



# American Institute of Timber Construction

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## AITC 402-2005

### STANDARD FOR STRUCTURAL COMPOSITE LUMBER (SCL) FOR USE IN STRUCTURAL GLUED LAMINATED TIMBER

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#### 402.1. SCOPE

This standard describes the requirements for structural composite lumber (SCL) to be used as a substitute for established grades of lumber in structural glued laminated timber. SCL is permitted to be used as a substitute for standard laminating grades, but is primarily intended for use as an alternate to AITC special tension lamination grades 302-20, 302-22, 302-24, 302-26, 302-28, or 302-30.

SCL is permitted to be manufactured in full-length pieces, or in pieces no less than 6 feet long which are end jointed to form laminations. Shorter length pieces are permitted if laminations are proof loaded in tension in accordance with ANSI/AITC A190.1.

All SCL meeting the requirements of this standard shall be qualified by test prior to use. Additionally, full-scale beam tests may be required to demonstrate adequate performance.

#### 402.2 MANUFACTURE OF SCL

**402.2.1. Types of SCL.** For the purposes of this standard, structural composite lumber (SCL) is defined as laminated veneer lumber (LVL), parallel strand lumber (PSL), laminated strand lumber (LSL), or oriented strand lumber (OSL) meeting the requirements of ASTM D5456.

**402.2.2. Surfacing of SCL.** SCL laminations shall be permitted to be surfaced, if necessary, for laminating. If SCL will be surfaced as part of the laminating process, similar surfacing shall be performed on the SCL prior to the qualification testing.

**402.2.3. Grading of SCL.** All criteria used to sort SCL by grade prior to qualification testing shall be recorded to assure reproducibility in daily production. Layup requirements shall be documented.

#### 402.3 SCL QUALIFICATION TESTING

**402.3.1. Mechanical Properties.** The properties that shall be evaluated by qualification testing include tensile strength parallel to grain, long span modulus of elasticity, edgewise bending strength, compression strength parallel to grain, compression perpendicular to grain, longitudinal shear strength, and equivalent sawn lumber specific gravity for connection design. All tests shall be conducted in

accordance with ASTM D5456, except for the tests for long span modulus of elasticity, which shall be conducted in accordance with AITC test T116. Test specimens shall be representative of production. Sample size and specimens for each test shall be as required by ASTM D5456 or specified herein, as applicable. Testing shall be conducted or witnessed by a qualified third-party agency acceptable to the laminator's accredited inspection and testing agency. Test results shall be certified by the witnessing agency.

**402.3.2. Long Term Load Performance.** Because the manufacturing parameters of SCL can have significant effects on long term load performance, the product shall demonstrate engineering equivalence to duration of load and creep effects of solid sawn lumber in accordance with ASTM D6815.

**402.3.3. Moisture Resistance.** The SCL shall be acceptable for wet use. Cyclic delamination tests shall be conducted on the SCL following AITC Test T110.

**402.3.4. Beam Tests.** If SCL will be used in the outer 5% of the depth on the tension side of horizontally laminated beams, qualification tests shall include full-scale beam tests representative of production. A minimum of one layup representing each group of similar layups within the combination shall be tested. A minimum of 15 members per group shall be tested with 30 or more members tested for the combination. The width of test specimens shall be representative of intended production sizes, and the depth shall be determined by the representative layups described above. Separate beam tests shall be required for each grade of SCL from each manufacturing facility. Beam test requirements shall be waived if the SCL tensile strength exceeds 2.1 times the QSL level of the laminated timber beam.

#### **402.4. CRITERIA FOR USE**

**402.4.1. Tensile Strength.** The 5% tolerance limit with 75% confidence for SCL tension strength shall equal or exceed the corresponding value for the grade shown in Table 1.

To substitute for grades that are not tabulated, the appropriate strength levels shall be determined as follows:

For standard laminating grades, the five percent tolerance limit with 75% confidence determined from the test shall equal or exceed 2.1 times the minimum tensile strength determined from ASTM D3737 as follows: the tension stress index shall be multiplied by the lesser of (1)the minimum strength ratio for knots or (2)the tension stress modification factor for slope of grain.

For special tension laminations, the required 5% tolerance limit with 75% confidence shall be determined by multiplying the ASTM D3737 bending stress index by 1.15 for 302-24 grade, 1.05 for 302-22 grade, or 0.95 for 302-20 grade.

