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主旨：美國國家標準協會頒定之結構用集成材產品標準 (ANSI
A190.1, American National Standard, Product
Standard for Structural Glued Laminated Timber, 英
文版如附件1、中譯版如附件2)，業經本部依木構造建築
物設計及施工技術規範，認可為符合框組式構造木質板材
之集成材之材料標準之一，請查照。

說明：

- 一、依木構造建築物設計及施工技術規範7.2.4及本部113年8月
27日內授國建管字第1130809581號函附本部113年7月16日
會議紀錄結論一辦理。
- 二、本案僅依木構造建築物設計及施工技術規範第7章框組式構
造7.2.4認可集成材(Glulam)之材料標準，至其他有關防
火、結構設計及非屬本規範7.2.4適用範圍者，仍應依建築
技術規則、本規範及國家標準規定辦理。
- 三、按美國在臺協會說明，目前認可結構用集成材之機構有：

1. APA—The Engineered Wood Association、2. AITC—
American Institute of Timber Construction，其結構用
集成材之認證章樣式如附件3。

正本：各直轄市及縣(市)政府、國家科學及技術委員會新竹科學園區管理局、國家科學及技術委員會中部科學園區管理局、國家科學及技術委員會南部科學園區管理局、交通部高速公路局、農業部農業科技園區管理中心、經濟部水利署臺北水源特定區管理分署、經濟部產業園區管理局、本部國家公園署墾丁國家公園管理處、國家公園署玉山國家公園管理處、國家公園署陽明山國家公園管理處、國家公園署太魯閣國家公園管理處、國家公園署雪霸國家公園管理處、國家公園署金門國家公園管理處、國家公園署海洋國家公園管理處、國家公園署台江國家公園管理處、國家公園署國家自然公園管理處、中華民國不動產開發商業同業公會全國聯合會、臺灣區綜合營造業同業公會、中華民國土木技師公會全國聯合會、中華民國結構工程技師公會全國聯合會、中華民國全國建築師公會、建築改革社、中華木質構造建築協會、臺灣木結構工程協會

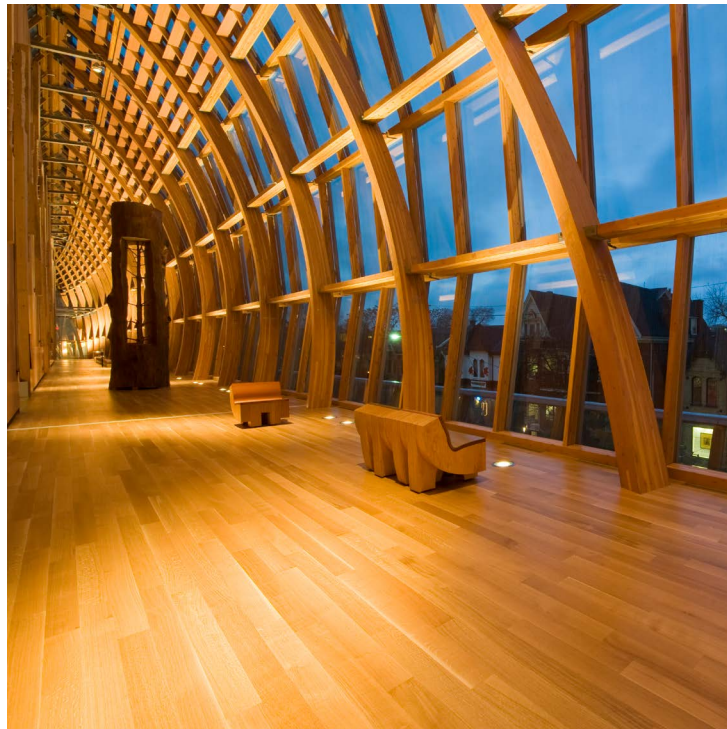
副本：美國在台協會(農業貿易辦事處)、本部建築研究所、國土管理署(建築管理組)
(均含附件)



AMERICAN NATIONAL STANDARD

ANSI A190.1-2022

Product Standard for Structural Glued Laminated Timber



AMERICAN NATIONAL STANDARD

Approval of an American National Standard requires review by ANSI that the requirements for due process, consensus, and other criteria for approval have been met by the standards developer. Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made towards their resolution. The use of American National Standards is completely voluntary; their existence does not in any respect preclude anyone from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standards.

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AMERICAN NATIONAL STANDARD

ANSI A190.1-2022

Product Standard for Structural Glued Laminated Timber

APA – The Engineered Wood Association

Approved February 17, 2022
American National Standards Institute

FOREWORD (This Foreword is not a Part of American National Standard ANSI A190.1-2022)

This Standard, which was initiated by APA – The Engineered Wood Association, has been developed under the provisions of the American National Standards Institute (ANSI) as a revision of American National Standard, *Standard for Wood Products – Structural Glued Laminated Timber* (ANSI A190.1-2017). See History of Project in Appendix X1, for further information.

Since January 1, 2013, APA – The Engineered Wood Association has assumed the Secretariat responsibilities for this Standard and re-designated it as ANSI A190.1. The maintenance of this Standard follows the *Operating Procedures for Development of Consensus Standards of APA – The Engineered Wood Association*, approved by ANSI.

Inquiries or suggestions for improvement of this Standard are welcome and should be directed to APA – The Engineered Wood Association at 7011 South 19th Street, Tacoma, WA 98466, www.apawood.org.

CONTENTS

AMERICAN NATIONAL STANDARD	ii	11. END JOINTS	17
FOREWORD	iv	11.1 Assembly and Bonding	17
ANSI A190.1-2022 PRODUCT STANDARD FOR STRUCTURAL GLUED LAMINATED TIMBER	1	11.2 Joint Thickness Tolerance	17
1. SCOPE	1	11.3 Knots In or Near End Joints	17
2. REFERENCED DOCUMENTS	2	11.4 Spacing of End Joints in Adjacent Laminations	18
2.1 U.S. Standards	2	11.5 Spacing of End Joints Within the Same Lamination	19
2.2 Other Standards	2	11.6 End Joints Used for Repair	19
3. TERMINOLOGY	3	12. APPEARANCE CLASSIFICATIONS	20
3.1 Definitions	3	12.1 Framing Appearance Classification	20
3.2 Terms Specific to This Standard	3	12.2 Framing-L Appearance Classification	20
4. GENERAL REQUIREMENTS	8	12.3 Industrial Appearance Classification	20
4.1 Minor Variations	8	12.4 Industrial-L Appearance Classification	21
4.2 Grade Combinations	8	12.5 Architectural Appearance Classification	21
4.3 Quality System	9	12.6 Premium Appearance Classification	22
5. TOLERANCES	9	13. QUALITY CONTROL SYSTEM	23
5.1 Tolerance for Dimensions	9	13.1 Plant and Process Qualification	24
5.2 Tolerance for Camber or Straightness	9	13.2 Adhesive Lot Testing	34
5.3 Tolerance for Squareness of Cross Section	9	13.3 Daily Quality Control	35
5.4 Tolerances for Other Measurements	9	13.4 Audit by an Accredited Inspection Agency	41
6. LUMBER FOR LAMINATING	10	13.5 Plant Manuals	41
6.1 Species	10	13.6 Quality Control Records	42
6.2 Moisture Content	10	14. MARKING	42
6.3 Sawn Lumber Grading	10	14.1 Non-Custom Members	42
6.4 Manufactured Lumber	11	14.2 Custom Members	43
6.5 Structural Composite Lumber (SCL)	11	14.3 Fire-Resistance Ratings	43
7. LAMINATIONS	12	14.4 Top Stamp Requirements	43
7.1 Bonding Surfaces	12	14.5 Certification of Conformance	43
7.2 Wane	12	14.6 Dual Manufacture	43
7.3 Lamination Thickness	12	14.7 Marking Truss Members	44
7.4 Dimensional Tolerances	13	14.8 Withdrawal of Marking	44
8. ADHESIVES	14	15. TECHNICAL REVIEW BOARD (TRB)	44
8.1 Labeling	14	15.1 Scope	44
8.2 Gap-Filling Adhesives	14	15.2 Membership	44
9. WOOD INSERTS	14	15.3 Requests for Services	45
9.1 Maximum Insert Depth	14	15.4 Conduct of Meetings	46
10. FACE AND EDGE JOINTS	15	15.5 Expenses	47
10.1 Adhesive Mixing and Application	15	APPENDIX XI. HISTORY OF PROJECT (NON-MANDATORY INFORMATION)	48
10.2 Face Joint Assembly and Bonding	16		
10.3 Edge Joint Assembly and Bonding	16		
10.4 Curing Schedules	16		

ANSI A190.1-2022 Product Standard for Structural Glued Laminated Timber

1. SCOPE

The purposes of this Standard are (1) to establish nationally recognized requirements for the production, inspection, testing and certification of structural glued laminated timber (glulam), and (2) to provide material suppliers, producers, distributors and users with a basis for common understanding of the characteristics of this product.

This Standard describes minimum requirements for the production of glulam, including size tolerances, grade combinations, lumber, adhesives, appearance classifications, and manufacture. It also describes the required quality control system for the laminator, including plant qualification, daily quality control, the functions of an accredited inspection agency, and product marking.

These requirements are intended to permit the use of any suitable method of manufacture which will produce a product equal to or superior in quality and performance to that specified, provided such method is approved in accordance with the requirements of this Standard.

The notes and appendix included in this Standard are non-mandatory. This Standard incorporates the U.S. customary units as well as the International System of Units (SI). The values given in the U.S. customary units are the standard and the SI values given in parentheses are for information only. In case of a dispute on size measurements, the U.S. customary method of measurement shall take precedence.

2. REFERENCED DOCUMENTS

This Standard incorporates dated references. Subsequent amendments or revisions to these references apply to this Standard only when incorporated into this Standard by amendments or revisions.

2.1 U.S. Standards

ANSI 117-2020, Standard Specification for Structural Glued Laminated Timber of Softwood Species

ANSI 405-2018, Adhesives for Use in Structural Glued Laminated Timber

ANSI/AWC NDS-2018, National Design Specification for Wood Construction

ASTM D2555-17a, Standard Practice for Establishing Clear Wood Strength Values

ASTM D3737-18e1, Standard Practice for Establishing Allowable Properties for Structural Glued Laminated Timber (Glulam)

ASTM D4444-13(2018), Standard Method for Laboratory Standardization and Calibration of Hand-Held Moisture Meters

ASTM D5456-21e1, Standard Specification for Evaluation of Structural Composite Lumber Products

ASTM D7341-21, Standard Practice for Establishing Characteristic Values for Flexural Properties of Structural Glued Laminated Timber by Full-Scale Testing

2.2 Other Standards

AITC Test T102-2007, Adhesive Spread Measurement

AITC Test T103-2007, Calibration of Plant Pressure System: Bolts or Screw Type Jacks

AITC Test T104-2007, Calibration of Torque Wrenches

AITC Test T105-2007, Diagnostic Tests for Finger Joint Quality

AITC Test T107-2007, Shear Test

AITC Test T110-2007, Cyclic Delamination Test

AITC Test T115-2007, Machining Test for End Joints

AITC Test T116-2007, Modulus of Elasticity for E-Rated Lumber by Static Loading

AITC Test T118-2007, Bending Proof Loading for End Joints

AITC Test T119-2007, Full Size End Joint Tension Test

AITC Test T121-2007, Tension Proof Loading for End Joints

AITC Test T122-2007, Mix Ratio Check for Automatic Adhesive Mixing Machines

AITC Test T123-2007, Sampling, Testing and Data Analysis to Determine Tensile Properties of Lumber

AITC 401-2005, Standard for Manufactured Lumber for Use in Structural Glued Laminated Timber

AITC 402-2005, Standard for Structural Composite Lumber (SCL) Used in Structural Glued Laminated Timber

AITC 403-2005, Standard for End Joints for Use in Lamination Repair

AITC 404-2005, Standard for Radially Reinforcing Curved Glued Laminated Timber Members to Resist Radial Tension

AITC 406-2005, Standard for Proof-Graded Lumber for Glued Laminated Timber

AITC 407-2005, Standard for Alternate Lumber Grades for Use in Structural Glued Laminated Timber

3. TERMINOLOGY

3.1 Definitions

See the referenced documents for definitions of terms used in this Standard.

