ANSI 117-2015 Letter Ballot (Ballot 1)

**Ballot issue date: 10/01/2014 Ballot closing date: 11/03/2014**

**Ballot Instructions:**

1. All members are required to return the letter ballot. Failure to return 3 consecutive letter ballots will lead to the termination of the membership from this committee.
2. All votes shall be cast by marking the appropriate column of each ballot item.
3. Ballot items marked Negative or Affirmative-with-Comment shall be accompanied by a written explanation and proposed resolution that would address the negative using the comment form at the end of this ballot form.

Exception: A written explanation and proposed resolution is not required for a ballot item to find a negative non-persuasive.

1. The Committee activities for the development of this standard can be found at [www.apawood.org/standards](http://www.apawood.org/standards).
2. Return ballot by e-mail to [borjen.yeh@apawood.org](mailto:borjen.yeh@apawood.org). Please attach the completed ballot and comments as a word processor file (e.g., Microsoft Word) to facilitate the collection of comments for committee actions.

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|  |  |  |  |  |
| Committee Member Name | | Signature (not required with e-mail) | | Date |

**Ballot** (Aff = affirmative; Aw/C = affirmative with comment; Neg = negative; Abst = abstention)

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| Item | Section | Description | Aff | Aw/C | Neg | Abst |
| 1 | Preface | Add the following sentence at the end of the 4th paragraph:  The design values for utility structures can be obtained by multiplying the reference design values provided in this Specification by the conversion factors specified in ANSI O5.2 (5).  **Rationale:** Glulam has been used for utility structures for years and should be recognized in this glulam standard. |  |  |  |  |
| 2 | 2.5 | Revise Section 2.5, as shown in **Attachment 1**.  **Rationale:** There have been confusions on the true (shear-free) E and apparent E for glulam. The proposed changes clarify this issue. |  |  |  |  |
| 3 | 2.11 | Revise the 1st sentence of Section 2.11 as follows:  In lieu of specific data, the modulus of rigidity shall be taken as 1/16 of the long-span modulus of elasticity, as defined in ASTM D3737 (10), for the lowest grade lamination used in the lay-up.  **Rationale:** Clarification. |  |  |  |  |
| Item | Section | Description | Aff | Aw/C | Neg | Abst |
| 4 | 2.12 | Revise the 2nd sentence in the 3rd paragraph as follows:  The design values in Table A3 shall replace the corresponding design values in Table A1 or Table A1-Expanded for all such ~~field-~~tapered beams.  **Rationale:** “Field-tapered” implies that the taper is cut outside a factory environment. In fact, tapers that remove compression materials are often cut in the factory. |  |  |  |  |
| 5 | 3.1 | Revise the Section as follows:  Lumber grades shall be in accordance with Section 4.3 – *Lumber for Laminating* of ANSI A190.1 (4). *AITC/WCLIB Grading Handbook for Laminating Lumber* (1) and *APA Grading Handbook for Laminating Lumber* (6) summarize ~~summarizes~~ the requirements for laminating grades of approved species and reference~~s~~ approved grading rules.  **Rationale:** This change recognizes proprietary grading handbooks published by both AITC/WCLIB and APA. |  |  |  |  |
| 6 | 3.3 | Revise the 1st paragraph and 1st example in Section 3.3, as shown in **Attachment 2**.  **Rationale:** The revised example clarifies the calculation of the number of laminations in each zone in the layup tables. |  |  |  |  |
| 7 | 3.6 | Revise the last sentence as follows:  Tudor arches (Figure 3.6-2) shall be laid up in accordance with *AITC/WCLIB 200* (2) or *APA QA Policy for Structural Glued Laminated Timber* (7), unless specified otherwise.  **Rationale:** This change recognizes proprietary QA policies published by both AITC/WCLIB and APA. |  |  |  |  |
| 8 | Tables A1, A1-Expanded, A2, and A3 | Revise Table A1, A1-Expanded, A2, and A3, as shown in **Attachment 3**.  **Rationale:** Add clarification to true (shear-free) E and apparent E. |  |  |  |  |
| 9 | References | Revise References, as shown in **Attachment 4**, and renumber the references in the text of the entire standard accordingly.  **Rationale:** Update the references in this standard. |  |  |  |  |

**Comment Form for the ANSI 117-2015 Letter Ballot 1**

Required only for Negative or Affirmative-with-Comment

**Please attach this page to the e-mail ballot return**

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| Item | Comments |
| 1 |  |
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Attachment 1

Revise Section 2.5, as shown in Attachment 1.

**Rationale:** There have been confusions on the true (shear-free) E and apparent E for glulam. The proposed changes clarify this issue.

## **2.5 Modulus of Elasticity Design Values, Ex true, Ex app, Ex min, Ey true, Ey, app, Ey min, Eaxial, and Eaxial min**

Design values for modulus of elasticity (E) are tabulated for bending about either axis (x-x or y-y, as shown in Figure 2.1-1). In general, the apparent moduli of elasticity, Ex app and Ey app, are used for calculation of deflection of bending members, and Ex min and Ey min are used for stability calculations for columns and beams.

Ex app and Ey app are based on a span to depth ratio of approximately 21, including an adjustment for shear deflection. These values can be used for most designs without considering shear deflections explicitly. For span-to-depth ratios of less than 14, deflections due to shear stresses should be considered. ASTM D2915 (9) presents one method of accounting for shear deformations.

Ex true and Ey ture are shear-free moduli of elasticity and generally estimated as 1.05 Ex app and 1.05 Ey app, respectively. When Ex true and Ey true are used, the calculated deflection of members accounts for the deflection due to bending only and therefore, the deflection due to shear must be calculated separately and then added to the bending deflection to account for the total deflection of the members.

For the calculation of extensional deformations, the axial modulus of elasticity for mixed grade lay-up combinations provided in Tables A1 and A1-Exapnded, can be estimated as Eaxial = 1.05 Ey app = Ey true, such as for use in calculating deflection of trusses. The bending modulus of elasticity for uniform grade lay-up combinations provided in Table A2 can be estimated as Ex true = Ey ture = Eaxial, and Ex app = Ey app = 0.95 Eaxial.

