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. 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:

$$E\_{min}=\frac{E\left[1-1.645\left(CoV\_{E}\right)\right]\left[1.05\right]}{1.66}=\frac{E\left[1-1.645\left(0.10\right)\right]\left[1.05\right]}{1.66}=0.528E$$



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 | CompressionPerpendicular to Grain | ShearParallel to Grain | Modulusof Elasticity | ExtremeFiber inBending | CompressionPerpendicular to Grain | ShearParallel to Grain | Modulusof Elasticity |
| Bottom of BeamStressed in Tension(Positive Bending) | Top of BeamStressed in Tension(Negative Bending) |
| ForDeflectionCalculations | ForStabilityCalculations | ForDeflectionCalculations | ForStabilityCalculations |
| **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** | 160020002400 | 92511001450 | 315425500 | 195195(6)210(6) | 1.41.61.8 | 1.31.51.7 | 0.690.790.90 | 8008001050 | 315315315 | 170170185 | 1.21.31.4 | 1.11.21.3 | 0.580.630.69 | 675725775 | 9259251000 | 0.410.410.42 |
| **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)** | 260028003000 | 195023002400 | 650805805 | 265(3)300300 | 2.02.2(9)2.2(9) | 1.92.1(9)2.1(9) | 1.001.091.09 | 160016001750 | 560650650 | 230(3)260260 | 1.71.81.8 | 1.61.71.7 | 0.850.900.90 | 115012501250 | 160017501750 | 0.50(10)0.550.55 |
| 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. |
| CombinationSymbol | SpeciesOuter/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 | CompressionPerpendicular to Grain | Shear Parallelto Grain | Modulusof Elasticity | ExtremeFiber inBending | CompressionPerpendicular to Grain | Shear Parallelto Grain | ModulusofElasticity | TensionParallel to Grain | CompressionParallel toGrain | Specific GravityforFastener Design |
| Bottom of beam Stressed in tension(Positive Bending) | Top of Beam Stressed in Tension(Negative Bending) | TensionFace | CompressionFace |  | 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-V316F-V616F-E216F-E316F-E616F-E7 | DF/DFDF/DF HF/HF DF/DF DF/DF HF/HF | 160016001600160016001600 | 125016001050120016001600 | 560560375560560375 | 560560375560560375 | 265265215265265215 | 1.61.71.51.71.71.5 | 1.51.61.41.61.61.4 | 0.790.850.740.850.850.74 | 145014501200140015501350 | 560560375560560375 | 230230190230230190 | 1.61.61.41.61.61.4 | 1.51.51.31.51.51.3 | 0.790.790.690.790.790.74 | 97510008259751000875 | 150016001150160016001250 | 0.50.50.430.50.50.43 | 0.50.50.430.50.50.43 |
|  |
| 16F-V216F-V316F-V516F-E116F-E3 | SP/SPSP/SP SP/SP SP/SP SP/SP | 16001600160016001600 | 14001450160012501600 | 740740650650650 | 650740650650650 | 300300300300300 | 1.61.51.71.71.8 | 1.51.41.61.61.7 | 0.790.740.850.850.90 | 14501450160014001650 | 650650650650650 | 260260260260260 | 1.51.51.61.71.7 | 1.41.41.51.61.6 | 0.740.740.790.850.85 | 1000975100010501100 | 13001400155015501550 | 0.550.550.550.550.55 | 0.550.550.550.550.55 |
