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# ICC-ES Report

## ESR-1940

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Reissued 01/2016

This report is subject to renewal 01/2018.

**DIVISION: 06 00 00—WOOD, PLASTICS AND COMPOSITES**

**SECTION: 06 02 00—DESIGN INFORMATION**

**REPORT HOLDER:**

**APA- THE ENGINEERED WOOD ASSOCIATION**

**7011 SOUTH 19<sup>TH</sup> STREET  
TACOMA, WASHINGTON 98466**

**EVALUATION SUBJECT:**

**GLUED-LAMINATED TIMBER COMBINATIONS AND THE GAP2006 COMPUTER PROGRAM**



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# ICC-ES Evaluation Report

**ESR-1940**

Reissued January 2016

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**DIVISION: 06 00 00—WOOD, PLASTICS AND  
COMPOSITES****Section: 06 02 00—Design Information****REPORT HOLDER:****APA—THE ENGINEERED WOOD ASSOCIATION**  
7011 SOUTH 19<sup>th</sup> STREET  
TACOMA, WASHINGTON 98466  
[www.apawood.org](http://www.apawood.org)  
[help@apawood.org](mailto:help@apawood.org)**EVALUATION SUBJECT:****GLUED-LAMINATED TIMBER COMBINATIONS AND THE  
GAP2006 COMPUTER PROGRAM****ADDITIONAL LISTEES:****ANTHONY FOREST PRODUCTS CO.**  
309 NORTH WASHINGTON  
EL DORADO, ARKANSAS 71730**CALVERT COMPANY, INC.**  
218 V STREET  
VANCOUVER, WASHINGTON 98661**ROSBORO, LLC**  
POST OFFICE BOX 20  
SPRINGFIELD, OREGON 97477**WESTERN STRUCTURES, INC.**  
POST OFFICE BOX 23355  
EUGENE, OREGON 97402**1.0 EVALUATION SCOPE****Compliance with the following codes:**

- 2009 *International Building Code*® (IBC)
- 2009 *International Residential Code*® (IRC)

**Property evaluated:**

Structural

**2.0 USES**

The GAP2006 computer program is utilized to determine design stresses for the specific layups of glued-laminated timbers listed in Tables 1 and 2 of this report.

Glued-laminated timbers manufactured to the glued-laminated timber combinations or single grade layups that have been developed using the GAP2006 program, and that are produced at the facilities listed in Table 3, are recognized as being in compliance with the design parameters indicated in Section 3.0 of this report.

**3.0 DESCRIPTION**

The GAP2006 computer program is based on the principles of ASTM D 3737. It is an alternative method for determining associated allowable design stresses for a given layup combination of glued-laminated timber. The GAP2006 computer program complies with the IBC and the IRC for allowable stress design. The design assumptions discussed in Sections 3.1 through 3.4 of this report are basic parameters utilized with the development of the allowable design stresses for the combinations listed in Table 1 or single grade layups listed in Table 2. See Section 5.4 for requirements applicable to these parameters.

**3.1 Adhesive:**

Face and end-joint bonding adhesives comply with ASTM D 2559 for exterior or wet use.

**3.2 End Joints:**

End joints comply with ANSI A190.1 and ASTM D 3737.

**3.3 Lumber:**

Lumber having a nominal thickness of 2 inches or less is glued-laminated into rectangular cross sections complying with industry standards for depth, width, and appearance. Lumber that is E-rated or visually graded complies with rules of applicable approved lumber grading agencies and the procedures set forth in the manufacturer's quality control documentation. Quality control for E-rating and beam fabrication is conducted under the supervision of an approved third-party inspection agency. Grade specifications are included in rules of the applicable approved lumber grading agencies and follow industry classifications and nomenclature as provided in the applicable code.

**3.4 Layup:**

Beams are fabricated in accordance with ANSI A190.1 using the grade combinations noted in Table 1 or single grade layups noted in Table 2 of this report. Combinations are in accordance with ASTM D 3737 requirements. Resawn purlin beams, manufactured by ripping nominally

6-inch beams vertically through their depth into two members of equal width, are permitted to be produced from Canadian spruce-pine (CSP) and spruce-pine-fir (SPF) combinations in this width without any variation in basic grade description or layup procedures.