Ex min, ~~and~~ Ey min, and Eaxial min are calculated using the following formula:



where: Emin = Ex min, ~~or~~ Ey min, or Eaxial min as appropriate

Eapp = Ex app, ~~or~~ Ey app, or 0.95 Eaxial as appropriate

CoVE = coefficient of variation for modulus of elasticity

~~E~~~~x~~ ~~and E~~~~y~~ ~~are based on a span to depth ratio of approximately 21, including an adjustment for shear deflection. These values can be used for most designs without considering shear deflections explicitly. For span to depth ratios of less than 14, deflections due to shear stresses should be considered. ASTM D2915 (6) presents one method of accounting for shear deformations.~~

Attachment 2

Revise the 1st paragraph and the 1st example in Section 3.3, as shown in Attachment 2.

**Rationale:** The revised example clarifies the calculation of the number of laminations in each zone in the layup tables.

## **3.3 Determining Number of Laminations in Each Zone**

The number of laminations to use in each zone in the lay-up shall be calculated based on the percentages shown in Tables B1 and B2. Percent values shall be multiplied by the total depth of the member expressed in the number of laminations. The required number of laminations shall be determined starting with the outer zones and working inward. When the calculated number of laminations results in a fractional number, the fractional number of laminations shall be rounded upward to the next whole number. For the inner zones, the resulting excess of percentage resulting from rounding upward of the outer zone is permitted to be subtracted from the next inner zone requirements.

Example: The tension zone of a hypothetical 16 lamination beam requires 5% 302-24, 15% L1, and 10% L2.

The number of 302-24 laminations is determined by: 16 x 0.05 = 0.8 (rounded up to 1).

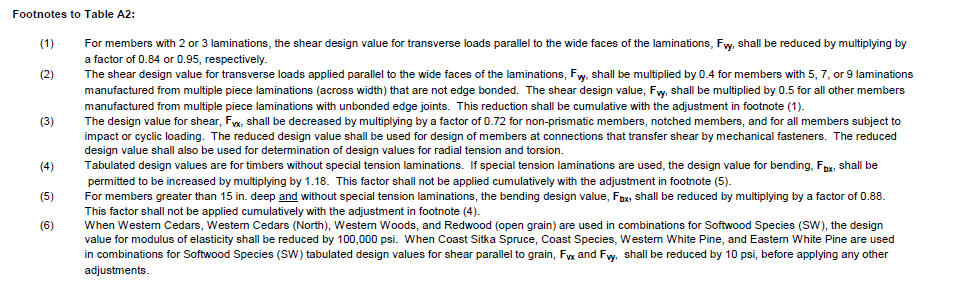
The combined number of 302-24 and L1 laminations is: ~~16 x 0.15 – (1 – 0.8) = 2.4 – 0.2 = 2.2 lams~~ 16 x (0.05 + 0.15) = 3.2 lams (round up to ~~3~~ 4). Since there is already 1 lam of 302-24 from the calculation above, the required number of L1 lams is 4 - 1 = 3 lams.

The combined number of 302-24, L1, and L2 lams is ~~16 x 0.1 – (3 – 2.2) = 1.6 – 0.8 = 0.8 (rounded up to 1)~~ 16 x (0.05 + 0.15 + 0.10) = 4.8 lams (rounded up to 5). Since there are already 1 lam of 302-24 and 3 lams of L1 from the calculation above, the required number of L2 lams is 5 - 4 = 1 lam.

Attachment 3

Revise Table A1, A1-Expanded, A2, and A3, as shown in **Attachment 3**.

**Rationale:** Add clarification to true (shear-free) E and apparent E. Note that the revised Footnote 4 to Table A2 is based on the same language as in AITC 117-2004 (combined Footnotes 4 and 5), as shown below. The wording was removed in AITC 117-2010 (now ANSI 117-2010) because of the concern that most Table A2 lay-up combinations are not manufactured with special tension lams. However, this information is very useful for the re-analysis of glulam design values when the compression lams from a mixed-grade glulam are removed by accident or by design (the tension lams remain intact). APA staff has used this information, as contained in ICC-ES ESR-1940, to help the designer in conservatively determining the residual beam strength. Therefore it is recommended that the footnote be restored in ANSI 117-2015.