**402.4.2. Modulus of Elasticity.** SCL shall be qualified for long span modulus of elasticity by testing in accordance with AITC Test T116 using a sample of 30 or more pieces. The upper 95% confidence bound on the sample mean long span modulus of elasticity (E) of the SCL shall equal or exceed the value shown in Table 1. For grades that are not tabulated, the upper 95% confidence bound on the sample mean long span E shall equal or exceed the long span E for the grade as determined by the procedures of ASTM D3737.

**Table 1. Qualification Levels for Laminating Grades**

Grade	Tension Strength 5% TL (psi)	E (10 <sup>6</sup> psi)
302-26 DF	4340	2.1
302-24 DF	4010	2.1
302-22 DF	3670	2.1
302-20 DF	3340	2.1
L1D DF	2420 <sup>1</sup>	2.1
L2D DF	1930 <sup>1</sup>	2.0
L2 DF	1680 <sup>1</sup>	1.7
L3 DF	1010 <sup>1</sup>	1.6
302-30 SP	5010	2.3
302-28 SP	4680	2.3
302-26 SP	4340	2.0
302-24 SP	4010	2.0
302-22 SP	3670	2.0
302-20 SP	3340	1.9
N1D SP	2000 <sup>2</sup>	2.0
N1 SP	1890 <sup>2</sup>	1.8
N2D SP	1630 <sup>2</sup>	1.8
N2 SP	1520 <sup>2</sup>	1.5
N3 SP	890 <sup>2</sup>	1.4
302-24 HF	4010	1.8
302-22 HF	3670	1.8
302-20 HF	3340	1.7
L1D HF	2320	1.8
L1 HF	1980	1.7
L2 HF	1580	1.5
L3 HF	870	1.3

<sup>1</sup> Values obtained by tests reported by Evans and Marx, 1988. (Forest Products Journal 38(7/8):6-14).

<sup>2</sup> 2x6 tension values from 2002 SPIB Standard Grading Rules for Southern Pine Lumber multiplied by 2.1.

**402.4.3. Shear Strength.** The required design value in shear (flatwise orientation) for SCL when used only in the outer laminations of a horizontally laminated beam shall be determined by multiplying the design value in shear ( $F_{vx}$ ) of the combination in which SCL is to be used by a shear adjustment factor ( $V_F$ ). The shear adjustment factor shall be determined for the shallowest depth beam produced as follows:

$$V_F = 1 - (C_1/C)^2$$

where:  $C_1$  = the distance from the neutral axis to the nearest portion of the LVL lumber and  
 $C$  = the distance from the neutral axis to the outer surface of the glued laminated timber.

**402.4.4. Compression Perpendicular to Grain.** The design value in compression perpendicular to grain (flatwise orientation) of the SCL shall equal or exceed the design value in compression perpendicular to grain of the structural glued laminated timber combination in which it is used.

**402.4.5. Secondary Mechanical Properties.** The edgewise bending strength, compression parallel to grain strength, shear strength perpendicular to the bond lines, and equivalent solid sawn connector performance shall meet or exceed the values for the grade the SCL is replacing or the corresponding design values for the structural glued laminated timber combination shall be reduced as appropriate.

**402.4.6. Cyclic Delamination.** For LVL, AITC Test T110 shall be conducted. The maximum allowable delamination shall be 5% on the first cycle, and 10% if a second cycle is required.

**402.4.7. Thickness Swell.** For LSL and OSL, thickness swell shall be determined after a 24 hour soak in water in accordance with ASTM D1037, except that the test specimens shall be permitted to be reduced to 5 ½ in. by 5 ½ in. The thickness swell after the 24 hour soak shall not exceed 25%. After re-drying the specimens, the non-recoverable thickness swell shall not exceed 10%.

**402.4.8. Beam Performance.** The beam strength 5% tolerance limit with 75% confidence determined in accordance with ASTM D2915 shall be a minimum of 2.1 times the design value for the beam. The test results of beams sampled according to 402.3.4. shall be considered representative of all layups in the combination meeting the following requirements.

(a) The lamination properties (grades, species, end joint strengths) and grade placement below the neutral axis of the beam shall be similar to the tested layup.

(b) The predicted stresses on the SCL shall be lower than the stresses at failure of the SCL in the tested layup at the assigned characteristic stress value.

#### **402.5. LAMINATING PLANT QUALIFICATION WITH SCL**

**402.5.1. General.** For purposes of qualification, SCL shall be considered the same as a separate species (see ANSI/AITC A190.1).