3.2 Terms Specific to This Standard

Accredited Inspection Agency—an agency meeting the following requirements:

- a. has trained personnel to verify that the grading, measuring, species, construction, bonding, workmanship, and other characteristics of the products as determined by inspection in compliance with all applicable requirements specified in this Standard,
- b. has written procedures to be followed by its personnel in performance of the inspection,
- c. has no financial interest in, or is not financially dependent upon, any single company manufacturing the product being inspected,
- d. is not owned, operated, or controlled by any such company, and
- e. is accredited by a recognized accreditation body under ISO/IEC 17020

Assembly Time—the interval of time between spreading of the adhesive on the laminations and application of final pressure to the entire assembly, which may be separated into open and closed assembly time

Assembly Time, Closed—the time interval between the assembling of adhesive-coated surface and the application of heat/or pressure to set the adhesive

Assembly Time, Open—the time interval between adhesive application to the laminations or end joints and assembly of the adhesive joints

Bending Members—members manufactured with higher lamination grades near the surfaces than in the core

Block-gluing—the process for bonding glulam components into a block-glued glulam using a gap-filling adhesive

Bond Line—the layer of adhesive which attaches two laminations or end joints

Camber—a small amount of curvature built into a glulam to offset anticipated deflection or to facilitate roof drainage

Certificate of Conformance—a certificate issued by an approved agency certifying that the product is in conformance to a standard or standards

Curing Time—the period of time which an adhesive takes to attain a specified degree of cure

Curved Members—glulam members which are designed and manufactured so that significant curvature remains after deflection due to service loads has taken place, such as curved beams and arches

Custom Members—members that are manufactured to meet individual job specifications and marked as required in Section 14.2

Note 1: Prismatic glulam manufactured in accordance with a layup combination provided in ANSI 117 and marked in accordance with Section 14.1 are not considered as Custom Members, regardless of the glulam size.

Delamination—the separation of layers in an assembly because of failure of the adhesive, either in the adhesive itself or at the interface between the adhesive and the lamination

Dry-Service Conditions—environmental exposure conditions that result in a member moisture content of less than 16% in service

Eased Corner—slightly rounded surfacing of corner of member to remove sharp edge

Equilibrium Moisture Content—a moisture content at which wood neither gains nor loses moisture to the surrounding air

Five Percent Tolerance Limit with 75% Confidence—a statistical term describing the lower estimate bound of the fifth percentile that ensures that the population fifth percentile equals or exceeds the estimate 75% of the time

Gap-Filling Adhesive—an adhesive that has the capability of filling voids of up to 1/16 in. (2 mm) between two mating surfaces

Glulam—see structural glued laminated timber

Glulam, Add-on—a glulam manufactured by adding one or more individual laminations to a pre-fabricated glulam in accordance with the layup requirements of the finished glulam (see Section 7.3.2)

Glulam, Block-glued—a glulam with solid rectangular cross-section comprised of 2 or more glulam components bonded together using a gap-filling adhesive and a layup required for the finished glulam (see Section 7.3.4)

Glulam, Re-glued—a glulam manufactured by gluing together 2 glulam components that were pre-pressed in the same process using a gap-filling adhesive and a layup required for the finished glulam (see Section 7.3.3)

Note 2: A large glulam may exceed the planer size even though it can be accommodated by the beam press. When manufacturing such a large glulam, the re-gluing process intentionally leave an unglued (dry) face joint between top and bottom sections of the glulam so that each part can be planed individually and re-glued to the final finished size. Re-glued glulam is typically used to manufacture a deeper finished glulam. Re-glued glulam is primarily different from block-glued glulam in that the components for the former are usually tight-fit from the initial pressing operation, while the components for the latter may not be as tight-fit. Re-gluing is permitted for 1 face joint and may be applicable to prismatic or curved members, but block-gluing is limited to prismatic members only. Re-glued glulam is limited to re-gluing of 2 glulam components due to the need to maintain the tight-fit between those 2 glulam components.

Glulam Component—a glulam manufactured for block-gluing or re-gluing into a larger finished glulam

Hardwood, Non-Dense—any hardwood having an average specific gravity of 0.42 or less when determined by oven-dry weight and green volume

Inserts, wood—wood strips used for non-structural repairs in the sides of glulam

Joint, Edge—a joint formed by two pieces of lumber laid edge to edge to form a wider lamination or portion thereof

Joint, End—a joint formed by joining pieces of lumber end to end with adhesives

Joint, Face—a joint occurring between the wide faces of laminations

Joint, Finger—an end joint made up of several meshing fingers of wood

Joint, Scarf—an end joint formed by joining with adhesive the ends of 2 pieces of lumber or SCL that have been tapered to form sloping plane surfaces and, in some cases, a step or hook is machined into the scarf to facilitate alignment of the 2 ends, in which case, the plane is discontinuous and the joint is known as a stepped or hooked scarf joint

Laminating—(n) the process of manufacturing glulam; (adj) pertaining to the process of manufacturing glulam

Lamination—a single layer of wood material extending the full width and full length of the finished glulam member, composed of one or several pieces of lumber in width or length

Lot—a definite quantity of product or material accumulated under conditions that are considered uniform for sampling purposes

Lot, Adhesives—generally used by adhesive manufacturers to identify a batch of adhesive

Manufactured Lumber—two or more pieces or strips of lumber structurally bonded to form a single piece of lumber

Mechanically Graded Lumber—lumber graded using mechanical or physical evaluation, combined with visual grading

Moisture Content—the amount of water contained in the wood, usually expressed as a percentage of the weight of oven-dry wood

Multiple-Piece Lamination—a lamination which contains 2 or more pieces of lumber across the width of the lamination

Non-custom Members—members that are not manufactured for an individual job specification and marked as required in Section 14.1

Note 3: California Building Code requires glulam used by the Department of Health Care Access and Information (HCAI, formerly the Office of Statewide Health Planning and Development or OSHPD) to be continuously inspected except for non-custom glulam members of 5-1/2 inches (140 mm) in maximum width, 18 inches (457 mm) in maximum depth and 32 feet (9.8 m) clear span in maximum length.

Occasional—where there is provision within the scope of the applicable rule or standard that allows for random variation in production practices, a frequency of occurrence of not more than 5% (1 in 20) shall apply. When the term occasional applies to lumber grading, a frequency of occurrence of not more than 10% (1 in 10) shall apply

Off-Line Tests—physical tests performed on representative specimens removed from production

Pencil Wane—wane limited to 1/4 in. (6 mm) measured across the width of a lamination

Pot Life—the period of time during which an adhesive, after mixing with catalyst, solvent or other compounding ingredients, remains suitable for use

Production Check-Points—those locations in production where an individual production step has been completed and the process or material is checked for conformance to the requirements of this Standard

Proof Graded Lumber—lumber that is graded for tensile strength by proof testing each piece in tension to eliminate low-strength pieces

Proof Loading—application of a known load to a lamination, either tension or bending

Qualification Stress Level (QSL)—the property established by dividing the 5% tolerance limit with 75% confidence from end joint qualification by 1.67

Reference Design Values—design value used in the U.S. based on normal duration of load, dry-service conditions, and reference temperatures up to 100°F (38°C) for Allowable Stress Design (ASD)

Note 4. Load and Resistance Factor Design (LRFD) values may be converted from the ASD reference design values in accordance with the National Design Specification for Wood Construction (NDS).

Re-gluing—the process for bonding glulam components into a re-glued glulam using a gap-filling adhesive

Ripping—the process of sawing any width lumber to develop narrower lumber

Sample—a group of specimens collected for testing

Specimen—all or part of a sample that has been selected for testing

Structural Composite Lumber (SCL)—an engineered wood product that is intended for structural use and bonded with adhesives, and meeting the definition and requirements of ASTM D5456

Structural Glued Laminated Timber (Glulam)—an engineered, stress rated product of a timber laminating plant comprising assemblies of specially selected and prepared wood laminations securely bonded together with adhesives. The grain of all laminations is approximately parallel longitudinally. The laminations may be composed of pieces end joined to form any length, of pieces placed or bonded edge-to-edge to make wider ones or pieces bent to curved form during bonding

Wet-Service Conditions—environmental exposure conditions that result in a member moisture content of 16% or greater in service

Wood Failure—that portion of a bonded surface which in cyclic delamination or strength tests exhibits ruptured wood fiber as opposed to failure of the adhesive

4. GENERAL REQUIREMENTS

Glulam represented as conforming to this Standard shall meet all of the requirements specified herein, subject to the minor variations described in Section 4.1.

Basic elements used to manufacture the glulam shall meet the requirements of Sections 6, 7 and 8. Manufacturing shall conform to the requirements in Sections 9, 10, 11 and 12, and the plant's procedures manual. All production shall be inspected and tested in accordance with Section 13. Products meeting the requirements of this Standard shall be marked in accordance with Section 14. The plant shall be subject to regular periodic auditing by an accredited inspection agency as defined in Section 3.

4.1 Minor Variations

A member conforms to this Standard where minor variations of a limited extent in non-critical locations exist, or where structural damage or defects have been repaired and, in the judgment of a qualified person, the member is structurally adequate for the use intended. The identity of the member and the nature of the minor variation shall be documented. A qualified person is one who is familiar with the job specifications and applicable design requirements and has first-hand knowledge of the manufacturing process.

4.2 Grade Combinations

Grade combinations and their corresponding design values shall be developed in accordance with ASTM D3737 or shall be obtained by performance testing and analysis in accordance with ASTM D7341 for flexural properties. Grade combinations shall be approved by an accredited inspection agency except that the grade combinations and their corresponding design values provided in ANSI 117 shall be permitted for use in conjunction with this Standard. Alternate grades of lumber are permitted to be used to replace standard laminating grades in grade combinations developed in accordance with ASTM D3737 or ASTM D7341, provided that the alternate grades are qualified in accordance with AITC 407.

4.2.1 Fire-Resistance-Rated Glulam

Custom or non-custom members manufactured to provide a one-hour fire rating shall be manufactured to the specified layup except that a core lamination shall be removed, the tension zone moved inward, and the equivalent of one additional nominal 2-in. (38-mm) thickness outer tension lamination added. Members manufactured to provide a two-hour fire rating shall be manufactured to the specified layup except that two core laminations shall be removed, the tension zone moved inward, and the equivalent of 2 additional nominal 2-in. (38-mm) thickness outer tension laminations added. Fire-resistance-rated glulam shall be marked in accordance with Section 14.3.

4.3 Quality System

The principal responsibilities for assuring conformance to this Standard are placed on the manufacturer's continuing quality control of the production operations and periodic audit thereof by an accredited inspection agency. This quality control system includes:

- a. A check of each step of the production process,
- b. Physical tests on samples representing finished production,
- c. A visual inspection of the finished production, and
- d. Periodic auditing by an accredited inspection agency as defined in Section 3.

5. TOLERANCES

The size and shape of the glulam shall be as agreed upon between buyer and seller.

5.1 Tolerance for Dimensions

The dimensional tolerances permitted at the time of manufacture shall be as follows:

Width – Plus or minus 1/16 in. (2 mm).

Depth – Plus 1/8 in. (3 mm) per ft (305 mm) of depth. Minus 3/16 in. (5 mm) or 1/16 in. (2 mm) per ft of depth, whichever is larger.

Length – Up to 20 ft (6.1 m), plus or minus 1/16 in. (2 mm). Over 20 ft (6.1 m), plus or minus 1/16 in. (2 mm) per 20 ft (6.1 m) of length or fraction thereof.

5.2 Tolerance for Camber or Straightness

Tolerances for camber are applicable at the time of manufacture without allowance for dead load deflection. Up to 20 ft (6.1 m), the tolerance is plus or minus 1/4 in. (6 mm). Over 20 ft (6.1 m), the tolerance shall increase 1/8 in. (3 mm) per each additional 20 ft (6.1 m) or fraction thereof, but not to exceed 3/4 in. (19 mm).

The tolerances are intended for use with straight or slightly cambered members and are not applicable to curved members such as arches.

5.3 Tolerance for Squareness of Cross Section

The tolerance for squareness shall be within plus or minus 1/8 in. (3 mm) per ft (305 mm) of specified depth unless a specially shaped section is specified. Squareness shall be measured by placing one leg of a square across a top and/or bottom face and measuring the offset from the other leg of the square to the member at the opposite face of the beam.

5.4 Tolerances for Other Measurements

Tolerances for measurements not addressed in Sections 5.1, 5.2, and 5.3 shall be as agreed upon between buyer and seller.

6. LUMBER FOR LAMINATING

6.1 Species

For purposes of this Standard, softwood and hardwood species shall be approved for use in glulam if stress indices and knot distributions are established as described in ASTM D3737, the wood species comply with requirements for layups or combinations developed in accordance with ASTM D7341, or other proposed criteria are determined to be in conformance with this Standard by the Technical Review Board.

6.2 Moisture Content

The moisture content of lumber shall not exceed 16% at the time of bonding. An exception applies when it is known that the equilibrium moisture content of the glulam in use will be 16% or more: the moisture content of laminations at the time of bonding shall not exceed 20%. Both end jointing and face bonding procedures for lumber with moisture content above 16% shall be approved by an accredited inspection agency.

The moisture content of a piece of lumber shall be taken as the average moisture content throughout the cross sections measured and along the length of the piece.

All moisture meters used for lumber segregation shall be calibrated according to ASTM D4444.

6.3 Sawn Lumber Grading

Sawn lumber is permitted to be visually graded, mechanically graded, or proof graded. All lumber shall be identified by grade prior to bonding. Lumber for multiple-piece laminations (laminations consisting of 2 or more pieces of lumber across the width) shall be graded as individual pieces of lumber except for manufactured lumber as described in Section 6.4.

6.3.1 Visually Graded Lumber

Lumber shall be graded according to standard grading rules approved by the Board of Review of the American Lumber Standard Committee (ALSC) or written special laminating grading rules. Such grades of lumber shall be modified, as necessary, to comply with additional requirements set forth in the laminating specifications for the species.