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| **Table A1 – Reference Design Values for Structural Glued Laminated Softwood Timber (Members stressed primarily in bending)** (Tabulated design values are for normal load duration and dry service conditions.) | | | | | | | | | | | | | | | | |
|  | **Bending About X-X Axis** Loaded Perpendicular to Wide Faces of Laminations | | | | | | | **Bending About Y-Y Axis** Loaded Parallel to Wide Faces of Laminations | | | | | | **Axially Loaded** | | **Fasteners** |
| Tension Parallel  to Grain | Compression Parallel  to Grain | Specific Gravity for  Fastener Design |
| Extreme Fiber  in Bending | | Compression  Perpendicular to Grain | Shear  Parallel to Grain | Modulus  of Elasticity | | | Extreme  Fiber in  Bending | Compression  Perpendicular  to Grain | Shear  Parallel  to Grain | Modulus  of Elasticity | | |
| Bottom of Beam  Stressed in Tension  (Positive Bending) | Top of Beam  Stressed in Tension  (Negative Bending) |
| For  Deflection  Calculations | | For  Stability  Calculations | For  Deflection  Calculations | | For  Stability  Calculations |
| **Stress Class** | **Fbx+**  (psi) | **Fbx– (1)**  (psi) | **Fc⊥x**  (psi) | **Fvx (4)**  (psi) | **Ex true**  (106 psi) | **Ex app**  (106 psi) | **Ex min**  (106 psi) | **Fby**  (psi) | **Fc⊥y**  (psi) | **Fvy (5)**  (psi) | **Ey true**  (106 psi) | **Ey app**  (106 psi) | **Ey min**  (106 psi) | **Ft**  (psi) | **Fc**  (psi) | **G** |
| **16F-1.3E**  **20F-1.5E**  **24F-1.7E** | 1600  2000  2400 | 925  1100  1450 | 315  425  500 | 195  195(6)  210(6) | 1.4  1.6  1.8 | 1.3  1.5  1.7 | 0.69  0.79  0.90 | 800  800  1050 | 315  315  315 | 170  170  185 | 1.2  1.3  1.4 | 1.1  1.2  1.3 | 0.58  0.63  0.69 | 675  725  775 | 925  925  1000 | 0.41  0.41  0.42 |
| **24F-1.8E** | 2400 | 1450(2) | 650 | 265(3) | 1.9 | 1.8 | 0.95 | 1450 | 560 | 230(3) | 1.7 | 1.6 | 0.85 | 1100 | 1600 | 0.50(10) |
| **26F-1.9E(7)**  **28F-2.1E SP(7)**  **30F-2.1E SP(7)(8)** | 2600  2800  3000 | 1950  2300  2400 | 650  805  805 | 265(3)  300  300 | 2.0  2.2(9)  2.2(9) | 1.9  2.1(9)  2.1(9) | 1.00  1.09  1.09 | 1600  1600  1750 | 560  650  650 | 230(3)  260  260 | 1.7  1.8  1.8 | 1.6  1.7  1.7 | 0.85  0.90  0.90 | 1150  1250  1250 | 1600  1750  1750 | 0.50(10)  0.55  0.55 |
| 1. For balanced layups, **Fbx–** shall be equal to **Fbx+** for the stress class. Designer shall specify when balanced layup is required. 2. Negative bending stress, **Fbx–**, is permitted to be increased to 1850 psi for Douglas Fir and to 1950 psi for Southern Pine for specific combinations. Designer shall specify when these increased stresses are required. 3. For structural glued laminated timber of **Southern Pine**, the basic shear design values, **Fvx** and **Fvy**, are permitted to be increased to **300 psi**, and **260 psi**, respectively. 4. The design values for shear, **Fvx** and **Fvy,** shall be decreased by multiplying by a factor of 0.72 for non-prismatic members, notched members, and for all members subject to impact or cyclic loading. The reduced design value shall be used for design of members at connections that transfer shear by mechanical fasteners. The reduced design value shall also be used for determination of design values for radial tension and torsion. 5. Design values are for timbers with laminations made from a single piece of lumber across the width or multiple pieces that have been edge bonded. For timbers manufactured from multiple piece laminations (across width) that are not edge bonded, value shall be multiplied by 0.4 for members with 5, 7, or 9 laminations or by 0.5 for all other members. This reduction shall be cumulative with the adjustment in footnote (4). 6. Certain Southern Pine combinations may contain lumber with wane. If lumber with wane is used, the design value for shear parallel to grain, **Fvx**, shall be multiplied by 0.67 if wane is allowed on both sides. If wane is limited to one side, **Fvx** shall be multiplied by 0.83. This reduction shall be cumulative with the adjustment in footnote (4). 7. 26F, 28F, and 30F beams are not produced by all manufacturers, therefore, availability may be limited. Contact supplier or manufacturer for details. 8. 30F combinations are restricted to a maximum 6 in. nominal width unless the manufacturer has qualified for wider widths based on full-scale tests subject to approval by an accredited inspection agency. 9. For 28F and 30F members with more than 15 laminations, Ex true = 2.1 million psi and **Ex app** = 2.0 million psi. 10. For structural glued laminated timber of Southern Pine, specific gravity for fastener design is permitted to be increased to 0.55.   **Stress classes represent groups of similar glued laminated timber combinations. Values for individual combinations are included in Table A1-Expanded. Design values are for members with 4 or more laminations. For 2 and 3 lamination members, see Table A2. Some stress classes ~~a~~re not available in all species. Contact manufacturer for availability.** | | | | | | | | | | | | | | | | |