| **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-V320F-V720F-V1220F-V1320F-V1420F-V1520F-E220F-E320F-E620F-E720F-E824F-E/SPF124F-E/SPF3 | DF/DFDF/DF AC/AC AC/AC POC/POC POC/POC HF/HF DF/DF DF/DF HF/HF ES/ES SPF/SPF SPF/SPF | 2000200020002000200020002000200020002000200024002400 | 1450200014002000145020001400120020002000130024001550 | 650650560560560560500560560500450560560 | 560650560560560560500560560500450560650 | 265265265265265265215265265215200215215 | 1.71.71.61.61.61.61.71.81.81.81.61.71.7 | 1.61.61.51.51.51.51.61.71.71.61.51.61.6 | 0.850.850.790.790.790.790.850.900.900.850.790.850.85 | 1450145012501250130013001200140015501450100011501200 | 560560470470470470375560560375315470470 | 230230230230230230190230230190175190195 | 1.61.71.51.51.51.51.51.71.71.51.51.71.6 | 1.51.61.41.41.41.41.41.61.61.41.41.61.5 | 0.790.850.740.740.740.740.740.850.850.740.740.850.79 | 100010509259509009009251050115010508251150900 | 1550160015001550160016001350160016501450110020001750 | 0.50.50.460.460.460.460.430.50.50.430.410.420.42 | 0.50.50.460.460.460.460.430.50.50.430.410.420.42 |
|  |
| 20F-V220F-V320F-V520F-E120F-E3 | SP/SPSP/SP SP/SP SP/SP SP/SP | 20002000200020002000 | 15501450200013002000 | 740650740650650 | 650650740650650 | 300300300300300 | 1.61.61.71.81.8 | 1.51.51.61.71.7 | 0.790.790.850.900.90 | 14501600145014001700 | 650650650650650 | 260260260260260 | 1.51.61.51.71.7 | 1.41.51.41.61.6 | 0.740.790.740.850.85 | 10001000105010501150 | 14001400150015501600 | 0.550.550.550.550.55 | 0.550.550.550.550.55 |
| **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-V524F-V1024F-E1124F-E15 | DF/HFDF/HF HF/HF HF/HF | 2400240024002400 | 1600240024001600 | 650650500500 | 650650500500 | 215215215215 | 1.81.91.91.9 | 1.71.81.81.8 ~~1.7~~ | 0.900.950.950.95 | 1350145015501200 | 375375375375 | 200200190190 | 1.61.61.61.6 | 1.51.51.51.5 | 0.790.790.790.79 | 110011501150975 | 1450155015501500 | 0.50.50.430.43 | 0.430.430.430.43 |
|  |
| 24F-V124F-V4(4)24F-V5 | SP/SPSP/SP SP/SP | 240024002400 | 175016502400 | 740740740 | 650650740 | 300210300 | 1.81.81.8 | 1.71.71.7 | 0.900.900.90 | 145013501700 | 650470650 | 260230260 | 1.61.61.7 | 1.51.51.6 | 0.790.790.85 | 11009751150 | 150013501600 | 0.550.550.55 | 0.550.430.55 |

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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. |
| CombinationSymbol | SpeciesOuter/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 | CompressionPerpendicular to Grain | Shear Parallelto Grain | Modulusof Elasticity | ExtremeFiber inBending | CompressionPerpendicular to Grain | Shear Parallelto Grain | ModulusofElasticity | TensionParallel to Grain | CompressionParallel toGrain | Specific GravityforFastener Design |
| Bottomof beam Stressed in tension (Positive Bending) | Top of Beam Stressed in Tension(Negative Bending) | TensionFace | CompressionFace |  |  |  |  |  |  | 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-V424F-V824F-E424F-E1324F-E18 | DF/DFDF/DF DF/DF DF/DF DF/DF | 24002400240024002400 | 18502400145024002400 | 650650650650650 | 650650650650650 | 265265265265265 | 1.81.81.81.81.8 | 1.81.81.81.81.8 | 0.950.950.950.950.95 | 14501550140017501550 | 560560560560560 | 230230230230230 | 1.71.71.81.81.8 | 1.61.61.71.71.7 | 0.850.850.900.900.90 | 1100110011001250975 | 16501650170017001700 | 0.50.50.50.50.5 | 0.50.50.50.50.5 |
|  |
| 24F-V324F-V824F-E124F-E4 | SP/SPSP/SP SP/SP SP/SP | 2400240024002400 | 2000240014502400 | 740740805805 | 740740650805 | 300300300300 | 1.81.81.81.9 | 1.81.81.81.9 | 0.950.950.951.00 | 1700170015501850 | 650650650650 | 260260260260 | 1.71.71.81.9 | 1.61.61.71.8 | 0.850.850.900.95 | 1150115011501450 | 1650165016001750 | 0.550.550.550.55 | 0.550.550.550.55 |