6.3.2 Mechanically Graded Lumber

Mechanically graded lumber shall be graded according to standard grading rules approved by the Board of Review of the ALSC or special rules determined to be in conformance with this Standard by the Technical Review Board. E-rated, machine stress rated (MSR) and machine evaluated lumber (MEL) are three commercial designations of mechanically graded lumber. Such grades shall be modified, as necessary, according to additional requirements set forth in the laminating specifications for the species.

6.3.3 Proof Graded Lumber

Proof testing shall be qualified under the supervision of an accredited inspection agency. Such proof graded lumber shall be subjected to quality control based on full-size tension tests as set forth in AITC 406. Proof grading shall be limited to individual pieces of lumber without end joints.

6.3.4 Grading of Lumber to be Ripped

Lumber to be ripped shall be graded so that resulting pieces conform to all applicable grade requirements including knot size, slope of grain, and density or rate of growth.

- a. Mechanically Graded Lumber** – When mechanically graded lumber is ripped, it shall be regraded using the grade-determining mechanical or physical property and applicable visual requirements. Regrading requirements for mechanically graded lumber are permitted to be waived if the modulus of elasticity and tensile strength performance of the ripped pieces are monitored by quality control procedures approved by an accredited inspection agency.
- b. Proof Graded Lumber** – Proof graded lumber shall be proof tested after ripping to the requirements established for the ripped size. Regrading requirements for proof graded lumber are permitted to be waived if the modulus of elasticity and tensile strength performance of the ripped pieces are monitored by quality control procedures approved by an accredited inspection agency.
- c. Ripping After End Jointing** – Ripping is permitted on laminations after end jointing and on completed members after bonding. Ripping shall be according to procedures approved by an accredited inspection agency.

6.4 Manufactured Lumber

Manufactured lumber consists of 2 or more pieces bonded together and qualified in accordance with the requirements set forth in AITC 401. Multiple-piece laminations which have been edge bonded are not considered to be manufactured lumber provided they are graded as separate pieces as set forth in Section 6.3.

6.5 Structural Composite Lumber (SCL)

SCL shall be as defined in ASTM D5456 and shall meet the requirements of AITC 402.

7. LAMINATIONS

7.1 Bonding Surfaces

All bonding surfaces including face, edge and end joints shall be smooth and, except for minor local variations, shall be free of raised grain, torn grain, skip, burns, glazing or other deviations from the plane of the surface that might interfere with the contact of sound wood fibers in the mating surfaces. All bonding surfaces shall be free from dust, foreign matter, and exudation which are detrimental to satisfactory bonding. For species requiring resurfacing before gluing, the lapse time between resurfacing and gluing shall not exceed 24 hours unless a longer lapse time is qualified and documented in the Plant Manual.

7.2 Wane

For dry-service conditions, wane up to 1/6 the width at each edge of interior laminations is permitted in certain grade combinations. Wane is permitted to be used in wet-service conditions only where moisture accumulation in the wane areas will not occur. For multiple piece laminations (across the width), wane shall not be permitted in the edge joints, whether bonded or not.

7.3 Lamination Thickness

7.3.1 Laminations shall not exceed 2 in. (51 mm) in net thickness unless a gap-filling adhesive is used for face and edge bonds. Exception: A non-gap-filling adhesive shall be permitted to be used to bond laminations thicker than 2 in. (51 mm) where the laminator's process is qualified and approved by an accredited inspection agency.

7.3.2 Add-on Glulam

7.3.2.1 A gap-filling adhesive shall not be required for bonding add-on laminations not exceeding 2 in. (51 mm) in net thickness.

7.3.2.2 Add-on glulam shall be manufactured with add-on laminations of the same nominal thickness as the laminations used in the original glulam. For each add-on glulam, the bonding surfaces of laminations shall meet the surfacing requirements specified in Sections 7.1.

7.3.2.3 Add-on glulam shall meet the layup requirements for the layup combination of the finished glulam.

7.3.3 Block-Glued Glulam

7.3.3.1 Block-glued glulam shall be manufactured using a gap-filling adhesive. Block-gluing of 2 or more glulam components shall be permitted. The glulam components shall be limited to prismatic straight glulam.

7.3.3.2 Each glulam component shall comply with this Standard. For each block-glued glulam, the bonding surfaces of glulam components shall meet the surfacing requirements specified in Sections 7.1. End jointing of glulam components shall not be permitted.

7.3.3.3 Block-glued glulam shall meet the requirements for the layup combination of the finished glulam.

7.3.4 Re-Glued Glulam

7.3.4.1 Re-glued glulam shall be manufactured using a gap-filling adhesive. Re-gluing shall be limited to 2 glulam components (i.e., 1 dry glue bond).

7.3.4.2 Re-gluing of re-glued glulam shall be completed within 72 hours after the glulam components are manufactured unless a longer lapsed time is specifically qualified, approved by an accredited inspection agency, and documented in the Plant Manual.

7.3.4.3 Each glulam component shall comply with this Standard. For each re-glued glulam, the bonding surfaces of glulam components shall meet the surfacing requirements specified in Sections 7.1. End jointing of glulam components shall not be permitted.

7.3.4.4 Re-glued glulam shall meet the layup requirements for the layup combination of the finished glulam.

7.4 Dimensional Tolerances

At the time of bonding, variations in thickness across the width of a lamination shall not exceed plus or minus 0.008 in. (0.2 mm). The variation in thickness along the length of an individual piece of lumber or the lamination shall not exceed plus or minus 0.012 in. (0.3 mm). The thickness variation shall occur randomly across the width and along the length such that the cumulative effect does not contribute to side-to-side depth variations greater than that allowed in Sections 5.1 and 5.3. Warp and cup shall not be so great that they will not be straightened out by pressure in bonding.

7.4.1 Thickness Tolerances for Laminating with Gap-Filling Adhesives

Where gap-filling adhesives which meet the requirements of Section 8.2 are used, all requirements of Section 7.4 apply except that variations in thickness of laminations are permitted to exceed the limitations specified in Section 7.4 but the maximum bond line thickness shall not exceed 1/16 in. (2 mm).

8. ADHESIVES

Adhesives required by this Standard shall conform to the requirements of ANSI 405.

8.1 Labeling

Each container of adhesive shall be identified with the name of the manufacturer, the name and/or designation of the adhesive, the adhesive manufacturer's lot number and the expiration date after which the adhesive shall not be used.

Labels on each container, with all required information shall be made visible and obvious to the observer. Expired adhesive shall not be used unless recertified in writing by the adhesive manufacturer and the new expiration date is displayed in an obvious place.

8.2 Gap-Filling Adhesives

Gap-filling adhesives shall meet all requirements of ANSI 405 and this Standard when tested with a bond line thickness of 1/16 in. (2 mm). Shims shall be used to ensure that the required bond line thickness is maintained during specimen preparation. Gap-filling adhesives shall be used for block-glued and re-glued glulam in accordance with Sections 7.3.3 and 7.3.4, respectively.

9. WOOD INSERTS

Wood inserts are permitted to be used to meet appearance classification requirements. The moisture content of inserts shall be in accordance with Section 6.2. Adhesives and the method for attaching inserts shall provide durability characteristics appropriate for the end use.

9.1 Maximum Insert Depth

- a. Insert depth shall be limited to 1/2 in. (13 mm) for laminations less than 6 in. nominal (140 mm) in width, and 3/4 in. (19 mm) for laminations 6 in. nominal (140 mm) or wider except for the outer 5% of the depth within the tension zone of bending members.
- b. The depth for inserts located in the outer 5% of the depth of a bending member within the tension zone shall be limited to 1/4 in. (6 mm) for laminations less than 6 in. nominal (140 mm) in width and shall be limited to 3/8 in. (10 mm) for laminations 6 in. nominal (140 mm) and wider.

When for a specific known loading of a member, engineering calculations are used to determine the zones in the tension portion of bending members which will be loaded to less than 50% of the design strength in bending, the depth of the insert is permitted to be that given in (a).

Inserts used in the tension portion of bending members shall be tapered at each end with a slope not steeper than 1:16.

10. FACE AND EDGE JOINTS

The selection and preparation of lumber, laminations, and adhesives shall be in accordance with Sections 6, 7, and 8. Glulam components for block-glued and re-glued glulam shall meet all requirements of this Standard before block-gluing or re-gluing into the finished glulam.

10.1 Adhesive Mixing and Application

Mixing of the adhesive, the interval between mixing and spreading, spreading, assembly time, assembly pressure, temperature and curing time of the adhesive shall be based on recommendations of the adhesive manufacturer with subsequent qualification and daily quality control by the laminator.

Proportions for each adhesive mix shall be determined by weight. Liquids are permitted to be measured by volume only after the containers have been calibrated on a weight basis. Automatic adhesive mixing equipment is permitted to be used provided appropriate mix proportions can be maintained within limits prescribed by the adhesive manufacturer. The mix ratio shall be verified a minimum of once daily by procedures described in AITC Test T122.

The adhesive, whether mixed prior to application or applied separately, shall be applied uniformly to wood surfaces in an amount adequate to meet the performance requirements of this Standard. Determination of the adhesive spread rate shall be made in accordance with AITC Test T102. No adhesive shall be used after expiration of its storage or pot life, as determined by the adhesive manufacturer.

Lumber surface temperature at the time of bonding is critical to achieving satisfactory adhesive bonds. Adjustments in assembly time, quantity of adhesive spread and curing conditions shall be made depending upon the lumber temperature and ambient temperature. The adequacy of adjustments shall be demonstrated by shear strength and bond durability tests conducted on bonds manufactured at the lowest and highest temperatures at which laminating takes place.

The temperature of the adhesive mix and other variables as required by the adhesive manufacturer shall be measured with sufficient frequency to assure that the working life of the adhesive is not exceeded.

10.2 Face Joint Assembly and Bonding

Face joints shall have pressure applied uniformly starting at any point but progressing continuously outward toward the ends or along the length of the member. Assembly pressure at the bond line shall be according to the adhesive manufacturer's recommendations. Caul boards or plates shall be used, if necessary, to prevent localized crushing of the outer laminations.

Pressure shall be maintained for a sufficient period of time so as to ensure close contact between laminations and not over-stress bond lines during development of bond strength. Pressures shall be checked prior to substantial cure and adjustments made as required.

The use of mechanical fasteners such as nails, screws, etc., to secure laminations in lieu of clamping pressure shall not be permitted.

10.3 Edge Joint Assembly and Bonding

Edge joint bonding shall not be required unless specified by the designer. When edge joint bonding is required, edge joints shall be tested in the same manner as face joints and the same requirements for wood failure and shear strength shall apply. A gap-filling adhesive shall be used to bond edge joints, unless the maximum net width of the pieces being bonded is less than or equal to 2 in. (51 mm).

When edge joints are not pre-bonded, they shall be staggered laterally in adjacent laminations by at least the net thickness of the lamination, but not less than 1 in. Where edge joints are pre-bonded in accordance with the requirements of Section 10.2, they need not be staggered laterally.

Where multiple-piece laminations are not edge bonded, it is intended that the edges of the pieces be reasonably close to each other. Edge spacing in top and bottom laminations is permitted to be up to 1/4 in. (6 mm) for the full length with an occasional 3/8 in. (10 mm) gap permitted. Edge spacing in interior laminations shall not exceed 3/8 in. (10 mm) for nominal widths of 10 in. (235 mm) and less, 1/2 in. (13 mm) for 12 in. nominal (286 mm) widths and 5/8 in. (16 mm) for 14 in. nominal (337 mm) widths. For widths wider than 14 in. nominal (337 mm), the allowable opening shall be proportional to the opening allowed for a nominal width of 14 in. (337 mm). Measurements of openings shall be cumulative across multiple-piece laminations containing 3 or more pieces.

Unbonded edge joints shall not be permitted in face laminations of members used in wet-service conditions where moisture is likely to accumulate in the unbonded joint.

10.4 Curing Schedules

The laminator's procedures and quality control manual shall include certified bonding procedures for each adhesive formulation used. A separate procedure shall be established for each combination of adhesive, species and treatment. The procedures shall include time-temperature relationships.

11. END JOINTS

End joints shall be bonded in accordance with the requirements for face joint bonding with appropriate modifications to the adhesive spreading, assembly time, application of pressure and curing time for the methods used. End jointing glulam shall not be permitted.

End joints shall be qualified in accordance with Section 13.1.3.

11.1 Assembly and Bonding

End joints shall be pre-bonded or assembled and bonded integrally with the face joint operation. Where end joints are bonded integrally with the face joint bonding of laminations, they must be positively maintained in alignment while the face joint bond is accomplished. Positioning and alignment methods shall permit measurement of tolerances with gauges. End joints for the production of curved members shall be pre-bonded unless the assembled thickness tolerance of the end joint area and alignment can be maintained by other methods.

11.2 Joint Thickness Tolerance

For plane scarf joints, the thickness tolerance in end joint areas at the time of face joint bonding shall be within plus 0.020 in. (0.5 mm) to minus 0.005 in. (0.1 mm) of the thickness of the lumber being end jointed. For finger joints, a thickness tolerance of plus 1/32 in. (0.8 mm) is allowed in the assembled thickness. The thickness of exposed tips of plane scarf joints or finger joints which occur across the full width of the face of the lamination shall not exceed 1/32 in. (0.8 mm).