#### 4.0 DESIGN

The design requirements of structural glued-laminated timber must comply with Section 2306 or 2307 of the IBC, or Sections R502.2 and R802.2 of the IRC, as applicable. Modifications of values for duration of load must comply with the IBC or the IRC, as applicable.

#### 5.0 CONDITIONS OF USE

The specific layups for the glued-laminated timbers described in this report comply with, or are suitable alternatives to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

- 5.1 The application of the GAP2006 computer program is limited to the layup combinations shown in Tables 1 or 2. Design stresses for normal conditions of loading must not exceed those set forth in Tables 1 or 2.
- 5.2 Design stresses for combinations, as noted in Tables 1 or 2, are for members with four or more laminations stressed primarily in bending due to loads applied perpendicular to the wide faces of the laminations.
- 5.3 The effects of checking of the members are outside the scope of this report.

- 5.4 Glued-laminated timber manufactured to the glued-laminated timber combinations or single grade layups that have been developed using the GAP2006 program, listed in Tables 1 and 2, and that are produced at the facilities listed in Table 3, are recognized as being in compliance with the design parameters indicated in Section 3.0 of this report.

Evaluation of glue-laminated timber manufactured in accordance with this report but produced by manufacturers not listed in Table 3 must be recognized in a current ICC-ES report as being in compliance with the design parameters indicated in Section 3.0 of this report.

- 5.5 The quality program for monitoring the use of the GAP2006 computer program must be in accordance with "Quality Control Requirements for the GAP Computer Program," dated July 26, 2006.

#### 6.0 EVIDENCE SUBMITTED

- 6.1 Program Guide for the GAP2006 Computer Program.
- 6.2 Data in accordance with ASTM D 3737.
- 6.3 Quality system documentation.

#### 7.0 IDENTIFICATION

Each glued-laminated beam manufactured using layup combinations determined in accordance with this report and produced at the facilities listed in Table 3 must be identified with the ICC-ES evaluation report number (ESR-1940).



TABLE 1 -- DESIGN VALUES FOR STRUCTURAL GLUED-LAMINATED SOFTWOOD TIMBER STRESSED PRIMARILY IN BENDING<sup>(1,2,3)</sup> (Continued)