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| **Table A1-Expanded – Reference Design Values for Structural Glued Laminated Softwood Timber Combinations(1)**  **(Members stressed primarily in bending)** (Tabulated design values are for normal load duration and dry service conditions. | | | | | | | | | | | | | | | | | | | |
| Combination Symbol | Species Outer/Core | **Bending About X-X Axis**  (Loaded Perpendicular to Wide Faces of Laminations) | | | | | | | | **Bending About Y-Y Axis**  (Loaded Parallel to Wide Faces of Laminations) | | | | | | **Axially Loaded** | | **Fasteners** | |
| Extreme Fiber  in Bending | | Compression Perpendicular  to Grain | | Shear  Parallel to Grain | Modulus of Elasticity | | | Extreme Fiber in Bending | Compression Perpendicular  to Grain | Shear Parallel to Grain | Modulus of  Elasticity | | | Tension Parallel to Grain | Compression Parallel to Grain | Specific Gravity for Fastener Design | |
| Bottom of beam Stressed in tension  (Positive Bending) | Top of Beam Stressed in Tension  (Negative Bending) | Tension  Face | Compression  Face |  | Top or Bottom Face | Side  Face |
| **Fbx+**  (psi) | **Fbx–**  (psi) | **Fc⊥x**  (psi) | | **Fvx (2)**  (psi) | **Ex true**  (106 psi) | **Ex app**  (106 psi) | **Ex min**  (106 psi) | **Fby**  (psi) | **Fc⊥y**  (psi) | **Fvy (3)**  (psi) | **Ey true**  (106 psi) | **Ey app**  (106 psi) | **Ey min**  (106 psi) | **Ft**  (psi) | **Fc**  (psi) | **G** | |
| **16F-1.3E** | | **1600** | **925** | **315** | | **195** | **1.4** | **1.3** | **0.69** | **800** | **315** | **170** | **1.2** | **1.1** | **0.58** | **675** | **925** | **0.41** | |
| 16F-V3  16F-V6  16F-E2  16F-E3  16F-E6  16F-E7 | DF/DF  DF/DF HF/HF DF/DF DF/DF HF/HF | 1600  1600  1600  1600  1600  1600 | 1250  1600  1050  1200  1600  1600 | 560  560  375  560  560  375 | 560  560  375  560  560  375 | 265  265  215  265  265  215 | 1.6  1.7  1.5  1.7  1.7  1.5 | 1.5  1.6  1.4  1.6  1.6  1.4 | 0.79  0.85  0.74  0.85  0.85  0.74 | 1450  1450  1200  1400  1550  1350 | 560  560  375  560  560  375 | 230  230  190  230  230  190 | 1.6  1.6  1.4  1.6  1.6  1.4 | 1.5  1.5  1.3  1.5  1.5  1.3 | 0.79  0.79  0.69  0.79  0.79  0.74 | 975  1000  825  975  1000  875 | 1500  1600  1150  1600  1600  1250 | 0.5  0.5  0.43  0.5  0.5  0.43 | 0.5  0.5  0.43  0.5  0.5  0.43 |
|  | | | | | | | | | | | | | | | | | | | |
| 16F-V2  16F-V3  16F-V5  16F-E1  16F-E3 | SP/SP  SP/SP  SP/SP  SP/SP  SP/SP | 1600  1600  1600  1600  1600 | 1400  1450  1600  1250  1600 | 740  740  650  650  650 | 650  740  650  650  650 | 300  300  300  300  300 | 1.6  1.5  1.7  1.7  1.8 | 1.5  1.4  1.6  1.6  1.7 | 0.79  0.74  0.85  0.85  0.90 | 1450  1450  1600  1400  1650 | 650  650  650  650  650 | 260  260  260  260  260 | 1.5  1.5  1.6  1.7  1.7 | 1.4  1.4  1.5  1.6  1.6 | 0.74  0.74  0.79  0.85  0.85 | 1000  975  1000  1050  1100 | 1300  1400  1550  1550  1550 | 0.55  0.55  0.55  0.55  0.55 | 0.55  0.55  0.55  0.55  0.55 |
| **20F-1.5E** | | **2000** | **1100** | **425** | | **195** | **1.6** | **1.5** | **0.79** | **800** | **315** | **170** | **1.3** | **1.2** | **0.63** | **725** | **925** | **0.41** | |