11.3 Knots In or Near End Joints

Knots or knotholes in plane scarf joints shall be limited to those permitted for the lumber grade. In no case shall they exceed 1/4 the nominal width of the piece in laminations occupying the outer 10% on each side of bending members.

Finger joints shall not contain knots except that an occasional occurrence of a single pin knot, not to exceed 3/8 in. (10 mm) diameter, is permitted in finger joints in the outer 10% of depth on the tension side of bending members. An occasional single knot up to 1/2 in. (13 mm) diameter is permitted in joints in the remainder of bending members and in uniform-grade members.

In bending members, knots exceeding 3/8 in. (10 mm) diameter shall not be permitted within 2 knot diameters or 6 in. (152 mm), whichever is less, of finger joints in the inner and outer tension zones (in no case less than 10% of the depth of bending members), nor shall knots over 1/2 in. (13 mm) diameter occur within one knot diameter of finger joints in the balance of the laminations.

In uniform-grade members, knots larger than 3/4 in. (19 mm) shall not be permitted within one knot diameter of finger joints.

Measurement of knot diameter for spacing near end joints shall be parallel to the longitudinal axis of the piece of lumber. The distance of knots from finger joints shall be measured from the edge of the knot nearest the joint to the closest part of the joint.

11.4 Spacing of End Joints in Adjacent Laminations

Spacing between finger joints in adjacent laminations shall be determined by measuring the distance between the closest parts of joints in adjacent laminations measured in a direction parallel to the longitudinal axis.

The spacing of scarf joints shall be determined by measuring the distance between tips along the face joint bond of adjacent laminations. Furthermore, a plane at a right angle to the axis of a member that intersects one plane scarf joint in a lamination shall not intersect any part of another plane scarf joint in an adjacent lamination.

For multiple-piece laminations, an end joint shall be considered in the same manner as a lamination consisting of a single piece when end joints in the pieces of the lamination are within 6 in. (152 mm) of each other. If only one piece of a multiple-piece lamination has an end joint within a 6 in. (152 mm) cross section, and an end joint occurs in one piece of an adjacent lamination closer than 6 in. (152 mm), this combination shall be considered on the same basis as a single piece lamination provided the combined width of the 2 end joints does not exceed the width of the lamination.

In those areas of members consisting of multiple-piece laminations where specific joint spacing is required, the sum of the widths of the end joints of multiple-piece lamination in any 2 laminations in any 6 in. (152 mm) of length shall not exceed the width of a single lamination; nor shall 3 or more end joints in adjacent laminations closer together than 6 in. (152 mm) appear on either side of members in this area.

Concentrations of end joints shall be avoided. In addition, end joints shall be dispersed as follows:

- a. The minimum spacing of end joints in adjacent laminations in the tension zone of bending members for the outer 1/8 of the depth of the member plus one lamination shall be 6 in. (152 mm). This spacing applies over the central 75% along the length of the zone stressed in tension. There are no minimum spacing requirements for the remaining portion of the tension zone.

Where engineering calculations are used to determine zones in the tension portions of bending members which are loaded to less than 50% of the design value in bending, the minimum spacing requirements shall not apply to these zones.

- b. When end joints are proof loaded in accordance with either AITC Test T118 or T121, there are no requirements for minimum spacing of end joints.

- c. When the outer lamination on the tension side of a member is repaired by the procedures described in AITC 403, the repair shall be made in such a manner that no end joint in the outer lamination or the next inner lamination occurs within 6 in. (152 mm) on either side of the repair tip(s).
- d. No specific end joint spacing is required in arches.

11.5 Spacing of End Joints Within the Same Lamination

- a. End joints within the same lamination shall be spaced a minimum of 6 ft (1.8 m) apart in the outer 10% of the total depth of bending members on the tension side. An occasional occurrence of two end joints less than 6 ft (1.8 m) apart along lamination lengths shall be permitted. In the remainder of bending members, end joint spacing within the same lamination shall be permitted to be less than 6 ft (1.8 m).
- b. Requirements for spacing of end joints within the same lamination shall not apply provided the full length of the lamination is proof loaded in tension by AITC Test T121, and the laminations are resurfaced after end jointing to the tolerances set forth in Section 6.4.

11.6 End Joints Used for Repair

Laminating repair procedures using end joints which are integrally bonded in the repair process shall be evaluated by an accredited inspection agency using the same test criteria and manufacturing tolerances that are applicable to production end joints. The procedure for testing and evaluation in AITC 403 shall be followed.

If structural repairs using end joints are made to laminations containing end joints that have been previously proof loaded, the member containing the repaired lamination shall not be marked as a member containing proof loaded end joints.

12. APPEARANCE CLASSIFICATIONS

Glulam shall be finished to a Framing, Framing-L, Industrial, Industrial-L, Architectural or Premium classification unless otherwise agreed upon by buyer and seller.

12.1 Framing Appearance Classification

12.1.1 Lamination Characteristics

Laminations are permitted to possess the natural growth characteristics of the lumber grade.

12.1.2 Void Repair

Voids appearing on the edge of laminations need not be filled. Loose knots and open knot holes in the wide face of laminations exposed to view need not be filled. Gaps in edge joints appearing on the wide face of laminations exposed to view need not be filled.

12.1.3 Wane

Pencil wane is permitted in all combinations and is not limited in length, subject to the provisions in Section 12.1.4. The frequency of occurrence of pencil wane shall not exceed one in ten pieces of lumber used. Occasional wane approximately one foot (305 mm) in length and not exceeding the permissible depth of a low lamination shall be permitted in all combinations without regard to the cumulative effects indicated in Section 12.1.4. Wane permitted in specific laminating combinations up to 1/6 the lumber width on each side is not limited in length.

12.1.4 Surfacing

Members are required to be surfaced on two sides only to match conventional framing lumber sizes. The following appearance requirements apply only to these two sides. Misses, low laminations, and pencil wane are permitted on a cumulative basis. The cumulative depth of misses, low laminations, and wane shall not exceed 10% of the width of the member at any bond line, except for combinations which permit more wane and have design values reduced accordingly. The maximum area of low laminations shall not exceed 25% of the surface area of a side.

12.2 Framing-L Appearance Classification

This appearance classification is the same as the Framing appearance classification except that the “L” indicates that SCL has been used for the outer laminations. All other characteristics remain the same as those listed for the Framing appearance classification.

12.3 Industrial Appearance Classification

12.3.1 Lamination Characteristics

Laminations are permitted to possess the natural growth characteristics of the lumber grade.

12.3.2 Void Repair

Voids appearing on the edge of laminations need not be filled. Loose knots and open knot holes in the wide face of laminations exposed to view need not be filled. Gaps in edge joints appearing on the wide face of laminations exposed to view need not be filled.

12.2.3 Wane

Pencil wane is permitted in all combinations and is not limited in length, subject to the provisions of Section 12.3.4. The frequency of occurrence of pencil wane shall not exceed one in ten pieces of lumber used. Occasional wane approximately one foot (305 mm) in length and not exceeding the permissible depth of a low lamination shall be permitted in all combinations without regard to the cumulative effects indicated in Section 12.3.4. Wane permitted in specific laminating combinations up to 1/6 the lumber width on each side is not limited in length.

12.3.4 Surfacing

Members are required to be surfaced on two sides only. The following appearance requirements apply only to these two sides. Occasional misses, low laminations, and pencil wane are permitted on a cumulative basis. The cumulative depth of the misses, low laminations, and wane shall not exceed 10% of the width of the member at any bond line, except for combinations which permit more wane and have shear design values reduced accordingly. The maximum area of low laminations shall not exceed 5% of the surface area of a side, and no more than two low laminations shall be adjacent to one another.

12.4 Industrial-L Appearance Classification

This appearance classification is the same as the Industrial appearance classification except that the “L” indicates that SCL has been used for the outer laminations. All other characteristics remain the same as those listed for the Industrial appearance classification.

12.5 Architectural Appearance Classification

12.5.1 Lamination Characteristics

The wide face of laminations exposed to view shall be free of loose knots. Otherwise, laminations are permitted to possess the natural growth characteristics of the lumber grade. SCL shall not be used for any laminations of this appearance classification.

12.5.2 Void Repair

In exposed surfaces, voids measuring over 3/4 in. (19 mm) long shall be filled by the manufacturer with a wood-tone colored filler that reasonably blends with the final product or with wood inserts selected for similarity to the grain and color of the adjacent wood. Exception: A void (not repaired) is permitted to be longer than 3/4 in. (19 mm) if its area does not exceed 1/2 in². (3.23 cm²). Open knot holes on the wide face of laminations exposed to view shall be filled.

12.5.2.1 Pencil Wane

All occurrences of pencil wane shall be repaired, regardless of length. Pencil wane shall be permitted to be repaired using filler up to a maximum length of 8 in. (203 mm). For pencil wane longer than 8 in. (203 mm), wood inserts shall be used for repairs.

12.5.2.2 Edge Joints

Voids greater than 1/16 in. (2 mm) wide in edge joints appearing on the wide face of laminations exposed to view shall be filled with wood-tone colored filler that reasonably blends with the final product.

12.5.3 Surfacing

Exposed faces shall be surfaced smooth. Misses, wane, and low laminations shall not be permitted. Occasional repaired pencil wane shall be permitted subject to the restrictions of Section 12.5.2.1.

12.5.4 Eased Corners

The corners of the member exposed to view in the final structure shall be eased with a minimum radius of 1/8 in. (3 mm) or equivalent chamfer.

12.6 Premium Appearance Classification**12.6.1 Lamination Characteristics**

Laminations shall be selected to minimize loose knots, unsound knots, knotholes, pencil wane, bark inclusions, and voids that will be visible after final surfacing of the member. On the wide face of laminations exposed to view in the finished member, knots shall be limited to 20% of the net face width of the lamination, and not over two maximum size knots or their equivalent shall occur in a 6 ft (1.8 m) length. Otherwise, laminations are permitted to possess the natural growth characteristics of the lumber grade. SCL shall not be used for any laminations of this appearance classification.

12.6.2 Void Repair

In exposed surfaces, voids measuring over 3/4 in. (19 mm) in length shall be filled by the manufacturer with wood-tone colored filler that reasonably blends with the final product or with clear wood inserts selected for similarity to the grain and color of the adjacent wood. Exception: A void (not repaired) is permitted to be longer than 3/4 in. (19 mm) if its area does not exceed 1/2 in². (3.23 cm²).

Occasional occurrences of voids due to loose knots, unsound knots, knotholes, etc., which were not detected during the grading process, shall be permitted subject to the repair requirements of the preceding paragraph.

12.6.2.1 Pencil Wane

All occurrences of pencil wane shall be repaired regardless of length. Pencil wane shall be permitted to be repaired using filler up to a maximum length of 8 in. (203 mm). For pencil wane longer than 8 in. (203 mm), wood inserts shall be used for repairs.

12.6.2.2 Edge Joints

Voids greater than 1/16 in. (2 mm) wide in edge joints appearing on the wide face of laminations exposed to view shall be filled with wood-tone colored filler that reasonably blends with the final product.

12.6.3 Surfacing

Exposed faces shall be surfaced smooth. Misses, wane, and low laminations are not permitted. Occasional repaired pencil wane shall be permitted subject to the restrictions of Section 12.6.2.1.

12.6.4 Eased Corners

The corners of the member exposed to view in the final structure shall be eased with a minimum radius of 1/8 in. (3 mm) or equivalent chamfer.

13. QUALITY CONTROL SYSTEM

The quality control system of the laminator shall be established, implemented, and maintained by the laminator and shall be subject to approval by an accredited inspection agency.

At a minimum the quality control system shall include:

- a. Plant and process qualification, including qualification tests as required in Section 13.1 and verification of such qualification by an accredited inspection agency.
- b. Adhesive lot testing as required in Section 13.2.
- c. Daily quality control as required in Section 13.3, consisting of:
 1. A continuous detailed check of each step of the process at production checkpoints including in-line tests.
 2. Physical tests of representative samples.
 3. Visual inspection of finished production.
- d. Regular audits by an accredited inspection agency (see Section 13.4).
- e. Plant manuals (see Section 13.5).
- f. Quality control records (see Section 13.6).

13.1 Plant and Process Qualification

All processes affecting the quality of glulam or the evaluation quality shall be qualified by test and approved by an accredited inspection agency prior to production. The following is required for plant qualification:

- a. Bonding qualification described in Section 13.1.1.
- b. Face and edge joint qualification described in Section 13.1.2.
- c. End joint qualification described in Section 13.1.3.
- d. Qualification of special materials used by the plant such as alternate lumber grades in accordance with AITC 407, SCL in accordance with AITC 402 or ASTM D5456, and manufactured lumber in accordance with AITC 401.
- e. Qualification of special processes used by the plant such as proof-grading lumber in accordance with AITC 406, lamination repairs in accordance with AITC 403, and radial reinforcement in accordance with AITC 404.
- f. Physical tests used by the plant for daily quality control shown in Section 13.1.5.
- g. Current calibration of test equipment and production gauges.

A summary of the tests for qualification is shown in Table 1.

