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## Standard Practice for Establishing Allowable Properties for Structural Glued Laminated Timber (Glulam)<sup>1</sup>

This standard is issued under the fixed designation D3737; 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.

<sup>ε1</sup> NOTE—Editorial changes were made throughout in October 2023.

### 1. Scope

1.1 This practice covers the procedures for establishing allowable properties for structural glued laminated timber. Included are the allowable stresses for bending, tension and compression parallel to the grain, horizontal shear, compression perpendicular to the grain, and radial tension and compression in curved members. Also included are modulus of elasticity and modulus of rigidity.

1.2 This practice is limited to the calculation of allowable properties subject to the given procedures for the selection and arrangement of grades of lumber of the species considered.

1.3 Requirements for production, inspection and certification are not included, but in order to justify the allowable properties developed using procedures in this practice, manufacturers must conform to recognized manufacturing standards. Refer to ANSI A190.1 and CSA O122.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in SI units are mathematical conversions 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.*

<sup>1</sup> 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. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

D9 Terminology Relating to Wood and Wood-Based Products

D143 Test Methods for Small Clear Specimens of Timber

D198 Test Methods of Static Tests of Lumber in Structural Sizes

D245 Practice for Establishing Structural Grades and Related Allowable Properties for Visually Graded Lumber

D2395 Test Methods for Density and Specific Gravity (Relative Density) of Wood and Wood-Based Materials

D2555 Practice for Establishing Clear Wood Strength Values

D2915 Practice for Sampling and Data-Analysis for Structural Wood and Wood-Based Products

D4761 Test Methods for Mechanical Properties of Lumber and Wood-Based Structural Materials

D5456 Specification for Evaluation of Structural Composite Lumber Products

D6570 Practice for Assigning Allowable Properties for Mechanically Graded Lumber

E105 Guide for Probability Sampling of Materials

#### 2.2 Other Standards:

ANSI A190.1 Structural Glued Laminated Timber<sup>3</sup>

ANSI/AWC National Design Specification for Wood Construction<sup>4</sup>

CSA O122 Structural Glued Laminated Timber<sup>5</sup>

### 3. Terminology

#### 3.1 Definitions:

3.1.1 *alternative lumber*—laminated veneer lumber (LVL), laminated strand lumber (LSL), oriented strand lumber (OSL),

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Available from APA – The Engineered Wood Association, Tacoma, WA 98466, <http://www.apawood.org>.

<sup>4</sup> Available from American Wood Council (AWC), 222 Catotcin Circle, SE, Suite 201, Leesburg, VA 20175, <http://www.awc.org>.

<sup>5</sup> Available from Canadian Standards Association (CSA), 5060 Spectrum Way, Mississauga, ON L4W 5N6, Canada, <http://www.csa.ca>.

or parallel strand lumber (PSL) meeting the requirements of Specification **D5456**; or solid-sawn lumber that is produced according to Practice **D6570** and the grading rules of the applicable grading or inspection agency.

3.1.2 *E-rated lumber*—lumber graded for use in manufacturing structural glued laminated timber by nondestructive measurement of a modulus of elasticity ( $E$ ) and by visual inspection in accordance with the grading rules of the applicable grading or inspection agency.

3.1.3 *glulam*—term used to denote structural glued laminated timber, which is a product made from suitably selected and prepared pieces of wood bonded together with an adhesive either in a straight or curved form with the grain of all pieces essentially parallel to the longitudinal axis of the member.

3.1.4 *horizontally laminated timber*—member designed to resist bending loads applied perpendicularly to the wide faces of the laminations (referred to as bending about the  $x$ - $x$  axis).

3.1.5 *lamination*—layer of lumber within the glued laminated timber.

3.1.6 *modulus of elasticity ( $E$ )*—for laminating,  $E$  is designated in two categories to distinguish mode of measurement and application.

3.1.6.1 *Long-Span  $E$  ( $LSE$ )*—modulus of elasticity calculated from deflection measured in a flat-wise static bending test of lumber with a center-point loading and a span-to-depth ratio ( $\frac{1}{4}$ ) of approximately 100 or the modulus of elasticity obtained from Practice **D2555** and multiplied by the appropriate factors from **Tables 1-6**.