Combination Symbol	Species <sup>(6)</sup> Outer/ Core	Bending About X-Y 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 <sup>(6)</sup>			Shear Parallel to Grain (Horizontal) <sup>(7,8)</sup>			Modulus of Elasticity <sup>(9)</sup>			Modulus of Elasticity <sup>(9)</sup>			Tension Parallel to Grain	Compression Parallel to Grain	Modulus of Elasticity	Specific Gravity for Dowel-Type Fastener Design	Top or Bottom Face	Side Face	
		Tension Stressed in Tension	Compression Stressed in Tension	Compression Perpendicular to Grain	Tension Face	Compression Face	F <sub>vx</sub> (psi)	F <sub>vy</sub> (psi)	E <sub>x</sub> (10 <sup>6</sup> psi)	F <sub>by</sub> (psi)	F <sub>clx</sub> (psi)	F <sub>cy</sub> (psi)	F <sub>ty</sub> (psi)	F <sub>ct</sub> (psi)	F <sub>c</sub> (psi)	E <sub>axial</sub> (10 <sup>6</sup> psi)				
<b>Southern Pine (Continued)</b>																				
EWS 26F-V3M1 <sup>(14)</sup>	U	2600	2100	740	740	740	300	2100	2100	650	265	1.8	1200	1600	1.9	0.55				
EWS 26F-V3M2 <sup>(14)</sup>	U	2600	2100	740	740	740	300	2100	2100	650	265	1.8	1200	1600	1.9	0.55				
EWS 26F-V4	B	2600	2600	740	740	740	300	2600	2600	650	265	1.8	1200	1600	1.9	0.55				
EWS 26F-V4M1 <sup>(14)</sup>	B	2600	2600	740	740	740	300	2600	2600	650	265	1.8	1200	1600	1.9	0.55				
EWS 26F-V4M2 <sup>(14)</sup>	B	2600	2600	740	740	740	300	2600	2600	650	265	1.8	1200	1600	1.9	0.55				
EWS 28F-E1	U	2800	2300	805	805	805	300	2300	2300	650	265	1.7	1300	1850	1.7	0.55				
EWS 28F-E1M1	U	2800	2300	805	805	805	300	2300	2300	650	265	1.7	1300	1850	1.7	0.55				
EWS 28F-E2	B	2800	2800	805	805	805	300	2800	2800	650	265	1.7	1300	1850	1.7	0.55				
EWS 28F-E2M1	B	2800	2800	805	805	805	300	2800	2800	650	265	1.7	1300	1850	1.7	0.55				
EWS 30F-E1 <sup>(17)</sup>	U	3000	2400	805	805	805	300	2400	2400	650	265	1.7	1250	1750	1.7	0.55				
EWS 30F-E1M1 <sup>(17)</sup>	U	3000	2400	805	805	805	300	2400	2400	650	265	1.7	1250	1750	1.7	0.55				
EWS 30F-E1M2 <sup>(18)</sup>	U	3000 <sup>(19)</sup>	2400	650 <sup>(20)</sup>	740	650 <sup>(20)</sup>	300	2400	2400	650	265	1.7	1250	1750	1.7	0.50				
EWS 30F-E2 <sup>(17)</sup>	B	3000	3000	805	805	805	300	3000	3000	650	265	1.7	1350	1750	1.7	0.55				
EWS 30F-E2M1 <sup>(17)</sup>	B	3000	3000	805	805	805	300	3000	3000	650	265	1.7	1350	1750	1.7	0.55				
EWS 30F-E2M2 <sup>(18)</sup>	B	3000 <sup>(19)</sup>	3000 <sup>(19)</sup>	650 <sup>(20)</sup>	650 <sup>(20)</sup>	650 <sup>(20)</sup>	300	3000 <sup>(19)</sup>	3000 <sup>(19)</sup>	650	265	1.7	1350	1750	1.7	0.50				
EWS 30F-E2M3 <sup>(18)</sup>	B	3000 <sup>(19)</sup>	3000 <sup>(19)</sup>	650 <sup>(20)</sup>	650 <sup>(20)</sup>	650 <sup>(20)</sup>	300	3000 <sup>(19)</sup>	3000 <sup>(19)</sup>	650	265	1.7	1350	1750	1.7	0.50				
		0.8	0.8	0.53	0.53	0.53	0.875	0.875	0.875	0.833	0.875	0.833	0.8	0.833	0.833	0.73	0.833			See NDS