TABLE 1

SUMMARY OF QUALIFICATION TESTS

Test Performed On	Minimum Number of Samples	Minimum Number of Specimens per Sample	AITC Test Number and Type of Test	Requirements or Limitations for	References Within this Standard
Face and Edge Joints ^c	2 beams ^{a,b} – 1 open assembly 1 closed assembly	10 total bond lines for each assembly	T107 Shear	Strength and Wood Failure	13.1.1 13.1.2
	2 beams ^{a,b} – 1 open assembly 1 closed assembly	3 sample blocks from each assembly	T110 Cyclic Delamination	Bond Line Openings	13.1.1 13.1.2
End Joints	1 ^a	30	T119 Tension	Strength and Wood Failure	13.1.1 13.1.3
	1 ^a	5	T110 Cyclic Delamination	Bond Line Openings	13.1.1 13.1.3
<i>The following tests are required in addition to the above requirements when these processes and/or materials are used in the plant.</i>					
Proof Loaded End Joints	2	30	T118 Bending or T121 Tension	Strength	13.1.3.3
End Joints for Repair	10 Repairs	2	T119 (Modified) Tension	Strength and Wood Failure	13.1.3 13.1.3.4
	1 ^d	5	Beam Test		AITC 403
Manufactured Lumber	1	102	T123 Tensile Properties	Strength	AITC 401
SCL	Per Applicable Requirements in ASTM D5456 and AITC 402	Per Applicable Requirements in ASTM D5456 and AITC 402	T123 Tension Plus Referenced ASTM Tests, T107, T110	Strength SCL/SCL plus SCL/Wood	ASTM D5456 AITC 402
			T116	Long Span E	AITC 402
Radially Reinforced Curved Members	1	10			AITC 404
Proof Graded Lumber	1	102	T123 Tensile Properties	Strength	AITC 406
			T116	Long Span E	AITC 406
Block-Glued (Edge or Face) or Re-Glued Glulam (Face only)	2 beams ^e – 1 open assembly 1 closed assembly	9 specimens for secondary glue bonds for each assembly	T107 Shear	Strength and Wood Failure	13.1.2.1, 13.1.2.2 or 13.1.2.3
	2 beams ^e – 1 open assembly 1 closed assembly	3 specimens for secondary glue bonds for each assembly	T110 Cyclic Delamination	Bond Line Openings	13.1.2.1, 13.1.2.2 or 13.1.2.3

a. For each adhesive-species-treatment combination used (SCL is considered a separate species for testing requirements).

b. When edge joint bonding is a structural requirement.

c. End joints are permitted in specimens used for face joint bonding.

d. End joint repair procedures must be verified for adequacy by supplemental full-scale beam tests in addition to AITC Test T119.

e. See sampling requirements specified in 13.1.2.1, 13.1.2.2 or 13.1.2.3, as applicable.

13.1.1 Bonding Qualification

Each combination of adhesive, species grouping, and treatment used for face, edge or end joint bonding shall be qualified for use prior to production in accordance with applicable provisions of this Section. Samples to be used for in-plant qualification shall be prepared using representative product manufacturing processes.

13.1.1.1 Basic Species Groupings

For qualification purposes, the species or species groups within the following groupings need not be qualified separately.

Group 1 – Douglas Fir-Larch*

Group 2 – Southern Pine

Group 3 – Hem-Fir, Mountain Hemlock, Douglas Fir South, Sitka Spruce

Group 4 – Softwood Species including Englemann Spruce, Lodgepole Pine, Ponderosa Pine, Spruce-Pine-Fir and other Western Species.

Group 5 – California Redwood

Group 6 – Alaska Cedar, Port-Orford Cedar

Group 7 – Red Oak, White Oak

* Larch shall require separate qualification for face bonding because of galactan content if deemed necessary by an accredited inspection agency.

13.1.1.2 Species Group Modifications for Qualification:

- a. Where a plant has qualified adhesives for a face joint bond on Group 1 species, a separate qualification is not required on Groups 3, 4 and 5.
 - b. Where end joints of both Douglas Fir-Larch and Hem-Fir have been separately qualified, it is not necessary to qualify the combined species, provided the end joint cure cycle used is controlled by the more restrictive requirement.
 - c. Where end joints have been qualified for Group 1 species for the Qualification Stress Levels (QSLs) of 2400 psi (16.5 MPa) or higher, a separate qualification is not required for Group 3 species for QSLs of 2000 psi (13.8 MPa) or less. Where end joints have been qualified for Group 1 and 2 species, a separate qualification for Group 4 species is not required for QSLs of 2000 psi (13.8 MPa) or less.
- Where qualification of end joints for a Group 3, 4, 5 or 6 species is required, and the plant has been previously qualified for the wider widths of Group 1 or 2 species, using the same configuration and jointing procedures, AITC Test T119 needs to be performed on the nominal 6 in. (140 mm) width only. However, wider widths shall not be exempted from the continuous daily quality control tests.

13.1.2 Face and Edge Joint Qualification

- a. Face and edge joints shall be prepared meeting the requirements of Section 10 and the plant's procedures and quality manuals. Where gap-filling adhesives are to be evaluated, test specimens shall be cut from samples specially made by using shims or by a similar method to maintain a bond line thickness equivalent to the maximum bond line thickness to be approved.
- b. A minimum of 10 bond lines from each of two beams shall be tested using AITC Test T107. The average shear strength of all specimens from each beam shall equal or exceed 90% of the average clear wood shear strength parallel to grain as determined from ASTM D2555. Where species groups are used, the procedures for assigning values for groups given in ASTM D2555 shall be used. Alternatively, the average shear strength of all specimens from each beam shall equal or exceed the value provided in Table 2. The shear value for 12% moisture content shall be used for moisture contents of 12% or less. The average wood failure of the sheared or broken surfaces of all specimens from each beam to be evaluated for qualification or lot verification testing of adhesives shall equal or exceed 80% for adhesives used with softwoods and non-dense hardwoods or shall equal or exceed 60% for adhesives used with dense hardwoods.
- c. A minimum of three cyclic delamination specimens shall be prepared and tested in accordance with AITC Test T110. After one complete cycle, softwoods shall have no more than 5% delamination and hardwoods shall have no more than 8% delamination from each specimen.

TABLE 2

REQUIRED SHEAR STRENGTH OF ADHESIVE JOINTS

Species or Species Group^a	Required Average Shear Strength at Moisture Content of					
	12% or Below		14%		16%	
	psi	MPa	psi	MPa	psi	MPa
Alaska Cedar	1020	7.0	980	6.8	930	6.4
California Redwood ^b	850	5.9	820	5.7	790	5.4
Douglas Fir	1020	7.0	980	6.8	940	6.5
Douglas Fir South	1360	9.4	1270	8.8	1180	8.1
Eastern Spruce	1080	7.4	1010	7.0	950	6.5
Hem-Fir	1040	7.2	980	6.8	930	6.4
Lodgepole Pine	790	5.4	760	5.2	730	5.0
Port-Orford Cedar	1230	8.5	1140	7.9	1060	7.3
Red Oak	1600	11.0	1500	10.3	1420	9.8
Softwood Species ^c	790	5.4	760	5.2	730	5.0
Southern Pine	1250	8.6	1150	7.9	1040	7.2
Sugar Maple	2100	14.5	1950	13.4	1820	12.5
Western Hemlock	1160	8.0	1110	7.7	1050	7.2
Western Larch	1220	8.4	1160	8.0	1100	7.6
White Oak	1800	12.4	1680	11.6	1560	10.8

a. For other species or species groups, the value shall be based on 90% of the shear strength parallel to grain as determined from the data and procedures presented in ASTM D2555 or Wood Handbook.

b. Average shear for old growth and new growth California Redwood.

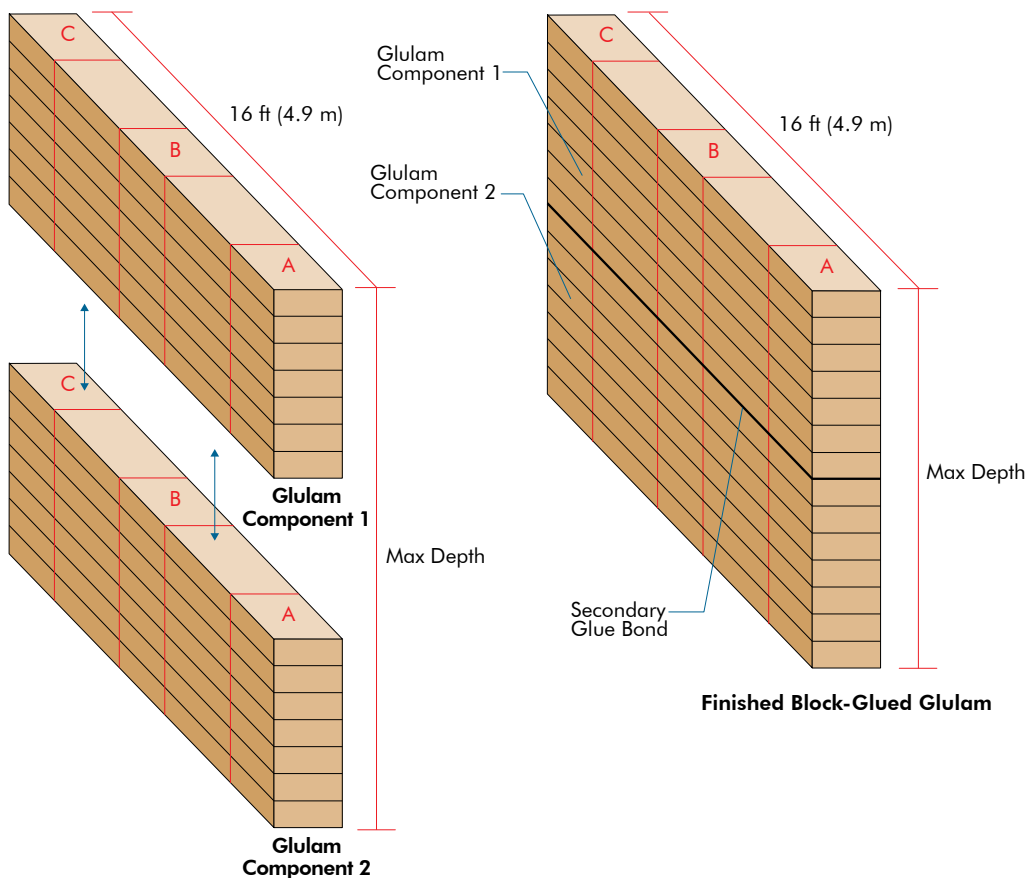
c. Based on the species with the lowest shear strength included in Softwood Species (Lodgepole Pine).

13.1.2.1 Face Joint Qualification for Block-Glued Glulam

Face joints used for the face bond qualification of block-glued glulam shall be obtained from a minimum of 2 finished block-glued glulams (test beams), 1 open assembly and 1 closed assembly, as shown in Figure 1.

FIGURE 1

BLOCK-GLUING ON THE FACE OF GLULAM COMPONENTS (DRAWING NOT TO SCALE)



Face bonding of block-glued glulam shall be qualified as follows:

1. Each test beam (finished block-glued glulam), as shown in Figure 1, shall be manufactured with the maximum depth intended for qualification with the secondary glue bond placed at mid-depth of the finished beam. Each test beam shall be at least 16 feet (4.9 m) in length.
2. Three sections (A, B and C in Figure 1) shall be sampled from both ends and the center of each test beam to prepare the specimens for AITC Tests T107 and T110.

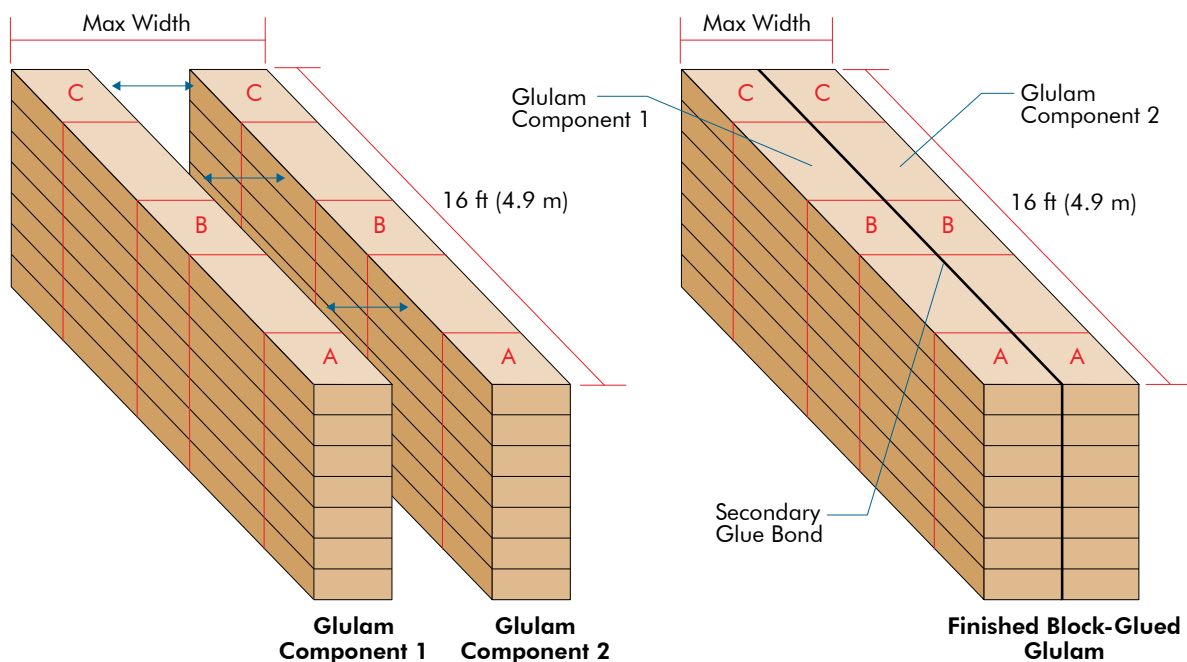
3. For AITC Test T107, 3 shear specimens shall be prepared from each section (A, B or C in Figure 1) with the secondary glue bond in the shear plane. The average shear strength and average wood failure of the secondary glue bond obtained from all 9 specimens in each test beam shall meet the requirements specified in Section 13.1.2(b).
4. For AITC Test T110, a specimen of 8 or more laminations in depth with the secondary glue bond located in the center of the specimen depth shall be prepared from each section (A, B or C in Figure 1). Cyclic delamination of each specimen on the secondary glue bond shall meet the requirements specified in Section 13.1.2(c).
5. All qualified manufacturing details shall be documented and included in the Plant Manual in accordance with Section 13.5.

