating or selecting species for specific end-use products. Cruciform sampling does not provide unbiased estimates of mean values, percentile or other descriptive statistics, or a means of associating statistical confidence with estimates of descriptive statistics.

4.4 Double sampling is used when it is desired to improve or update existing estimates of mechanical property values that are the basis for establishing allowable design stresses for stress-graded lumber, plywood, poles and piling, and other wood products. The method involves predicting one property by carefully observing a well-correlated auxiliary property that is presumably easier or cheaper to measure. A sample estimate of the auxiliary property is obtained with a high degree of precision by representatively sampling the population. A smaller independent sample or a subsample of the large sample is used to establish a relationship between the auxiliary property and the property for which an estimate is desired. As applied to sampling a forest, double sampling has employed specific gravity to predict mechanical properties. The double-sampling method provides unbiased estimates of mean mechanical property values and an approximation method for estimating percentile values. Statistical confidence may be associated with the estimates of the means but not the percentile values.

4.5 Random sampling is used when probability estimates of descriptive statistics and property distributional characteristics are desired as the basis for establishing allowable design stresses for lumber and other stress-rated products. It is applicable when data for a species do not exist or when existing estimates are believed no longer applicable because of a changing forest character. Random sampling provides better probability estimates than double sampling and is less expensive and quicker if sampling and testing must be completed to establish mechanical property-specific gravity regressions for the double-sampling method.

5. Authentic Identification

5.1 The material shall be from trees selected in the forest by one qualified to identify the species and to select the trees. Where necessary, herbarium samples such as leaves, fruit, twigs, and bark shall be obtained to ensure positive identification.

6. Cruciform Sampling – Primary Method

6.1 The standard methods for preparing small, clear specimens of timber, primary method, provide for cutting the log sections (divided into and identified as bolts) systematically into sticks of nominal 2½ in. by 2½ in. (64 mm by 64 mm) in cross section, that are later surfaced to provide the test specimens 2 in. by 2 in. (51 mm by 51 mm) in cross section, on which the system is based. These methods have served as a basis for the evaluation of the various mechanical and related physical properties of the clear wood of different species of wood. These methods have been extensively used, and a large amount of data based on them have been obtained and published.

6.1.1 The 2 in. by 2 in. (51 mm by 51 mm) test specimen has the advantage that it embraces a number of growth rings, is less influenced by earlywood and latewood differences than smaller specimens, and is large enough to represent a considerable proportion of the material.

6.1.2 The choice of specimen size may be influenced by the objectives of sampling and by the rate of growth of the material. Radial property gradients are primarily influenced by age, and large specimens that encompass several rings may mask the age influence. Height gradients must be evaluated by specimens from the same annual ring because of age influence. Thus, small specimens are preferred for measuring both radial and height gradients. When the purpose of sampling is to estimate clear wood properties, large specimens that include a number of annual rings are preferred. Even with 2 in. by 2 in. (51 mm by 51 mm) specimens, fast rates of growth will result in few rings per specimen. Regardless of the purpose of sampling, the analysis and reporting of data may require careful consideration of the character of the specimen.

6.2 *Selection of Number of Trees*—For each species to be tested, select the number and the character of the trees to accomplish the purpose of the sampling. For traditional mechanical property data base development, a minimum of five trees have usually been selected that have been judged “representative” of the trees harvested of the species. Note that if unbiased estimates and statistical confidence statements are required, other methods are needed (Section 4).

6.3 *Selection and Number of Bolts*—The material of each species selected for test shall be representative of the clear, straight-grained wood in the merchantable bole of the tree. A traditional method of selection is shown in **Appendix X2**. Note that the sampling permits varying the intensity of sampling by tree (in accordance with **Appendix X2**) if the resulting data will support the anticipated analysis. **X2.1** illustrates merchantable section and bolt labeling.

6.4 *Substitution of Flitches for Bolts:*