| **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-V126F-V2 | DF/DFDF/DF | 26002600 | 19502600 | 650650 | 650650 | 265265 | 2.02.0 | 2.02.0 | 1.061.06 | 18501850 | 560560 | 230230 | 1.91.9 | 1.81.8 | 0.950.95 | 13501350 | 18501850 | 0.50.5 | 0.50.5 |
|  |  |
| 26F-V126F-V226F-V326F-V426F-V5 | SP/SPSP/SP SP/SP SP/SP SP/SP | 26002600260026002600 | 20002100210026002600 | 740740740740740 | 740740740740740 | 300300300300300 | 1.81.91.91.91.9 | 1.81.91.91.91.9 | 0.951.001.001.001.00 | 17001950195017001950 | 650740650650650 | 260260260260260 | 1.71.91.91.91.9 | 1.61.81.81.81.8 | 0.850.950.950.950.95 | 11501300125012001300 | 16001850180016001850 | 0.550.550.550.550.55 | 0.550.550.550.550.55 |
| **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-E128F-E2 | SP/SP SP/SP | 28002800 | 23002800 | 805805 | 805805 | 300300 | 2.1**(7)**2.1**(7)** | 2.1**(7)**2.1**(7)** | 1.091.09 | 16002000 | 650650 | 260260 | 1.81.8 | 1.71.7 | 0.900.90 | 13001300 | 18501850 | 0.550.55 | 0.550.55 |
| **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-E130F-E2 | SP/SP SP/SP | 30003000 | 24003000 | 805805 | 805805 | 300300 | 2.1**(7)**2.1**(7)** | 2.1**(7)**2.1**(7)** | 1.091.09 | 17501750 | 650650 | 260260 | 1.81.8 | 1.71.7 | 0.900.90 | 12501350 | 17501750 | 0.550.55 | 0.550.55 |
| **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.) |
| CombinationSymbol | Species | Grade | **All Loading** | **Axially Loaded** | **Bending about Y-Y Axis**Loaded Parallel to WideFaces 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 | CompressionParallel to Grain |
| Bending | Shear Parallelto Grain(1)(2) | Bending | Shear Parallelto Grain(3) |
| 2 or More Lami- nations **Ft**(psi) | 4 or More Lami- nations **Fc**(psi) | 2 or 3Lami- nations **Fc**(psi) | 4 or More Lami- nations **Fby**(psi) | 3Lami- nations **Fby**(psi) | 2Lami- 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 |  |
| 12345 | DFDFDFDFDF | L3L2L2D L1CL L1 | 1.61.72.02.02.1 | 1.51.61.91.92.0 | 0.790.851.001.001.06 | 560560650590650 | 9501250145014001650 | 15501950230021002400 | 12501600190019502100 | 14501800210022002400 | 12501600185020002100 | 10001300155016501800 | 230230230230230 | 12501700200021002200 | 265265265265265 |
| 14151617 | HFHFHFHF | L3L2L1L1D | 1.41.51.71.8 | 1.31.41.61.7 | 0.690.740.850.90 | 375375375500 | 800105012001400 | 1100135015001750 | 1050135015001750 | 1200150017502000 | 1050135015501850 | 850110013001550 | 190190190190 | 1100145016001900 | 215215215215 |
| 22(5) | SW | L3 | 1.1 | 1.0 | 0.53 | 315 | 525 | 850 | 725 | 800 | 700 | 575 | 170 | 725 | 195 |
| 69707172 | ACACACAC | L3L2L1D L1S | 1.31.41.71.7 | 1.21.31.61.6 | 0.630.690.850.85 | 470470560560 | 72597512501250 | 1150145019001900 | 1100145019001900 | 1100140018501850 | 975125016501650 | 775100014001400 | 230230230230 | 1000135017501900 | 265265265265 |
| 737475 | POCPOC POC | L3L2L1D | 1.41.51.8 | 1.31.41.7 | 0.690.740.90 | 470470560 | 77510501350 | 150019002300 | 120015502050 | 120014501950 | 105013001750 | 82511001500 | 230230230 | 105014001850 | 265265265 |
| Visually Graded Southern Pine |  |