13.1.2.2 Edge Joint Qualification for Block-Glued Glulam

Edge joints used for the edge bond qualification of block-glued glulam shall be obtained from a minimum of 2 finished block-glued glulams (test beams), 1 open assembly and 1 closed assembly, as shown in Figure 2.

FIGURE 2

BLOCK-GLUING ON THE EDGE OF GLULAM COMPONENTS (DRAWING NOT TO SCALE)



Edge bonding of block-glued glulam shall be qualified as follows:

1. Each test beam (finished block-glued glulam), as shown in Figure 2, shall be manufactured with the maximum width intended for qualification with the secondary glue bond placed at mid-width of the finished beam. Each test beam shall be at least 16 feet (4.9 m) in length.
2. Three sections (A, B and C in Figure 2) shall be sampled from both ends and the center of each test beam to prepare the specimens for AITC Tests T107 and T110.
3. For AITC Test T107, 3 shear specimens shall be prepared from each section (A, B or C in Figure 2) with the secondary glue bond in the shear plane. The average shear strength and average wood failure of the secondary glue bond obtained from all 9 specimens in each test beam shall meet the requirements specified in Section 13.1.2(b).
4. For AITC Test T110, a specimen of 6 or more laminations in depth with the secondary glue bond located in the center of the specimen width shall be prepared from each section (A, B or C in Figure 2). Cyclic delamination of each specimen on the secondary glue bond shall meet the requirements specified in Section 13.1.2(c).
5. All qualified manufacturing details shall be documented and included in the Plant Manual in accordance with Section 13.5.

13.1.2.3 Face Joint Qualification for Re-Glued Glulam

Face joints used for the face bond qualification of re-glued glulam shall be obtained from a minimum of 2 finished re-glued glulams (test beams), 1 open assembly and 1 closed assembly, as shown in Figure 1. Face bonding of re-glued glulam shall be qualified in accordance with Section 13.1.2.1 with the following exceptions:

- a. Radius of the glulam components shall represent the smallest radius intended for re-gluing, and
- b. A minimum of 72 hours shall be lapsed after the glulam components are manufactured before re-gluing unless a longer lapsed time is intended to be qualified.

13.1.3 End Joint Qualification

- a. Full-size end joint specimens shall be prepared meeting the requirements of Section 11 and the plant's procedures and quality manuals. Qualification of end joints in any width qualifies all narrower widths. Where both nominal 1 in. (19 mm) and nominal 2 in. (38 mm) thick lumber are used in production, each shall be qualified separately where the joint geometry is judged to be significantly different by an accredited inspection agency.

- b. A minimum of 30 specimens shall be tested in tension using AITC Test T119. Average wood failure of all specimens tested shall equal or exceed 80% for softwoods or non-dense hardwoods, or 60% for dense hardwoods. The average strength and the 5% tolerance limit on strength with 75% confidence shall be determined. The strength value at the 5% tolerance limit with 75% confidence divided by 1.67 shall be the QSL for the process.
- c. A minimum of 5 specimens shall be tested for durability using AITC Test T110. After one complete cycle, softwoods shall have no more than 5% delamination and hardwoods shall have no more than 8% delamination from each specimen.

13.1.3.1 Minimum QSL

- a. **Multiple Grade Members** – The QSL shall meet or exceed the reference bending design value provided that the outer fiber stresses determined by a transformed section analysis using the average modulus of elasticity for each grade do not exceed the design stress by more than 10%. Where the outer fiber stress determined by the transformed section analysis exceeds the design value by more than 10%, the QSL shall meet or exceed 90% of the outer fiber stress determined by transformed section analysis. The QSL shall also meet or exceed 1.25 times the reference tension design value.
- b. **Uniform-grade Members** – For uniform-grade layups and other layups with calculated outer fiber stresses less than 10% greater than the reference bending design value, the QSL shall meet or exceed 90% of the outer fiber stress as determined by transformed section analysis. The QSL shall also meet or exceed 1.25 times the reference tension design value.

The required strength is applicable to nominal 2x6 (38 mm x 140 mm) lumber. For other widths in nominal 2 in. (38 mm) thick lumber, the required strengths are permitted to be multiplied by the factors listed in Table 3.

Note 5: For example, when 2x8 end joints are manufactured with 302-24 Douglas fir tension lamination for qualification, the required tension test value at 5% tolerance limit with 75% confidence, when the end joints are tension-tested at its full width of 2x8, is the requirement for a 2x6 end joint of 4,000 psi (27.6 MPa) times the strength adjustment factor of 0.95 provided in Table 3, or 3,800 psi (26.2 MPa). See Section 13.1.3.5 if each end joint is split into 2 pieces of 2x4 for tension testing.

TABLE 3

STRENGTH ADJUSTMENT FACTORS FOR LUMBER LARGER THAN 2x6 USED IN AITC TEST T119

Size	All Species Except Southern Pine	Southern Pine
2 x 8 (38 mm x 184 mm)	0.95	0.98
2 x 10 (38 mm x 235 mm)	0.90	0.95
2 x 12 (38 mm x 286 mm)	0.85	0.93

13.1.3.2 QSL for Inner Laminations of Bending Members

End joints with lower QSLs than those required for outer tension zone laminations are permitted in inner tension and compression zones of bending members provided:

- a. The edges of each lamination shall be clearly marked to identify the strength level until beam surfacing unless the end joint configuration is such that the end joint with the lower QSL is readily distinguishable from the end joint with the higher QSL used in outer laminations when viewed from the edge of the laminations.
- b. The end joint with the lower QSL shall be qualified for the maximum stress level for which it is used.
- c. The end joint with the lower QSL shall not be used in the outer tension zone nor in the outer 10% of the depth on the tension side, whichever is greater.
- d. End joints with QSL levels less than 75% of the QSL of the outer tension zone shall not be used in the outer compression zone of bending members.
- e. The required strength level for the lower strength end joint shall be determined by straight-line interpolation from the outer tension lamination to the mid-depth of the member. For this procedure, the stress at the outer tension lamination shall be the 1.67 times the reference bending stress for the beam combination, and the stress at the mid-depth of the member shall be taken as zero.

13.1.3.3 Proof Loaded End Joints Qualification

When proof loaded end joints are to be used, such end joints shall be qualified by AITC Test T118 for bending proof loading; or by AITC Test T121 for tension proof loading.

13.1.3.4 End Joints Used in Lamination Repair

End joints used in lamination repairs shall be qualified by testing in accordance with the procedures given in AITC 403.

13.1.3.5 Split End Joints

If the end joint is larger than 2x6 (38 mm x 140 mm) and is split into 2 equal-width pieces prior to tension testing to accommodate small-capacity tension test machines, the average of those 2 split pieces shall be multiplied by the correction factors listed in Table 4 when compared to the required tensile strength.

TABLE 4

CORRECTION FACTORS FOR TENSION TEST RESULTS OBTAINED FROM SPLIT END JOINTS

Size	Correction Factor to Adjust to Nominal 2x6 (38 mm x 140 mm)		Correction Factor to Adjust to the Width Before Splitting	
	All Species Except Southern Pine	Southern Pine	All Species Except Southern Pine	Southern Pine
Split 2 x 8 (38 mm x 184 mm)	0.95	0.99	0.90	0.97
Split 2 x 10 (38 mm x 235 mm)	0.97	0.99	0.87	0.94
Split 2 x 12 (38 mm x 286 mm)	1.00	1.00	0.85	0.93

Note 6: For example, when 2x8 end joints are manufactured with 302-24 Douglas fir tension lamination for qualification but the tension test machine at the manufacturing facility does not have the capacity to break the end joints in full width, each 2x8 end joint may be split into 2 pieces of 2x4. The average tension value obtained from both 2x4 split end joints for each 2x8 end joint should be adjusted by the correction factor of 0.90 provided in Table 4 to represent the tensile strength of the parent 2x8 end joint. The adjusted tension test value for all 2x8 end joints at 5% tolerance limit with 75% confidence is compared to the 2x8 end joint tension requirement of 3,800 psi (26.2 MPa) in accordance with Note 5.

Alternatively, the average tension value obtained from both 2x4 split end joints for each 2x8 end joint may be adjusted by the correction factor of 0.95 provided in Table 4 to represent the tensile strength of a standard 2x6 end joint. However, the adjusted tension value test value for the standard 2x6 end joints at 5th percentile with 75% confidence should be compared to the 2x6 end joint tension requirement of 4,000 psi (27.6 MPa).

13.1.4 Other Qualification Tests

All inspection and test procedures required in Section 13.2 for daily quality control shall be performed as a part of the qualification procedure.

13.2 Adhesive Lot Testing

Each new lot of adhesive previously qualified under Section 13.1.1 shall be tested for strength, wood failure, and durability prior to shipment of the members manufactured with this lot. Samples for this testing shall be made-up separately prior to use of the adhesive in production or taken from the first production run. Tests shall be made on specimens which have been manufactured from the species to be used in the production of glulam and using the same adhesive curing procedures. Testing of a new lot of adhesives for face joint bonding will satisfy the requirements for edge joint bonding using the same adhesive.

Where gap-filling adhesives are to be evaluated, test specimens shall be cut from samples specially made by using shims or by a similar method to maintain a bond line thickness equivalent to the maximum bond line thickness to be approved.

13.2.1 Face Joint Bonding: Strength and Wood Failure

Shear tests shall be performed on each new lot of adhesives in accordance with AITC Test T107. The average shear strength of all specimens from each beam shall equal or exceed 90% of the average clear wood shear strength parallel to grain as determined from ASTM D2555. Where species groups are used, the procedures for assigning values for groups given in ASTM D2555 shall be used. The shear value for 12% moisture content shall be used for moisture contents of 12% or less. The average wood failure of the sheared or broken surfaces of all specimens from each beam to be evaluated for qualification or lot verification testing of adhesives shall equal or exceed 80% for adhesives used with softwoods and non-dense hardwoods or shall equal or exceed 60% for adhesives used with dense hardwoods.

13.2.2 End Joint Bonding: Strength and Wood Failure

End joint specimens shall be prepared using the same adhesive curing procedures used in production. End joint adhesives shall be evaluated for strength and wood failure according to AITC Test T119. A minimum of 4 end joints shall be tested for adhesive lot testing. Average wood failure of all specimens tested shall equal or exceed 80% for softwoods or non-dense hardwoods, or 60% for dense hardwoods. Average strength required of all the specimens tested shall be as determined by the qualification test required in Section 13.1.3.

13.2.3 Durability of Adhesive Bonds: Face and End Joint Bonding

Face and end joint bond durability shall be tested in accordance with AITC Test T110 on each new lot of adhesive. After one complete cycle, softwoods shall have no more than 5% delamination and hardwoods shall have no more than 8% delamination from each specimen. Face and end joint test specimens shall be prepared using the same adhesive curing procedures used in production.

13.3 Daily Quality Control

For the purposes of quality control, an 8-hour work shift or portion thereof shall constitute one day. Daily testing requirements shall apply to each work shift or portion thereof. Daily quality control shall include in-line assessments, off-line tests of representative specimens, and inspection of finished production.

13.3.1 In-line Assessments

In-line assessments shall be conducted at production checkpoints identified in the plant's quality manual. Assessments shall include, but not be limited to, the measurement of moisture content; evaluation of surfacing quality; measurement of temperature; observation of end joint, edge joint, face joint bonding processes; tests of adhesive mix ratios; measurement and observation of adhesive spread; and monitoring of assembly time, pressure and curing conditions.

13.3.2 Off-line Tests

Strength and durability of face joints, edge joints and end joints shall be monitored daily by off-line tests of representative specimens. Machining and fitment of end joints shall also be conducted as part of daily quality control. The secondary glue bond for block-glued and re-glued glulam shall be subject to off-line tests. A summary of daily quality control tests is shown in Table 5.