| 20F-V3  20F-V7  20F-V12  20F-V13  20F-V14  20F-V15  20F-E2  20F-E3  20F-E6  20F-E7  20F-E8  24F-E/SPF1  24F-E/SPF3 | DF/DF  DF/DF AC/AC AC/AC POC/POC POC/POC HF/HF DF/DF DF/DF HF/HF  ES/ES SPF/SPF SPF/SPF | 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2400  2400 | 1450  2000  1400  2000  1450  2000  1400  1200  2000  2000  1300  2400  1550 | 650  650  560  560  560  560  500  560  560  500  450  560  560 | 560  650  560  560  560  560  500  560  560  500  450  560  650 | 265  265  265  265  265  265  215  265  265  215  200  215  215 | 1.7  1.7  1.6  1.6  1.6  1.6  1.7  1.8  1.8  1.8  1.6  1.7  1.7 | 1.6  1.6  1.5  1.5  1.5  1.5  1.6  1.7  1.7  1.6  1.5  1.6  1.6 | 0.85  0.85  0.79  0.79  0.79  0.79  0.85  0.90  0.90  0.85  0.79  0.85  0.85 | 1450  1450  1250  1250  1300  1300  1200  1400  1550  1450  1000  1150  1200 | 560  560  470  470  470  470  375  560  560  375  315  470  470 | 230  230  230  230  230  230  190  230  230  190  175  190  195 | 1.6  1.7  1.5  1.5  1.5  1.5  1.5  1.7  1.7  1.5  1.5  1.7  1.6 | 1.5  1.6  1.4  1.4  1.4  1.4  1.4  1.6  1.6  1.4  1.4  1.6  1.5 | 0.79  0.85  0.74  0.74  0.74  0.74  0.74  0.85  0.85  0.74  0.74  0.85  0.79 | 1000  1050  925  950  900  900  925  1050  1150  1050  825  1150  900 | 1550  1600  1500  1550  1600  1600  1350  1600  1650  1450  1100  2000  1750 | 0.5  0.5  0.46  0.46  0.46  0.46  0.43  0.5  0.5  0.43  0.41  0.42  0.42 | 0.5  0.5  0.46  0.46  0.46  0.46  0.43  0.5  0.5  0.43  0.41  0.42  0.42 |
|  | | | | | | | | | | | | | | | | | | | |
| 20F-V2  20F-V3  20F-V5  20F-E1  20F-E3 | SP/SP  SP/SP  SP/SP  SP/SP  SP/SP | 2000  2000  2000  2000  2000 | 1550  1450  2000  1300  2000 | 740  650  740  650  650 | 650  650  740  650  650 | 300  300  300  300  300 | 1.6  1.6  1.7  1.8  1.8 | 1.5  1.5  1.6  1.7  1.7 | 0.79  0.79  0.85  0.90  0.90 | 1450  1600  1450  1400  1700 | 650  650  650  650  650 | 260  260  260  260  260 | 1.5  1.6  1.5  1.7  1.7 | 1.4  1.5  1.4  1.6  1.6 | 0.74  0.79  0.74  0.85  0.85 | 1000  1000  1050  1050  1150 | 1400  1400  1500  1550  1600 | 0.55  0.55  0.55  0.55  0.55 | 0.55  0.55  0.55  0.55  0.55 |
| **24F-1.7E** | | **2400** | **1450** | **500** | | **210** | **1.8** | **1.7** | **0.90** | **1050** | **315** | **185** | **1.4** | **1.3** | **0.69** | **775** | **1000** | **0.42** | |
| 24F-V5  24F-V10  24F-E11  24F-E15 | DF/HF  DF/HF HF/HF HF/HF | 2400  2400  2400  2400 | 1600  2400  2400  1600 | 650  650  500  500 | 650  650  500  500 | 215  215  215  215 | 1.8  1.9  1.9  1.9 | 1.7  1.8  1.8  1.8 ~~1.7~~ | 0.90  0.95  0.95  0.95 | 1350  1450  1550  1200 | 375  375  375  375 | 200  200  190  190 | 1.6  1.6  1.6  1.6 | 1.5  1.5  1.5  1.5 | 0.79  0.79  0.79  0.79 | 1100  1150  1150  975 | 1450  1550  1550  1500 | 0.5  0.5  0.43  0.43 | 0.43  0.43  0.43  0.43 |
|  | | | | | | | | | | | | | | | | | | | |
| 24F-V1  24F-V4(4)  24F-V5 | SP/SP  SP/SP  SP/SP | 2400  2400  2400 | 1750  1650  2400 | 740  740  740 | 650  650  740 | 300  210  300 | 1.8  1.8  1.8 | 1.7  1.7  1.7 | 0.90  0.90  0.90 | 1450  1350  1700 | 650  470  650 | 260  230  260 | 1.6  1.6  1.7 | 1.5  1.5  1.6 | 0.79  0.79  0.85 | 1100  975  1150 | 1500  1350  1600 | 0.55  0.55  0.55 | 0.55  0.43  0.55 |