Wet-use factors  
For S1 psl = 6,895 Pa

- The combinations in this table are applicable to members consisting of 4 or more laminations, unless otherwise noted, and are intended primarily for members stressed in bending due to loads applied perpendicular to the wide faces of the laminations.
- The tabulated design values are for dry conditions of use. For wet conditions of use, multiply the tabulated values by the factors shown at the bottom of the table.
- The tabulated design values are for normal duration of loading. For other durations of loading, see applicable building code.
- The symbols used for species are AC = Alaska cedar, CSP = Canadian spruce-pine, DF = Douglas fir-larch, ES = Eastern spruce, HF = Hem-fir, POC = Port Orford cedar, SP = Southern pine, SPF = Spruce-pine-fir, and SW = Softwood species.
- The unbalanced layouts are intended primarily for simple-span applications and the balanced layouts are intended primarily for continuous or cantilevered applications.
- The tabulated design values in bending,  $F_{bx}$ , are based on members 5-1/8 inches in width by 12 inches in depth by 21 feet in length. For members with a larger volume,  $F_{bx}$  must be multiplied by a volume factor,  $C_v$ , determined in accordance with applicable building code. The tabulated  $F_{bx}$  values require the use of special tension laminations. If these special tension laminations are omitted, the  $F_{bx}$  values must be multiplied by 0.75 for members greater than or equal to 15 inches or by 0.85 for members less than 15 inches in depth. EWS 20F-E2S1 does not require special tension laminations.
- For non-prismatic members, notched members, members subject to impact or cyclic loading, or shear design of bending members at connections (NDS 3.4.3.3), the design value for shear must be multiplied by a factor of 0.72.
- $F_{vx}$  and  $F_{vy}$  values do not include adjustments for checking.
- The tabulated  $E_x$  and  $E_y$  values already include a 5% shear deflection (also known as "apparent  $E'$ "). For beam and column stability calculations,  $E_{min}$  must be determined by multiplying the tabulated modulus of elasticity by 0.518.
- The values of  $F_{by}$  were calculated based on members 12 inches in depth (bending about Y-Y axis). For depths other than 12 inches, the  $F_{by}$  values are permitted to be increased by multiplying by the size factor,  $(12/d)^{1/9}$ , where  $d$  is the beam depth in inches. When  $d$  is less than 3 inches, use the size adjustment factor for 3 inches.
- 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 must be multiplied by 0.4 for members with 5, 7, or 9 laminations or by 0.5 for all other members. This reduction must be cumulative with the adjustment in Footnote 7.
- The beam depth limitation is as follows: 20F-E2S1: 15 inches; 24F-V5M3DF: 27 inches; 24F-V5M3DF and 24F-VDF1: 24 inches; 26F-E/DF1 and 26F-E/DF1M1: 9-1/2, 11-7/8, 14, and 16 inches.
- 20F-E/SPF1 is limited to 1-1/2 to 3-1/2 inches in width, and 7-1/2, 9, 9-1/2, 11-7/8, and 14 inches in depth. 24F-E/SP1 is limited to 1-1/2, 11-7/8, 14, 16, and 18 inches in depth.
- When containing wane, this combination must be used in dry conditions only. In this case, wet-use factors must not be applied. Because of the wane, this combination is available only for an industrial appearance characteristic.
- If wane is omitted, these restrictions must not apply. This combination is limited to 9 to 20 laminations in depth except for 16F-V5M1/SP, which contains a maximum of 1/6 wane on each side and must be 4 laminations or more in depth. For 28F-E/DF1, the  $F_{bx}$  value is permitted to be increased to 2,200 psi for beam depths less than 16 inches. For 24F-VDF1, the  $F_{bx}$  value is permitted to be increased to 1,300 psi for beam depths of at least 10-1/2 inches.
- This combination must be manufactured from either EWS 24F-V4WS, EWS 24F-V5M1/WS, EWS 24F-V5M2/WS, EWS 24F-V5M3/WS, EWS 24F-E/SPF4, or EWS 24F-V3/SP, and is intended primarily for use in header applications.
- This layout combination is limited to nominal 6 inches or less in width. In addition, 30F-E1M1/SP and 30F-E2M1/SP are limited to 18 inches or less in depth.
- The beam depth is limited to 16 inches or less for 30F-E2M2/SP, and 30 inches or less for 30F-E1M2/SP and 30F-E2M3/SP. The tension lamination requirements for these layouts must not be omitted.
- The tabulated design values in bending,  $F_{bx}$ , must be multiplied by a volume factor,  $C_v$ , determined in accordance with applicable building code using 1/10 as the exponent.
- The allowable compressive stress perpendicular to grain of the beam must be permitted to be increased to the published allowable compressive stress perpendicular to grain of the outermost laminated veneer lumber.
- For members of more than 15 laminations,  $E_x = 2.0 \times 10^6$  psi.
- This combination may contain wane. If wane lumber is used,  $F_{vx}$  must be multiplied by 0.67 if wane is allowed on both sides. If wane is limited to one side,  $F_{vx}$  must be multiplied by 0.83. This reduction is cumulative with the adjustment in Footnote 7.



**TABLE 2 -- DESIGN VALUES FOR STRUCTURAL GLUED-LAMINATED SOFTWOOD TIMBER STRESSED PRIMARILY IN AXIAL TENSION AND COMPRESSION<sup>(1,2,3)</sup>**