Where manufactured lumber and sawn lumber of the same species are used during the same shift, daily quality control tests for face, edge and end joint bonding need to be run only on the material which has controlling test values as determined during qualification.

TABLE 5

SUMMARY OF OFF-LINE TESTS – FOR DAILY REQUIREMENTS

Test Performed on	Minimum Number of Specimens per Sample per Sampling Period	AITC Test Number and Type of Test	Requirements or Limitations for	References Within this Standard
Face and Edge Joints ^{a,b,f}	10	T107 Shear	Strength and Wood Failure	13.3.4
	1	T110 Cyclic Delamination	Bond Line Openings	13.3.6
End Joints ^{a,c}	2	T119 Tension	Strength and Wood Failure	13.3.5
	Varies ^d	T105 ^e		13.3.5
	1	T110 Cyclic Delamination	Bond Line Openings	13.3.6
<i>The following tests are required in addition to the above requirements when these processes and/or materials are used in the plant.</i>				
Proof Loaded End Joints	All joints tested in production.	T118 Bending or T121 Tension	Strength	13.3.5.3
End Joints for Repair	1 or 5 or 10 Plus 1	T119 Tension or T106 Tension or T107 Shear	Strength and Wood Failure	AITC 403 13.3.5.4
	1	T110 Cyclic Delamination	Bond Line Openings	AITC 403 13.3.6
Manufactured Lumber	Varies ^d	T123 Tensile Properties	Strength	AITC 401
SCL	Per Applicable Test	T107, T110	Strength and Wood Failure	AITC 402
		T116	Long Span E	AITC 402
Radially Reinforced Curved Members	Per Manufacturer's Procedures and QC Manual			AITC 404
Proof Graded Lumber	Varies ^d	T116	Long Span E	AITC 406
		T123 Tensile Properties	Strength	AITC 406
Block-Glued (Edge or Face) or Re-Glued Glulam (Face only) ^g	6 specimens with a secondary glue bond from each sampled member	T107 Shear	Strength and Wood Failure	13.3.4
	2 specimens with a secondary glue bond from each sampled member	T110 Cyclic Delamination	Bond Line Openings	13.3.6

a. For each adhesive-species-treatment combination used (SCL is considered a separate species for testing requirements).

b. Where edge joint bonding is a structural requirement.

c. In outer tension zone(s). When no outer tension laminations are produced during sampling period, make test end joints from outer tension zone material.

d. Sample size varies with quality control requirements per each laminator's qualification.

e. AITC Test T115 should be used for plane scarf joints and integrally bonded end joints.

f. End joints are permitted in specimens used for face joint bonding.

g. See sampling requirements specified in 13.3.4 or 13.3.6, respectively, as applicable.

13.3.3 Sampling

Face, edge and end joint bonding for each combination of species, type of adhesive and treatment used during the work shift shall be represented by this sampling. Where bonded concurrently, species, within a group, as indicated by Section 13.1.1.1, can be grouped together and the test of one species can apply to all species in this group for a given sampling period. The sampling of species from day-to-day should be approximately in proportion to the volume of production of each species used in the plant.

13.3.4 Face and Edge Joints

- a. A minimum of one sample shall be taken from every 50,000 board feet (118 m³), or portion thereof, which is bonded during each work shift. Samples shall be representative of production members made under production conditions. Where possible, samples shall be cut from the ends of production members.

For face and edge joints, 10 or more bond lines shall be tested. Where a sampled cross section contains more than 10 bond lines, all bond lines shall be tested. If production members contain less than 10 bond lines, a minimum of 2 cross sections shall be sampled and all bond lines in each sampled cross section shall be tested.

- b. For the secondary glue bond of block-glued and re-glued glulam, a section shall be taken from each end of every 3 or less production members. Samples shall be representative of production glulams made under production conditions during each work shift. Three shear specimens shall be prepared from each section in accordance with Section 13.1.2.1 or 13.1.2.2, as applicable, for block-glued glulam or Section 13.1.2.3 for re-glued glulam.

13.3.4.1 Tests for Face Joint Bonding

- a. Shear tests on bond lines between laminations shall be conducted in accordance with AITC Test T107. The shear strengths of all specimens to be evaluated shall be averaged and this average shall equal or exceed 90% of the average clear wood shear strength parallel to grain as determined from ASTM D2555. Alternatively, the shear strengths of all specimens to be evaluated shall be averaged and this average shall equal or exceed the value provided in Table 2.

The wood failure on the sheared or broken surfaces of all specimens to be evaluated shall be averaged and this average shall equal or exceed 70% for adhesives used with softwoods and non-dense hardwoods and 50% for adhesives used for dense hardwoods.

- b. For block-glued or re-glued glulam, shear tests on the secondary glue bond shall be conducted in accordance with AITC Test T107. The average shear strength and wood failure of all specimens on the secondary glue bond, as obtained from each sampled production member, shall meet the requirements specified in Section 13.3.4.1(a).

13.3.4.2 Tests for Edge Joint Bonding

Where edge joint bonding is a structural requirement, shear tests shall be conducted as for face joint bonding with appropriate modification of width depending upon the thickness of the lamination. The criteria specified in Section 13.3.4.1 shall be met.

13.3.5 End Joints

A lot size shall be established by the laminator and approved by an accredited inspection agency. The number of end joints to be tested by AITC Test T119 shall be based on the production of end joints for the outer tension zone of bending members (a minimum of 10% of depth) and for the full depth of uniform-grade members. The number of end joints to be tested shall be a minimum of 1 end joint per 200 of these joints, but no less than 2 end joints per lot, shift, or every 50,000 board feet (118 m³) or portion thereof of production.

Where no end joints are produced for the outer tension zone in a bending member, a minimum of two specimens per lot, shift, or every 50,000 board feet (118 m³), or portion thereof, shall be tested.

The end joints tested shall be made using lumber meeting the requirements for the highest grade of lumber required in the outer 5% of depth on the tension side of a bending member for the combination used to determine the QSL.

In addition, a minimum of one end joint shall be tested by AITC Test T105:

- a. At the beginning of each shift.
- b. Following any major change in end joint production variables, including the curing sequence.
- c. Following a change of end joint cutter heads.

AITC Test T115 is permitted to be substituted for AITC Test T105 where plain scarf joints and integrally bonded end joints are used. The selection of test specimens and evaluation of test results from all samples shall be in accordance with procedures approved by an accredited inspection agency.

13.3.5.1 Separate Production Lines

The requirements for testing of end joints shall be applicable to each end joint production process or separate end joint fabrication line.

13.3.5.2 Tests for End Joint Bonding

End joints shall be tested daily for strength and wood failure in accordance with AITC Test T119. The criteria for wood failure shall be as specified in Section 13.3.4.1 for face joint bonding. Strength quality control requirements shall be based on lot sampling. Lot quality control shall be monitored with a continuous quality control program. Statistical Process Control (SPC) limits for lot sample average strength shall be established to maintain the required end joint strength.

13.3.5.3 Tests for Proof Loaded End Joints

Where proof loaded end joints are used, all of the daily production line checks and daily tests required for end joints shall be performed. In addition, all quality control procedures set forth in AITC Test T118 or T121, whichever is applicable shall be followed.

13.3.5.4 Tests for End Joints Used in Lamination Repair

Where end joints are used in the repair of laminations, daily quality control and tests set forth in AITC 403 shall be performed.

13.3.6 Tests for Integrity of Adhesive Bonds

- a. Cyclic delamination tests made in accordance with AITC Test T110 shall be conducted on samples from face joints and end joints, and on edge joints where edge joint bonding is used. End joints are permitted in the specimens used for face joint bonding. Where the lamination repair procedure is used, a cyclic delamination sample is to be made in combination with each required strength test sample. Delamination for each specimen after one complete cycle shall not exceed 5% for softwoods and 8% for hardwoods. If delamination exceeds these values after one cycle, a second cycle shall be performed on the same specimen, in which case the delamination shall not exceed 10%.
- b. A cyclic delamination specimen shall be taken from each end of every 3 or less production members in accordance with Section 13.1.2.1 or 13.1.2.2, as applicable, for block-glued glulam or Section 13.1.2.3 for re-glued glulam. Samples shall be representative of production glulams made under production conditions during each work shift. Cyclic delamination tests shall be conducted in accordance with AITC Test T110. Delamination for each specimen on the secondary glue bond, as obtained from each sampled production member, shall meet the requirements specified in Section 13.3.6(a).

13.3.7 Inspection of Finished Production

All production shall be inspected for conformance to the requirements of this Standard as to:

- a. Dimensions (width, depth and length).
- b. Shape, including camber and squareness of cross section.
- c. Type, quality and location of structural bond lines.
- d. Appearance classification.
- e. Lumber species and placement of grades.
- f. Moisture content.
- g. Adhesive type – If adhesive appears to have the wrong color, the type must be ascertained from records or determined by suitable test if records do not correspond with the visual observation.
- h. Bond line – If bond line thicknesses do not fall within the range of 0.006 in. (0.2 mm) plus or minus 0.004 in. (0.1 mm) (except gap-filling adhesives which are permitted to have a 1/16 in. (2 mm) or less bond line thickness), investigation of the production procedures shall be made to assure conformance with this Standard. Infrequent occurrences of separations of bond lines shall be limited (in the judgment of a qualified inspector), to no greater than the lamination characteristics permitted at the bond line. Any separation of bond lines shall require investigation of records and production procedures and may require additional physical tests. Probes, increment borings or other means shall be used to evaluate the degree of separations.
- i. Application of the appropriate marks.

13.4 Audit by an Accredited Inspection Agency

All products conforming to this Standard shall be manufactured in facilities that are subject to periodic, unannounced audits by an accredited inspection agency. All processes and records relevant to the production of such products shall be subject to audit.

13.5 Plant Manuals

Production procedures and the plant quality control system shall be fully described in the plant's procedures manual and quality control manual. Production check points, physical testing and visual inspection procedures shall be included in the quality control manual. Manuals shall be kept up to date by the manufacturing facility. These manuals shall have the approval of an accredited inspection agency and shall be reviewed periodically by that agency.

13.6 Quality Control Records

Records of quality control procedures shall be maintained by the laminator. The following records shall be kept by the laminator for a minimum of 5 years.

- Qualification test results.
- Daily tests on finished production, including shear tests, cyclic delamination tests and end joint strength tests.
- Production line test results – daily check sheet listing each phase of production to be checked. Items shall be initialed as having been checked with comments indicating compliance. When noncompliance is found, the action and correction of the procedure shall be noted.
- Documentation of any engineering analysis performed in accordance with Section 4.1.

14. MARKING

Glulam represented to comply with this Standard shall be distinctively marked..

14.1 Non-Custom Members

Non-custom members shall be marked with the following:

- Identification of this Standard, **ANSI A190.1**
- Identification of an accredited inspection agency (see Section 3.2)
- Identification of the laminating plant
- The species or species group of lumber in the glulam
- The applicable laminating specification and combination symbol. (Where design values for shear (F_v) compression perpendicular to grain ($F_{c\perp}$) and bending (F_b) are other than the published design values for a combination, these design values must be included in the mark.)
- Appearance classification denoted by **FRAM** – Framing, **FRAM-L** – Framing-L, **IND** – Industrial, **IND-L** – Industrial-L, **ARCH** – Architectural, and **PREM** – Premium
- PROOF LOADED END JOINTS** if the member has the required laminations proof loaded
- A lot number or job identification number as a means to trace the member back to the production and quality control records at the manufacturing facility
- Alternate Tension Laminations – Where alternate tension laminations are used, a mark shall be added to the member to identify the alternate face lamination grade used (e.g., C14-24).

Non-custom members shall not be required to be marked as “Non-Custom.”

14.1.1 Frequency of Marking

Required marks in this Section shall be placed on non-custom members at intervals of 8 ft (2.4 m) or less in order that each piece cut from a longer piece will have at least one each of the required marks.

14.2 Custom Members

For members laminated to meet specific job specifications (custom members), the marking shall consist of only items (a), (b), (c), (h), and (i) in Section 14.1. Custom-made members shall bear at least one mark containing the required identification. When long members shipped to a job are to be cut later into several members for use in the structure, the frequency of marking required for non-custom members shall be followed. Custom members shall not be required to be marked as “Custom.”

Note 7: Custom members have less stringent marking requirements than non-custom members because the end use is usually known and the relevant information can be communicated in documentation for the specific job rather than relying on markings on the members. In addition, non-custom members are marked every 8 ft (2.4 m) to allow for cutting into shorter lengths prior to installation, where custom members are only required to be marked at one location.

14.3 Fire-Resistance Ratings

Fire-resistance-rated glulam members, when manufactured in accordance with Section 4.2.1, are permitted to be marked with a **1-HOUR FIRE RATING** or a **2-HOUR FIRE RATING** designation, as applicable.

14.4 Top Stamp Requirements

Prismatic members with unbalanced layups or camber shall be marked “TOP” with letters approximately 2 in. (51 mm) high. Custom members shall be stamped on the top at both ends. Non-custom members shall be stamped along the top at intervals set forth in Section 14.1.1.