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| **Table A1 Expanded – Reference Design Values for Structural Glued Laminated Softwood Timber Combinations(1)**  **(Members stressed primarily in bending)** (Tabulated design values are for normal load duration and dry service conditions. | | | | | | | | | | | | | | | | | | | | |
| Combination Symbol | Species Outer/Core | | **Bending About X-X Axis**  (Loaded Perpendicular to Wide Faces of Laminations) | | | | | | | | **Bending About Y-Y Axis**  (Loaded Parallel to Wide Faces of Laminations) | | | | | | **Axially Loaded** | | **Fasteners** | |
| Extreme Fiber  in Bending | | Compression Perpendicular  to Grain | | Shear  Parallel to Grain | Modulus of Elasticity | | | Extreme Fiber in Bending | Compression Perpendicular  to Grain | Shear Parallel to Grain | Modulus of  Elasticity | | | Tension Parallel to Grain | Compression Parallel to Grain | Specific Gravity for Fastener Design | |
| Bottom of beam Stressed in tension (Positive Bending) | Top of Beam Stressed in Tension  (Negative Bending) | Tension  Face | Compression  Face |  |  |  |  |  |  | Top or Bottom Face | Side Face |
| **Fbx+**  (psi) | **Fbx–**  (psi) | **Fc⊥x**  (psi) | | **Fvx (2)**  (psi) | **Ex true**  (106 psi) | **Ex app**  (106 psi) | **Ex min**  (106 psi) | **Fby**  (psi) | **Fc⊥y**  (psi) | **Fvy (3)**  (psi) | Ey true  (106 psi) | **Ey app**  (106 psi) | **Ey min**  (106 psi) | **Ft**  (psi) | **Fc**  (psi) | **G** | |
| **24F-1.8E** | | | **2400** | **1450** | **650** | | **265** | **1.8** | **1.8** | **0.95** | **1450** | **560** | **230** | **1.7** | **1.6** | **0.85** | **1100** | **1600** | **0.5** | |
| 24F-V4  24F-V8  24F-E4  24F-E13  24F-E18 | | DF/DF  DF/DF DF/DF DF/DF DF/DF | 2400  2400  2400  2400  2400 | 1850  2400  1450  2400  2400 | 650  650  650  650  650 | 650  650  650  650  650 | 265  265  265  265  265 | 1.8  1.8  1.8  1.8  1.8 | 1.8  1.8  1.8  1.8  1.8 | 0.95  0.95  0.95  0.95  0.95 | 1450  1550  1400  1750  1550 | 560  560  560  560  560 | 230  230  230  230  230 | 1.7  1.7  1.8  1.8  1.8 | 1.6  1.6  1.7  1.7  1.7 | 0.85  0.85  0.90  0.90  0.90 | 1100  1100  1100  1250  975 | 1650  1650  1700  1700  1700 | 0.5  0.5  0.5  0.5  0.5 | 0.5  0.5  0.5  0.5  0.5 |
|  | | | | | | | | | | | | | | | | | | | | |
| 24F-V3  24F-V8  24F-E1  24F-E4 | | SP/SP  SP/SP SP/SP SP/SP | 2400  2400  2400  2400 | 2000  2400  1450  2400 | 740  740  805  805 | 740  740  650  805 | 300  300  300  300 | 1.8  1.8  1.8  1.9 | 1.8  1.8  1.8  1.9 | 0.95  0.95  0.95  1.00 | 1700  1700  1550  1850 | 650  650  650  650 | 260  260  260  260 | 1.7  1.7  1.8  1.9 | 1.6  1.6  1.7  1.8 | 0.85  0.85  0.90  0.95 | 1150  1150  1150  1450 | 1650  1650  1600  1750 | 0.55  0.55  0.55  0.55 | 0.55  0.55  0.55  0.55 |
| **26F-1.9E(5)** | | | **2600** | **1950** | **650** | | **265** | **1.9** | **1.9** | **1.00** | **1600** | **560** | **230** | **1.7** | **1.6** | **0.85** | **1150** | **1600** | **0.5** | |
| 26F-V1  26F-V2 | | DF/DF  DF/DF | 2600  2600 | 1950  2600 | 650  650 | 650  650 | 265  265 | 2.0  2.0 | 2.0  2.0 | 1.06  1.06 | 1850  1850 | 560  560 | 230  230 | 1.9  1.9 | 1.8  1.8 | 0.95  0.95 | 1350  1350 | 1850  1850 | 0.5  0.5 | 0.5  0.5 |
|  | | | | | | | | | | | | | | | | | | | |  |
| 26F-V1  26F-V2  26F-V3  26F-V4  26F-V5 | | SP/SP  SP/SP SP/SP SP/SP SP/SP | 2600  2600  2600  2600  2600 | 2000  2100  2100  2600  2600 | 740  740  740  740  740 | 740  740  740  740  740 | 300  300  300  300  300 | 1.8  1.9  1.9  1.9  1.9 | 1.8  1.9  1.9  1.9  1.9 | 0.95  1.00  1.00  1.00  1.00 | 1700  1950  1950  1700  1950 | 650  740  650  650  650 | 260  260  260  260  260 | 1.7  1.9  1.9  1.9  1.9 | 1.6  1.8  1.8  1.8  1.8 | 0.85  0.95  0.95  0.95  0.95 | 1150  1300  1250  1200  1300 | 1600  1850  1800  1600  1850 | 0.55  0.55  0.55  0.55  0.55 | 0.55  0.55  0.55  0.55  0.55 |
| **28F-2.1E SP(5)** | | | **2800** | **2300** | **805** | | **300** | **2.1(7)** | **2.1(7)** | **1.09** | **1600** | **650** | **260** | **1.8** | **1.7** | **0.90** | **1250** | **1750** | **0.55** | |
| 28F-E1  28F-E2 | | SP/SP SP/SP | 2800  2800 | 2300  2800 | 805  805 | 805  805 | 300  300 | 2.1**(7)**  2.1**(7)** | 2.1**(7)**  2.1**(7)** | 1.09  1.09 | 1600  2000 | 650  650 | 260  260 | 1.8  1.8 | 1.7  1.7 | 0.90  0.90 | 1300  1300 | 1850  1850 | 0.55  0.55 | 0.55  0.55 |
| **30F-2.1E SP(5)(6)** | | | **3000** | **2400** | **805** | | **300** | **2.1(7)** | **2.1(7)** | **1.09** | **1750** | **650** | **260** | **1.8** | **1.7** | **0.90** | **1250** | **1750** | **0.55** | |
| 30F-E1  30F-E2 | | SP/SP SP/SP | 3000  3000 | 2400  3000 | 805  805 | 805  805 | 300  300 | 2.1**(7)**  2.1**(7)** | 2.1**(7)**  2.1**(7)** | 1.09  1.09 | 1750  1750 | 650  650 | 260  260 | 1.8  1.8 | 1.7  1.7 | 0.90  0.90 | 1250  1350 | 1750  1750 | 0.55  0.55 | 0.55  0.55 |
| **Footnotes to Table A1:**   1. The combinations in this table are applicable to members consisting of 4 or more laminations and are intended primarily for members stressed in bending due to loads applied perpendicular to the wide faces of the ~~the~~ laminations. However, design values are tabulated for loading both perpendicular and parallel to the wide faces of the laminations. For combinations and design values applicable to members loaded primarily axially or parallel to the wide faces of the laminations, see Table A2. For members of 2 or 3 laminations, see Table A2. 2. The design values for shear, **Fvx** and **Fvy** shall be decreased by multiplying by a factor of 0.72 for non-prismatic members, notched members, and for all members subject to impact or cyclic loading. The reduced design value shall be used for design of members at connections that transfer shear by mechanical fasteners. The reduced design value shall also be used for determination of design values for radial tension and torsion. 3. Design values are for timbers with laminations made from a single piece of lumber across the width or multiple pieces that have been edge bonded. For timber manufactured from multiple piece laminations (across width) that are not edge-bonded, value shall be multiplied by 0.4 for members with 5, 7, or 9 laminations or by 0.5 for all other members. This reduction shall be cumulative with the adjustment in footnote 3. 4. This combination may contain lumber with wane. If lumber with wane is used, the design value for shear parallel to grain, **FVX**, shall be multiplied by 0.67 if wane is allowed on both sides. If wane is limited to one side, **Fvx** shall be multiplied by 0.83. This reduction shall be cumulative with the adjustment in footnote 3. 5. 26F, 28F, and 30F beams are not produced by all manufacturers, therefore, availability may be limited. Contact supplier or manufacturer for details. 6. 30F combinations are restricted to a maximum 6 in. nominal width unless the manufacturer has qualified for wider widths based on full-scale tests subject to approval by an accredited inspection agency. 7. For 28F and 30F members with more than 15 laminations, Ex true = 2.1 million psi and **Ex app** = 2.0 million psi. | | | | | | | | | | | | | | | | | | | | |

