Designation: D245 – 22

Standard Practice for Establishing Structural Grades and Related Allowable Properties for Visually Graded Lumber[1]

This standard is issued under the fixed designation D245; 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 This practice (**1**, **2**)[2] covers the basic principles for establishing related unit stresses and stiffness values for design with visually-graded solid sawn structural lumber. This practice starts with property values from clear wood specimens and includes necessary procedures for the formulation of structural grades of any desired strength ratio.

1.2 The grading provisions used as illustrations herein are not intended to establish grades for purchase, but rather to show how stress-grading principles are applied. Detailed grading rules for commercial stress grades which serve as purchase specifications are established and published by agencies which formulate and maintain such rules and operate inspection facilities covering the various species.

1.3 The material covered in this practice appears in the following order:

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1.4 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.

1.5 *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.*

1.6 *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:*[3]

D9 Terminology Relating to Wood and Wood-Based Products
D143 Test Methods for Small Clear Specimens of Timber
D2555 Practice for Establishing Clear Wood Strength Values
E105 Guide for Probability Sampling of Materials
IEEE/ASTM SI-10 Practice for Use of the International System of Units (SI) (the Modernized Metric System)

3. Significance and Use

3.1 *Need for Lumber Grading:*

3.1.1 Individual pieces of lumber, as they come from the saw, represent a wide range in quality and appearance with respect to freedom from knots, cross grain, shakes, and other characteristics. Such random pieces likewise represent a wide range in strength, utility, serviceability, and value. One of the obvious requirements for the orderly marketing of lumber is the establishment of grades that permit the procurement of any required quality of lumber in any desired quantity. Maximum economy of material is obtained when the range of quality-determining characteristics in a grade is limited and all pieces are utilized to their full potential. Many of the grades are established on the basis of appearance and physical characteristics of the piece, but without regard for mechanical properties. Other grades, called structural or stress grades, are established on the basis of features that relate to mechanical properties. The latter designate near-minimum strength and near-average stiffness properties on which to base structural design.

[1] This practice is under the jurisdiction of ASTM Committee D07 on Wood and is the direct responsibility of Subcommittee D07.02 on Lumber and Engineered Wood Products.

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[2] The boldface numbers in parentheses refer to references at the end of this practice.

[3] 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.

3.1.2 The development of this practice is based on extensive research covering tests of small clear specimens and of full-sized structural members. Detailed studies have included the strength and variability of clear wood, and the effect on strength from various factors such as density, knots (See Terminology D9), and other defects, seasoning, duration of stress, and temperature.

3.2 *How Visual Grading is Accomplished*— Visual grading is accomplished from an examination of all four faces and the ends of the piece, in which the location as well as the size and nature of the knots and other features appearing on the surfaces are evaluated over the entire length. Basic principles of structural grading have been established that permit the evaluation of any piece of stress-graded lumber in terms of a strength ratio for each property being evaluated. The strength ratio of stress-graded lumber is the hypothetical ratio of the strength property being considered compared to that for the material with no strength-reducing characteristic. Thus a piece of stress-graded lumber with a strength ratio of 75 % in bending would be expected to have 75 % of the bending strength of the clear piece. In effect, the strength ratio system of visual structural grading is thus designed to permit practically unlimited choice in establishing grades of any desired quality to best meet production and utilization requirements.

3.3 *Classification of Stress-Graded Lumber:*

3.3.1 The various factors affecting strength, such as knots, deviations of grain, shakes, and checks, differ in their effect, depending on the kind of loading and stress to which the piece is subjected. Stress-graded lumber is often classified according to its size and use. Four classes are widely used, as follows:

3.3.1.1 *Dimension Lumber*—Pieces of rectangular cross section, from nominal 2 to 4 in. thick and 2 or more in. wide, graded primarily for strength in bending edgewise or flatwise, but also frequently used where tensile or compressive strength is important. Dimension lumber covers many sizes and end uses. Lumber graded for specific end uses may dictate a special emphasis in grading and require an identifying grade name.

NOTE 1—For example, in North American grading under the American Lumber Standards Committee, stress graded dimension lumber categories that reflect end use include Light Framing, Structural Light Framing, Structural Joists and Planks, and Studs.

3.3.1.2 *Beams and Stringers*—Pieces of rectangular cross section, 5 in. nominal and thicker, nominal width more than 2 in. greater than nominal thickness, graded for strength in bending when loaded on the narrow face.

3.3.1.3 *Posts and Timbers*—Pieces of square or nearly square cross section, 5 by 5 in., nominal dimensions and larger, nominal width not more than 2 in. greater than nominal thickness, graded primarily for use as posts or columns.

3.3.1.4 *Stress-Rated Boards*—Lumber less than 2 in. nominal in thickness and 2 in. or wider nominal width, graded primarily for mechanical properties.

3.3.2 The assignment of names indicating the uses for the various classes of stress-graded lumber does not preclude their use for other purposes. For example, posts and timbers may give service as beams. The principles of stress grading permit the assignment of any kind of allowable properties to any of the classes of stress-graded lumber, whether graded primarily for that property or not. Recommendations for allowable properties may include all properties for all grades or use classes. While such universal application may result in loss of efficiency in some particulars, it offers the advantage of a more simple system of grades of stress-graded lumber.

3.4 *Essential Elements in a Stress-Grade Description:*

3.4.1 A stress grade formulated by this practice contains the following essential elements:

3.4.2 A grade name that identifies the use-class as described in 3.3.

3.4.3 A description of permissible growth characteristics that affect mechanical properties. Characteristics that do not affect mechanical properties may also be included.

3.4.4 One or more allowable properties for the grade related to its strength ratio.

4. Basic Principles of Strength Ratios

4.1 *General Considerations:*

4.1.1 Strength ratios associated with knots in bending members have been derived as the ratio of moment-carrying capacity of a member with cross section reduced by the largest knot to the moment-carrying capacity of the member without defect. This gives the anticipated reduction in bending strength due to the knot. For simplicity, all knots on the wide face are treated as being either knots along the edge of the piece (edge knots) or knots along the centerline of the piece (centerline knots).

4.1.2 Strength ratios associated with slope of grain in bending members, and in members subjected to compression parallel to grain, were obtained, experimentally (**3**).

4.1.3 Strength ratios associated with shakes, checks, and splits are assumed to affect only horizontal shear in bending members. These strength ratios were derived, as for knots, by assuming that a critical cross section is reduced by the amount of the shake, or by an equivalent split or check.

4.1.4 Strength ratios associated with knots in compression members have been derived as the ratio of load-carrying capacity of a member with cross section reduced by the largest knot to the load-carrying capacity of the member without defect. No assumption of combined compression and bending is made.

4.1.5 Tensile strength of lumber has been related to bending strength and bending strength ratio from experimental results (**4**).

4.1.6 Strength in compression perpendicular to grain is little affected in lumber by strength-reducing characteristics, and strength ratios of 100 % are assumed for all grades.

4.1.7 Modulus of elasticity of a piece of lumber is known to be only approximately related to bending strength ratio. In this standard, the relationship between full-span, edgewise bending modulus of elasticity and strength ratio was obtained experimentally.

4.1.8 In developing a stress-grade rule, economy may be served by specifying strength ratios such that the allowable stresses for shear and for extreme fiber in bending will be in balance, under the loading for which the members are designed.