3.1.6.2 *member  $E$  ( $E_{axial}$ ,  $E_x$ ,  $E_y$ )*—allowable modulus of elasticity values of the structural glued laminated member as defined in this practice.

3.1.7 *vertically laminated timber*—member designed to resist bending loads applied parallel to the wide faces of the laminations (referred to as bending about the  $y$ - $y$  axis).

3.1.8 *visually graded lumber*—lumber graded by visual inspection in accordance with the grading rules of the applicable grading or inspection agency.

3.1.9 *GDC*—ratio of the cross-sectional area of the local grain deviation, which may or may not be associated with a

knot, away from the edge of the lumber to the cross-sectional area of the lumber (see **Fig. 1**).

3.1.10 *GDE*—ratio of the cross-sectional area of the local grain deviation, which may or may not be associated with a knot, at the edge of the lumber to the cross-sectional area of the lumber (see **Fig. 1**).

3.1.11 *GDS*—projected sum of all *GDE* and *GDC* values within a one-foot length of lumber as defined in **Fig. 1**.

3.1.12 *KC*—ratio of the cross-sectional area of a knot located away from the edge of the lumber to the cross-sectional area of lumber. When a knot at the edge of the wide face and a knot located away from the edge are in the same cross-section, the combination of the two shall be used in determining *KC* (see **Fig. 2**).

3.1.13 *KE*—ratio of cross-sectional area of a knot at the edge of wide face of lumber to the cross-sectional area of the lumber (see **Fig. 2**).

3.1.14 *SR<sub>lt</sub>*—required strength ratio of the tension lamination at the outermost fiber.

## 4. Materials Requirements

### 4.1 Requirements for Laminations:

4.1.1 Laminations of glulam shall be of lumber with net thickness of 2 in. (5 cm) or less.

4.1.2 Lumber is permitted to be joined end to end with structural end joints to form long-length laminations. End joints shall be qualified and quality controlled in accordance with a recognized manufacturing standard.

4.1.3 Lumber is permitted to be placed or joined side to side to form wide laminations.

4.1.4 Dimension lumber used to form laminations shall be visually graded or *E*-rated according to established grading rules.

4.1.5 Alternative lumber material is permitted by demonstrating equivalence to a dimension lumber grade in accordance with **Annex A1**.

4.1.6 For the analysis of a glulam layup, all laminations in a single cross-section shall be of equal thickness.

4.1.7 The analytical procedures of this standard practice are based on specific lamination characteristics.

4.1.7.1 Lumber properties including knot size and frequency, physical properties such as specific gravity, and mechanical properties such as modulus of elasticity shall be based on measurements of 2 by 6 lumber for definition of grade characteristics.

4.1.7.2 The effect of decay or compression failures upon strength cannot be readily determined, thus these defects shall be prohibited from laminating grades insofar as existing inspection and grading technology permit. Firm white speck or light white pocket is permissible in grades of lumber that permit knots to occupy up to one third or more of the cross-section provided their extent in combination with knots does not exceed that of the largest edge knot permitted. The exception is that firm white speck and light white pocket shall be excluded from end joints in tension members and the outer 10 % of the total depth on the tension side of bending members.

**TABLE 1 Adjustment Factors for Clear Wood Stresses**  
(Practice **D2555**)

| Property                      | Multipliers for Average or 5 <sup>th</sup> Percentile |                                | Seasoning Factor for a 12 % Average Moisture Content |
|-------------------------------|-------------------------------------------------------|--------------------------------|------------------------------------------------------|
|                               | Softwoods                                             | Hardwoods                      |                                                      |
| Bending                       | 0.476<br>( $\frac{1}{2.1}$ )                          | 0.435<br>( $\frac{1}{2.3}$ )   | 1.35                                                 |
| Compression parallel to grain | 0.526<br>( $\frac{1}{1.9}$ )                          | 0.476<br>( $\frac{1}{2.1}$ )   | 1.75                                                 |
| Modulus of elasticity         | 1.095<br>( $\frac{1}{0.913}$ )                        | 1.095<br>( $\frac{1}{0.913}$ ) | 1.20                                                 |
| Horizontal shear              | 0.244<br>( $\frac{1}{4.1}$ )                          | 0.222<br>( $\frac{1}{4.5}$ )   | 1.13                                                 |