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| **Table A2 – Reference Design Values for Structural Glued Laminated Softwood Timber (Members stressed primarily in axial tension or compression)** (Tabulated design values are for normal load duration and dry service conditions.) | | | | | | | | | | | | | | | |
| Combination  Symbol | Species | Grade | **All Loading** | | | | **Axially Loaded** | | | **Bending about Y-Y Axis**  Loaded Parallel to Wide  Faces of Laminations | | | | **Bending About X-X Axis**  Loaded Perpendicular to  Wide Faces of Laminations | |
| Modulus of  Elasticity | | | Compression Perpendicular to Grain  **Fc**⊥  (psi) | Tension Parallel to Grain | Compression  Parallel to Grain | |
| Bending | | | Shear Parallel  to Grain(1)(2) | Bending | Shear Parallel  to Grain(3) |
| 2 or More Lami- nations  **Ft**  (psi) | 4 or More Lami- nations  **Fc**  (psi) | 2 or 3  Lami- nations  **Fc**  (psi) | 4 or More Lami- nations  **Fby**  (psi) | 3  Lami- nations  **Fby**  (psi) | 2  Lami- nations  **Fby**  (psi) | **Fvy**  (psi) | 2 Lami- nations to  15 in. Deep(4)  **Fbx**  (psi) | **Fvx**  (psi) |
| **Eaxial**  (106 psi) | **0.95 Eaxial**  (106 psi) | **Eaxial min**  (106 psi) |
| Visually Graded Western Species | | | | | | |  | | | | | | | | |
| 1  2  3  4  5 | DF  DF  DF  DF  DF | L3  L2  L2D L1CL  L1 | 1.6  1.7  2.0  2.0  2.1 | 1.5  1.6  1.9  1.9  2.0 | 0.79  0.85  1.00  1.00  1.06 | 560  560  650  590  650 | 950  1250  1450  1400  1650 | 1550  1950  2300  2100  2400 | 1250  1600  1900  1950  2100 | 1450  1800  2100  2200  2400 | 1250  1600  1850  2000  2100 | 1000  1300  1550  1650  1800 | 230  230  230  230  230 | 1250  1700  2000  2100  2200 | 265  265  265  265  265 |
| 14  15  16  17 | HF  HF  HF  HF | L3  L2  L1  L1D | 1.4  1.5  1.7  1.8 | 1.3  1.4  1.6  1.7 | 0.69  0.74  0.85  0.90 | 375  375  375  500 | 800  1050  1200  1400 | 1100  1350  1500  1750 | 1050  1350  1500  1750 | 1200  1500  1750  2000 | 1050  1350  1550  1850 | 850  1100  1300  1550 | 190  190  190  190 | 1100  1450  1600  1900 | 215  215  215  215 |
| 22(5) | SW | L3 | 1.1 | 1.0 | 0.53 | 315 | 525 | 850 | 725 | 800 | 700 | 575 | 170 | 725 | 195 |
| 69  70  71  72 | AC  AC  AC  AC | L3  L2  L1D  L1S | 1.3  1.4  1.7  1.7 | 1.2  1.3  1.6  1.6 | 0.63  0.69  0.85  0.85 | 470  470  560  560 | 725  975  1250  1250 | 1150  1450  1900  1900 | 1100  1450  1900  1900 | 1100  1400  1850  1850 | 975  1250  1650  1650 | 775  1000  1400  1400 | 230  230  230  230 | 1000  1350  1750  1900 | 265  265  265  265 |
| 73  74  75 | POC  POC POC | L3  L2  L1D | 1.4  1.5  1.8 | 1.3  1.4  1.7 | 0.69  0.74  0.90 | 470  470  560 | 775  1050  1350 | 1500  1900  2300 | 1200  1550  2050 | 1200  1450  1950 | 1050  1300  1750 | 825  1100  1500 | 230  230  230 | 1050  1400  1850 | 265  265  265 |
| Visually Graded Southern Pine | | | | | | |  | | | | | | | | |
| 47  47 1:10  47 1:8  48  48 1:10  48 1:8  49  49 1:14  49 1:12  49 1:10  50  50 1:12  50 1:10 | SP  SP  SP  SP  SP  SP  SP  SP  SP  SP  SP  SP  SP | N2M12  N2M10  N2M N2D12  N2D10  N2D N1M16  N1M14  N1M12  N1M N1D14  N1D12  N1D | 1.5  1.5  1.5  1.8  1.8  1.8  1.8  1.8  1.8  1.8  2.0  2.0  2.0 | 1.4  1.4  1.4  1.7  1.7  1.7  1.7  1.7  1.7  1.7  1.9  1.9  1.9 | 0.74  0.74  0.74  0.90  0.90  0.90  0.90  0.90  0.90  0.90  1.00  1.00  1.00 | 650  650  650  740  740  740  650  650  650  650  740  740  740 | 1200  1150  1000  1400  1350  1150  1350  1350  1300  1150  1550  1500  1350 | 1900  1700  1500  2200  2000  1750  2100  2000  1900  1700  2300  2200  2000 | 1150  1150  1150  1350  1350  1350  1450  1450  1450  1450  1700  1700  1700 | 1750  1750  1600  2000  2000  1850  1950  1950  1950  1850  2300  2300  2100 | 1550  1550  1550  1800  1800  1800  1750  1750  1750  1750  2100  2100  2100 | 1300  1300  1300  1500  1500  1500  1500  1500  1500  1500  1750  1750  1750 | 260  260  260  260  260  260  260  260  260  260  260  260  260 | 1400  1400  1400  1600  1600  1600  1800  1800  1800  1800  2100  2100  2100 | 300  300  300  300  300  300  300  300  300  300  300  300  300 |
| **Footnotes to Table A2**   1. For members with 2 or 3 laminations, the shear design value for transverse loads parallel to the wide faces of the laminations, **Fvy**, shall be reduced by multiplying by a factor of 0.84 or 0.95, respectively. 2. The shear design value for transverse loads applied parallel to the wide faces of the laminations, **Fvy**, shall be multiplied by 0.4 for members with 5, 7, or 9 laminations manufactured from multiple piece laminations (across width) that are not edge bonded. The shear design value, **Fvy**, shall be multiplied by 0.5 for all other members manufactured from multiple piece laminations with unbonded edge joints. This reduction shall be cumulative with the adjustment in footnote (1). 3. The design values for shear, **Fvx** and **Fvy**, shall be decreased by multiplying by a factor of 0.72 for non-prismatic members, notched members, and for all members subject to impact or cyclic loading. The reduced design value shall be used for design of members at connections that transfer shear by mechanical fasteners. The reduced design value shall also be used for determination of design values for radial tension and torsion. 4. The tabulated Fbx values are for members without special tension lams up to 15 inches in depth. If the member depth is greater than 15 inches without special tension lams, the tabulated Fbx values must be multiplied by a factor of 0.88. If special tension lams are used, the tabulated Fbx values are permitted to be increased by a factor of 1.18 regardless of the member depth. ~~For members greater than 15 in. deep, the bending design value,~~ **~~F~~~~bx~~~~,~~** ~~shall be reduced by multiplying by a factor of 0.88.~~ 5. When Western Cedars, Western Cedars (North), Western Woods, and Redwood (open grain) are used in combinations for Softwood Species (SW), the design value for modulus of elasticity shall be reduced by 100,000 psi. When Coast Sitka Spruce, Coast Species, Western White Pine, and Eastern White Pine are used in combinations for Softwood Species (SW) tabulated design values for shear parallel to grain, **Fvx** and **Fvy**, shall be reduced by 10 psi, before applying any other adjustments. | | | | | | | | | | | | | | | |