**402.5.2. End Joints.** Tension testing of end joints in SCL (if used) shall be in accordance with AITC Test T119 and ANSI/AITC A190.1.

**402.5.3. Face Bonds.** SCL to SCL face bonds and SCL to solid-sawn lumber bonds shall be tested in accordance with AITC Tests T107 and T110 with the following requirements.

(a) Dry Shear Tests-AITC Test T107. The required strength is 90% of the average shear value for the SCL as determined from the qualification tests. The required wood failure is 70%.

(b) Vacuum-Pressure Cyclic Delamination Test-AITC Test T110. The requirements call for a maximum allowable delamination of 5% on the first cycle, and 10% if a second cycle is required.

(c) Wet Shear Tests-AITC Tests T110, T107. The required strength shall be 65% of the average shear value for the SCL determined from the qualification tests. Wood failure shall equal or exceed 70% and shall be read after drying the sheared test specimens.

Test specimens for cyclic delamination need to be at least six inches deep or the full depth of the member if less than six inches deep. Since the SCL to lumber portion may be less than the depth of the specimen, the specimen may include some lumber to lumber bond lines.

The determination of delamination is to be based only on the SCL to lumber bond line or the SCL to SCL bond line. Enough specimens shall be tested to test twenty SCL to lumber bond lines.

#### **402.6. LAMINATING PLANT GLUING**

**402.6.1 Surfacing.** SCL shall be permitted to be surfaced prior to gluing for the purpose of meeting the requirements of ANSI/AITC A190.1. If SCL will be surfaced as part of the laminating process, qualification tests for tensile strength, modulus of elasticity, and compression perpendicular to grain stress shall be performed on surfaced specimens. Surfacing of SCL used in specimens for full-scale beam tests shall be typical of the production process.

**402.6.2 Moisture Content.** Moisture content of SCL at the time of gluing shall be 12% or less. The moisture content of the SCL shall be permitted to be outside the 5% range required for laminations in a single timber in ANSI/AITC A190.1. SCL moisture content shall be determined by the oven-dry method.

#### **402.7. QUALITY CONTROL -- LAMINATING WITH SCL**

The following quality control checks are required at the laminating plant.

**402.7.1. SCL Shipment Testing.** Each shipment of SCL material shall be sampled and tested upon receipt in accordance with the laminating plant quality control manual. Sufficient testing shall be conducted to verify that the shipment is similar to the qualification sample. Quality control test data from the SCL manufacturer shall be permitted to be used to satisfy this requirement.

**402.7.1.1. Modulus of Elasticity.** The modulus of elasticity shall be determined in accordance with AITC Test T116 and compared with the modulus of elasticity of the qualification test specimens.

**402.7.1.2. Tensile Strength.** The tensile strength shall be evaluated and compared with the tensile strength of the qualification tests specimens.

**402.7.1.3. Special Grading Criteria.** Any special grading criteria used in manufacturing or grading the SCL shall be monitored upon receipt of each shipment.

**402.7.2. Tests for End Joint Bonding (Daily).** End joint specimens manufactured from SCL (if used) shall be tested daily for adequacy as required by ANSI/AITC A190.1.

**402.7.3. Tests for Face Joint Bonding (Daily).** The following quality control tests shall be performed on SCL to SCL bonds and SCL to solid wood bonds on a daily basis.

(a) Dry Shear Tests-AITC Test T107. The required strength is 90% of the average shear value for the SCL determined from the qualification tests. The required wood failure is 70%.

- (b) Vacuum-Pressure Cyclic Delamination Test--AITC Test T110. The requirements call for a maximum allowable delamination of 5% on the first cycle, and 10% if a second cycle is required.
- (c) Wet Shear Tests-AITC Tests T110, T107. The required strength is 65% of the average shear value for the SCL determined from the qualification tests. Wood failure shall equal or exceed 70% and shall be read after drying the sheared test specimens.

Test specimens for cyclic delamination need to be at least six inches deep or the full depth of the member if less than six inches deep. Since the SCL to lumber portion may be less than the depth of the specimen, the specimen may include some lumber to lumber glue lines.

The determination of delamination is to be based only on the SCL to lumber glue line or the SCL to SCL glue line. Enough specimens shall be tested to include ten SCL to lumber glue lines and ten SCL to SCL glue lines.

When the internal glue lines of the SCL exhibit excessive delamination in the cyclic delamination test or the SCL exhibits excessive thickness swell, the SCL manufacturer shall be notified and additional tests shall be made on the lot of SCL.