| 4747 1:1047 1:84848 1:1048 1:84949 1:1449 1:1249 1:105050 1:1250 1:10 | SPSPSPSPSPSPSPSPSPSPSPSPSP | N2M12N2M10N2M N2D12N2D10N2D N1M16N1M14N1M12N1M N1D14N1D12N1D | 1.51.51.51.81.81.81.81.81.81.82.02.02.0 | 1.41.41.41.71.71.71.71.71.71.71.91.91.9 | 0.740.740.740.900.900.900.900.900.900.901.001.001.00 | 650650650740740740650650650650740740740 | 1200115010001400135011501350135013001150155015001350 | 1900170015002200200017502100200019001700230022002000 | 1150115011501350135013501450145014501450170017001700 | 1750175016002000200018501950195019501850230023002100 | 1550155015501800180018001750175017501750210021002100 | 1300130013001500150015001500150015001500175017501750 | 260260260260260260260260260260260260260 | 1400140014001600160016001800180018001800210021002100 | 300300300300300300300300300300300300300 |
| **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)** |
| CombinationSymbol | SpeciesOuter/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-V316F-V616F-E216F-E316F-E616F-E716F-V216F-V316F-V516F-E116F-E3 | DF/DFDF/DFHF/HFDF/DFDF/DFHF/HFSP/SPSP/SPSP/SPSP/SPSP/SP | 16001600135016001600135014501550155016001600 | 1.61.61.51.71.71.51.61.51.61.71.7 | 1.51.51.41.61.61.41.51.41.51.61.6 | 0.790.790.740.850.850.740.790.740.790.850.85 | 560560375560560375650650650650650 | 190190155190190155215215215215215 |
| **20F-1.5E** | **1250** | **1.5** | **1.4** | **0.74** | **375** | **150** |
| 20F-V320F-V720F-V1220F-V1320F-E220F-E320F-E620F-E720F-V220F-V320F-V520F-E120F-E3 | DF/DFDF/DFAC/AC AC/AC HF/HF DF/DF DF/DF HF/HF SP/SP SP/SP SP/SP SP/SP SP/SP | 1900190016501650170019001900170015001700150019501900 | 1.71.71.51.51.61.71.71.61.51.61.61.71.7 | 1.61.61.41.41.51.61.61.51.41.51.51.61.6 | 0.850.850.740.740.790.850.850.790.740.790.790.850.85 | 560560470470375560560375650650650650650 | 190190190190155190190155215215215215215 |
| **24F-1.7E** | **1250** | **1.5** | **1.4** | **0.74** | **375** | **150** |
| 24F-V524F-V1024F-E224F-E1124F-E1524F-V124F-V424F-V5 | DF/HFDF/HF HF/HF HF/HF HF/HF SP/SP SP/SP SP/SP | 19001900190019001900180012502100 | 1.71.71.71.71.71.71.51.8 | 1.61.61.61.61.61.61.41.7 | 0.850.850.850.850.850.850.740.90 | 375375375375375650470650 | 190155155155155215215215 |
| **24F-1.8E** | **2000** | **1.8** | **1.7** | **0.90** | **560** | **190** |
| 24F-V424F-V824F-E424F-E1324F-E1824F-V324F-V824F-E124F-E4 | DF/DFDF/DF DF/DFDF/DF DF/DF SP/SP SP/SP SP/SP SP/SP | 210021002100210021002100210021002100 | 1.81.81.81.81.81.81.81.81.8 | 1.71.71.71.71.71.71.71.71.7 | 0.900.900.900.900.900.900.900.900.90 | 560560560560560650650650650 | 190190190190190215215215215 |
| **26F-1.9E** | **2000** | **1.8** | **1.7** | **0.90** | **560** | **190** |
| 26F-V126F-V226F-V126F-V226F-V326F-V426F-V5 | DF/DFDF/DFSP/SP SP/SP SP/SP SP/SP SP/SP | 2100210020002400200020002000 | 1.81.81.81.91.91.91.9 | 1.71.71.71.81.81.81.8 | 0.900.900.900.950.950.950.95 | 560560650740650650740 | 190190215215215215215 |
| **28F-2.1E** | **2400** | **2.0** | **1.9** | **1.00** | **650** | **215** |
| 28F-E128F-E2 | SP/SPSP/SP | 24002400 | 2.02.0 | 1.91.9 | 1.001.00 | 650650 | 215215 |
| **30F-2.1E** | **2400** | **2.0** | **1.9** | **1.00** | **650** | **215** |
| 30F-E130F-E2 | SP/SPSP/SP | 24002400 | 2.02.0 | 1.91.9 | 1.001.00 | 650650 | 215215 |
| 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.

# **References**

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