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| **Table A3 – Reference Design Values for Structural Glued Laminated  Softwood Timber Combinations with Taper Cuts (Figure 3.6-1) on the Compression Face(1)(2)** | | | | | | | |
| Combination Symbol | Species Outer/Core | **Fbx**+(psi) | **Ex true**(106 psi) | **Ex app**(106 psi) | **Ex min**(106 psi) | **Fc⊥x Top**(psi) | **Fvx(3)** (psi) |
| **16F-1.3E** | | **1050** | **1.3** | **1.2** | **0.63** | **315** | **140** |
| 16F-V3  16F-V6  16F-E2  16F-E3  16F-E6  16F-E7  16F-V2  16F-V3  16F-V5  16F-E1  16F-E3 | DF/DF  DF/DF HF/HF DF/DF DF/DF HF/HF SP/SP SP/SP SP/SP SP/SP SP/SP | 1600  1600  1350  1600  1600  1350  1450  1550  1550  1600  1600 | 1.6  1.6  1.5  1.7  1.7  1.5  1.6  1.5  1.6  1.7  1.7 | 1.5  1.5  1.4  1.6  1.6  1.4  1.5  1.4  1.5  1.6  1.6 | 0.79  0.79  0.74  0.85  0.85  0.74  0.79  0.74  0.79  0.85  0.85 | 560  560  375  560  560  375  650  650  650  650  650 | 190  190  155  190  190  155  215  215  215  215  215 |
| **20F-1.5E** | | **1250** | **1.5** | **1.4** | **0.74** | **375** | **150** |
| 20F-V3  20F-V7  20F-V12  20F-V13  20F-E2  20F-E3  20F-E6  20F-E7  20F-V2  20F-V3  20F-V5  20F-E1  20F-E3 | DF/DF  DF/DF AC/AC  AC/AC  HF/HF  DF/DF  DF/DF  HF/HF  SP/SP  SP/SP  SP/SP  SP/SP  SP/SP | 1900  1900  1650  1650  1700  1900  1900  1700  1500  1700  1500  1950  1900 | 1.7  1.7  1.5  1.5  1.6  1.7  1.7  1.6  1.5  1.6  1.6  1.7  1.7 | 1.6  1.6  1.4  1.4  1.5  1.6  1.6  1.5  1.4  1.5  1.5  1.6  1.6 | 0.85  0.85  0.74  0.74  0.79  0.85  0.85  0.79  0.74  0.79  0.79  0.85  0.85 | 560  560  470  470  375  560  560  375  650  650  650  650  650 | 190  190  190  190  155  190  190  155  215  215  215  215  215 |
| **24F-1.7E** | | **1250** | **1.5** | **1.4** | **0.74** | **375** | **150** |
| 24F-V5  24F-V10  24F-E2  24F-E11  24F-E15  24F-V1  24F-V4  24F-V5 | DF/HF  DF/HF  HF/HF  HF/HF  HF/HF  SP/SP  SP/SP  SP/SP | 1900  1900  1900  1900  1900  1800  1250  2100 | 1.7  1.7  1.7  1.7  1.7  1.7  1.5  1.8 | 1.6  1.6  1.6  1.6  1.6  1.6  1.4  1.7 | 0.85  0.85  0.85  0.85  0.85  0.85  0.74  0.90 | 375  375  375  375  375  650  470  650 | 190  155  155  155  155  215  215  215 |
| **24F-1.8E** | | **2000** | **1.8** | **1.7** | **0.90** | **560** | **190** |
| 24F-V4  24F-V8  24F-E4  24F-E13  24F-E18  24F-V3  24F-V8  24F-E1  24F-E4 | DF/DF  DF/DF  DF/DF DF/DF  DF/DF  SP/SP  SP/SP  SP/SP  SP/SP | 2100  2100  2100  2100  2100  2100  2100  2100  2100 | 1.8  1.8  1.8  1.8  1.8  1.8  1.8  1.8  1.8 | 1.7  1.7  1.7  1.7  1.7  1.7  1.7  1.7  1.7 | 0.90  0.90  0.90  0.90  0.90  0.90  0.90  0.90  0.90 | 560  560  560  560  560  650  650  650  650 | 190  190  190  190  190  215  215  215  215 |
| **26F-1.9E** | | **2000** | **1.8** | **1.7** | **0.90** | **560** | **190** |
| 26F-V1  26F-V2  26F-V1  26F-V2  26F-V3  26F-V4  26F-V5 | DF/DF DF/DF SP/SP  SP/SP  SP/SP  SP/SP  SP/SP | 2100  2100  2000  2400  2000  2000  2000 | 1.8  1.8  1.8  1.9  1.9  1.9  1.9 | 1.7  1.7  1.7  1.8  1.8  1.8  1.8 | 0.90  0.90  0.90  0.95  0.95  0.95  0.95 | 560  560  650  740  650  650  740 | 190  190  215  215  215  215  215 |
| **28F-2.1E** | | **2400** | **2.0** | **1.9** | **1.00** | **650** | **215** |
| 28F-E1  28F-E2 | SP/SP  SP/SP | 2400  2400 | 2.0  2.0 | 1.9  1.9 | 1.00  1.00 | 650  650 | 215  215 |
| **30F-2.1E** | | **2400** | **2.0** | **1.9** | **1.00** | **650** | **215** |
| 30F-E1  30F-E2 | SP/SP  SP/SP | 2400  2400 | 2.0  2.0 | 1.9  1.9 | 1.00  1.00 | 650  650 | 215  215 |
| 1. Design values are applicable to beams that have up to 2/3 of the depth on the compression side removed by taper cutting. 2. Tabulated design values apply only to tapered portion of member 3. Shear design value has been reduced for non-prismatic members | | | | | | | |

Attachment 4

Revise References as shown in **Attachment 4**, and update the references in the text of the standard.

**Rationale:** Update the references in this standard.

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