Comb Symbol	Species	Grade	Modulus of Elasticity <sup>(4)</sup> E 10 <sup>6</sup> psi	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)				Fasteners		
				Compression Perpendicular to Grain		Compression Parallel to Grain		Bending		Shear Parallel to Grain		Bending			Shear Parallel to Grain	
				F <sub>cL</sub> psi	F <sub>c</sub> psi	F <sub>c</sub> psi	F <sub>c</sub> psi	4 or More Lams	2 or 3 Lams	3 Lams	2 Lams	See Notes 5 and 6	F <sub>bx</sub> psi		F <sub>by</sub> psi	2 Lams to 15 in. Deep <sup>(7)</sup>
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
<b>Western Species</b>																
EWS 1	DF	L3	1.5	560	900	1,550	1,200	1,450	1,250	1,000	230	1,250	265	0.50		
EWS 2	DF	L2	1.6	560	1,250	1,950	1,600	1,800	1,600	1,300	230	1,700	265	0.50		
EWS 3	DF	L2D	1.9	650	1,450	2,300	1,850	2,100	1,850	1,550	230	2,000	265	0.50		
EWS 5	DF	L1	2.0	650	1,600	2,400	2,100	2,400	2,100	1,800	230	2,200	265	0.50		
EWS 22 <sup>(9)</sup>	SW	L3	1.0	315	525	850	675	800	700	550	170	725	195	0.35		
EWS 70	AC	L2	1.3	470	975	1,450	1,450	1,400	1,250	1,000	230	1,350	265	0.46		
<b>Southern Pine</b>																
EWS 47	SP	N2M14	1.4	650	1,200	1,900	1,150	1,750	1,550	1,300	260	1,400	300	0.55		
EWS 48	SP	N2D14	1.7	740	1,400	2,200	1,350	2,000	1,800	1,500	260	1,600	300	0.55		
EWS 49	SP	N1M16	1.7	650	1,350	2,100	1,450	1,950	1,750	1,500	260	1,800	300	0.55		
EWS 50	SP	N1D14	1.9	740	1,550	2,300	1,700	2,300	2,100	1,750	260	2,100	300	0.55		
<b>Wet-use factors</b>																
			0.833	0.53	0.8	0.73					0.8	0.875	0.8	0.875	see NDS	

For S1, 1 psi = 6,895 Pa

- The tabulated design values are for dry conditions of use. For wet conditions of use, multiply the tabulated values by the factors shown at the bottom of the table.
- The tabulated design values are for normal duration of loading. For other durations of loading, see applicable building code.
- The symbols used for species are AC = Alaska cedar, DF = Douglas fir-larch, SP = Southern pine, and SW = Softwood species.
- For beam and column stability calculations, E<sub>min</sub> must be determined by multiplying the tabulated modulus of elasticity by 0.518.
- The tabulated F<sub>vy</sub> values are for members of 4 or more lams. The tabulated F<sub>vy</sub> values must be multiplied by a factor of 0.95 for 3 lams and 0.84 for 2 lams.
- For members with 5, 7, or 9 lams manufactured from multiple-piece lams with unbonded edge joints, the tabulated F<sub>vy</sub> values must be multiplied by a factor of 0.4. For all other members manufactured from multiple-piece lams with unbonded edge joints, the tabulated F<sub>vy</sub> values must be multiplied by a factor of 0.5. This adjustment must be cumulative with the adjustment given in Footnote No. 5.
- The tabulated F<sub>bx</sub> 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 F<sub>bx</sub> values must be multiplied by a factor of 0.88. If special tension lams are used, the tabulated F<sub>bx</sub> values are permitted to be increased by a factor of 1.18 regardless of the member depth.
- For non-prismatic members, notched members, members subject to impact or cyclic loading, or shear design of bending members at connections (NDS 3.4.3.3), the tabulated F<sub>vx</sub> values must be multiplied by 0.72.
- When Western Cedars, Western Cedars (North), Western Woods, and Redwood (open grain) are used in combinations for Softwood Species (SW), the design values for modulus of elasticity (E<sub>x</sub> and E<sub>y</sub>) must 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), design values for shear parallel to grain (F<sub>vx</sub> and F<sub>vy</sub>) must be reduced by 10 psi before applying any adjustments.

**TABLE 3—MANUFACTURING LOCATIONS USING GAP 2006 PROGRAM**

MANUFACTURER	LOCATION
Anthony Forest Products Co.	256 Cooper Drive, El Dorado, AR 71730
Anthony Forest Products Co.	256 Edison Road, Washington, GA 30676
Calvert Company, Inc.	218 V Street, Vancouver, WA 98661
Calvert Company, Inc.	3559 Truman Road, Washougal, WA 98671
Rosboro	22833 Vaughn Road, Veneta, OR 97487
Rosboro	2509 Main Street, Springfield, OR 97477
Western Structures, Inc.	1381 Bailey Hill Road, Eugene, OR 97402