14.5 Certification of Conformance

When a Certificate of Conformance is issued, all glulam covered by the certification must be appropriately marked with the mark of an accredited inspection agency.

14.6 Dual Manufacture

This Standard is applicable to glulam manufactured in a single plant, or partly in one plant and partly in another. When more than one plant is involved, each plant must be qualified under this Standard and the Certificate of Conformance shall so indicate. The mark placed on the member(s) shall be the mark of the last plant involved in the manufacturing process.

14.7 Marking Truss Members

When trusses are shipped, each assembly, subassembly, or separate part shall be marked.

14.8 Withdrawal of Marking

Marking and/or certification of the product shall be removed and certificates (if required) withdrawn if any one of the following conditions is met.

- a. Physical tests, visual inspection, and review of production records indicate that a marked or certified product is not in conformance with the requirements of this Standard.
- b. Investigation shows that the product does not conform to the requirements of the Standard.

15. TECHNICAL REVIEW BOARD (TRB)

15.1 Scope

The Secretariat of this Standard, APA – The Engineered Wood Association, shall provide a Technical Review Board with the following functions:

- a. Interpretation of this Standard,
- b. Processing of appeals to the suitability of this Standard, and
- c. Determination of the applicability and consistency of later issues of documents referenced in this Standard.

15.2 Membership

The Technical Review Board shall consist of five voting members. The representation of the Board members shall be as follows:

- a. One member representing laminators receiving testing and inspection services from the Secretariat.
- b. One member representing the majority of laminators that receive inspection and testing services from accredited agencies other than the Secretariat.
- c. One qualified expert in the field of glulam representing an educational or research organization.
- d. One qualified expert in the field of engineered timber construction who is a registered professional engineer or architect. This member shall not be an employee of any firm engaged in the manufacture of glulam or other engineered wood products, or of any firm that supplies raw materials, equipment, or services for the manufacture of such products.

- e. One qualified expert in the field of engineered timber construction who is a registered professional engineer to serve as Chairman of the Technical Review Board. The Chairman shall not be an employee of any firm engaged in the manufacture of glulam or other engineered wood products, or of any firm that supplies raw materials, equipment, or services for the manufacture of such products.
- f. A nonvoting secretary provided by the Secretariat.

15.2.1 Selection

The Secretariat shall conduct a selection process that ensures the criteria of Section 15.2 have been satisfied. Each accredited agency shall provide the TRB secretary with TAC membership lists for the purpose of requesting nominees and conducting elections of TRB members. Members shall be elected for two-year terms, except for the Chairman who shall be elected for a four-year term. Terms shall begin on May 1 and end on April 30.

- a. The member representing Category 15.2 (a) shall be nominated and elected by the laminators to be represented by this member. This member shall be elected for a two-year term beginning in each even-numbered year.
- b. The member representing Category 15.2 (b) shall be nominated and elected by the laminators to be represented by this member. This member shall be elected for a two-year term beginning in each odd-numbered year.
- c. The member representing Category 15.2 (c) shall be nominated and elected by the Technical Advisory Committees of all accredited agencies. This member shall be elected for a two-year term beginning in each even-numbered year.
- d. The member representing Category 15.2 (d) shall be nominated and elected by the Technical Advisory Committees of all accredited agencies. This member shall be elected for a two-year term beginning in each odd numbered year.
- e. The Chairman of the Technical Review Board shall be nominated and elected by the Technical Advisory Committees of all accredited agencies. The Chairman shall be elected for a four-year term beginning in every other odd numbered year.
- f. If a member resigns from the Board prior to the end of his term or becomes ineligible, a new member meeting the criteria shall be elected to the vacated position to serve for the remainder of the term.

15.3 Requests for Services

Requests for services of the Technical Review Board shall be made in writing to the secretary. A minimum of eight (8) copies of the request and any supporting data shall be provided to the secretary for distribution to the TRB members and for inclusion in the records.

15.4 Conduct of Meetings

- a. Meeting Calls** – The secretary of the Technical Review Board shall issue all meeting calls and notices. A minimum of 30 days' notice shall be given.
- b. Acting Chairman** – In the absence of the elected Chairman, the members of the Technical Review Board shall elect an Acting Chairman from among themselves for a specific meeting.
- c. Quorum** – A quorum must be present for a valid Technical Review Board vote. A quorum shall consist of the Chairman or Acting Chairman, at least one member from Category 15.2 (a) or (b), and at least one member from Category 15.2 (c) or (d).
- d. Voting** – Each member of the Technical Review Board shall have one vote except that (1) the secretary shall not vote; (2) the Chairman or Acting Chairman shall not vote except to break a tie; (3) members representing Category 15.2 (a) or (b) shall not vote on any matter which has been presented by their respective companies. A majority of those voting carries a motion provided a quorum is present. Letter ballots of the Technical Review Board shall be permitted.
- e. Rules** – The Chairman or Acting Chairman shall conduct all meetings under Robert's Rules of Order.
- f. Hearings** – The Technical Review Board is permitted to invite affected, interested or knowledgeable persons or firms to testify at hearings or to supply supplemental data or information. Hearings shall be open to all interested parties.
- g. Deliberations** – After the hearings, the Technical Review Board shall meet to discuss and deliberate on the case. Deliberations shall be closed to all except the TRB members and secretary. Representatives of accredited inspection agencies shall be permitted to observe the deliberations.
- h. Challenge** – When the TRB has reached a decision, the proponent for the hearing matter shall be permitted to challenge the TRB decision. Additional deliberation shall be at the discretion of the TRB Chairman.
- i. Decisions** – The decision of the Technical Review Board shall be binding and final.
- j. Records and Reports** – The secretary shall maintain a file of correspondence, meeting minutes, and other records of the Technical Review Board. Meeting minutes shall be made available to the public upon request. Proprietary information shall not be made available without express written consent of its owner.

15.5 Expenses

The expenses of the administration of the Technical Review Board shall be apportioned as follows:

- a. Direct administrative expenses shall be borne by the Secretariat.
- b. Meeting expenses shall be allocated to the party or parties requesting the convening of the Technical Review Board including:
 1. Transportation, food, and lodging expenses incurred by the Board members in conjunction with a meeting.
 2. An honorarium for the TRB members of Categories 15.2 (c), 15.2 (d), and 15.2 (e) for each day the board meets. The amount shall be as determined by the Secretariat.
 3. Rental of meeting rooms and audiovisual equipment necessary for the meeting.
 4. Food or beverages served at the meeting.

APPENDIX X1: History of Project (Non-Mandatory Information)

Commercial Standard CS 253-63, Structural Glued Laminated Timber, was developed at the request of the American Institute of Timber Construction (AITC) and was published in 1963.

In 1970, AITC requested that the National Bureau of Standards initiate a revision of CS 253-63 under the Procedures for the Development of Voluntary Product Standards. A proposed revision was approved by the Standing Committee in June 1972. The recommended revision was then circulated for acceptance in July 1972. The response to this circulation indicated that certain changes to the Standard were necessary. A new proposal was approved by the Standing Committee in October 1972. The new recommended Standard was circulated for acceptance in January 1973. The response to this circulation indicated a consensus among producers, distributors and users, in accordance with the published procedures. This edition of the Standard was designated PS 56-73, Structural Glued Laminated Timber, and became effective on July 1, 1973.

This Standard was also processed through ANSI and was given the designation ANSI A190.1-1973. Amendment 1 to this Standard was developed in accordance with the Department of Commerce Procedures for the Development of Voluntary Product Standards and became effective on July 19, 1976. In 1982, AITC requested that this Standard be revised as American National Standard ANSI/AITC A190.1-1983. The revision was accomplished under the ANSI canvass process and was approved by the ANSI Board of Standards Review on June 3, 1983.

In 1991, AITC requested this Standard be revised as American National Standard ANSI/AITC A190.1-1992. This revision was again accomplished under the ANSI canvass process and approved by the ANSI Board of Standards Review on March 16, 1992.

In 2002, AITC requested this Standard be revised as American National Standard ANSI/AITC A190.1-2002. This revision was again accomplished under the ANSI canvass process and approved by the ANSI Board of Standards Review on October 10, 2002.

In 2007, AITC requested this Standard be revised as American National Standard ANSI/AITC A190.1-2007. This revision was again accomplished under the ANSI canvass process and approved by the ANSI Board of Standards Review on April 30, 2007.

In 2012, AITC requested this Standard be revised as American National Standard ANSI/AITC A190.1-2012. This revision was again accomplished under the Procedures for Development of American Institute of Timber Construction Consensus Standards and approved by the ANSI on January 23, 2013.

On January 1, 2013, APA – The Engineered Wood Association assumed the Secretariat responsibilities for this Standard and re-designated it as ANSI A190.1-2012.

In 2017, this Standard was revised as ANSI A190.1-2017 and approved by ANSI on January 24, 2017.

In 2022, this Standard was revised as ANSI A190.1-2022 and approved by ANSI on February 17, 2022 with the title change from Standard for Wood Products – Structural Glued Laminated Timber to Product Standard for Structural Glued Laminated Timber. Major changes to this Standard included the introduction of new qualification and quality assurance requirements for add-on, block-glued, and re-glued glulam, and the addition of correction factors for tension test results obtained from split end joints (see Table 4), which had been used by the glulam industry for years but had not been included in this Standard. In addition, the layup combinations provided in ANSI 117 were recognized in this Standard and the required average shear strengths for adhesive joints are tabulated (see Table 2). The format of this Standard was also updated by relocating the definition section to the front portion of this Standard for consistency with most national and international standards.

The names of ANSI A190.1 Committee members when this Standard is published are as follows. The current list of the committee membership is available from the Committee Secretariat upon request.

Name	Affiliation	Note
DeepaReddy Akula	Vinside Capital	
Linda Brown	Southern Pine Inspection Bureau	
Kevin Cheung	Western Wood Products Association	
Mark Clark	Hexion, Inc.	ExSub Member
David Conner	Timber Products Inspection, Inc.	
Brad Douglas	American Wood Council	
Julie Frappier	Nordic Structures	
Bill Gareis	Ashland Chemical	
William Gould	ICC-ES	
Jim Henjum	SmartLam N.A.	
Benjamin Herzog	University of Maine	
Levi Huffman	DR Johnson Wood Innovations	
Jessica Jennings	Georgia-Pacific Chemicals, LLC	
Henry Morris	Pacific Lumber Inspection Bureau	ExSub Member
Jeff Morrison	Rosboro LLC	Chair
Brent Olson	PFS TECO	
Steven Reiersen	Akzo Nobel Coatings, Inc.	
Andreas Rhude	Consultant	
Glen Robak	Weyerhaeuser	
Sheldon Shi	University of North Texas	
Jeffrey Stefani	Anthony Canfor	
Robert Taylor	Boise Cascade	
Leif Van Cott	Unalam	
Travis Van De Vliet	Western Archrib	
Chris Whelan	Henkel Corporation	
Tom Williamson	Timber Engineering, LLC	Vice-Chair
Clay Winje	Kalesnikoff Lumber	
B.J. Yeh	APA - The Engineered Wood Association	Secretariat
Larry Zhou	Universal Timber Structures Inc	

Inquiries or suggestions for improvement of this Standard should be directed to:

Secretariat, ANSI A190.1

APA – The Engineered Wood Association

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ANSI A190.1-2022

Product Standard for Structural Glued Laminated Timber

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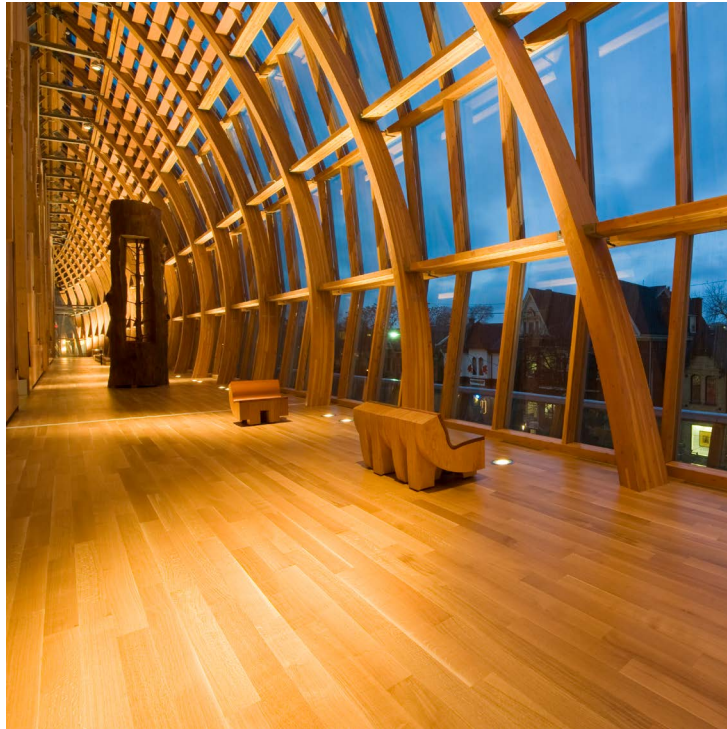
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AMERICAN NATIONAL STANDARD

ANSI A190.1-2022 Product Standard for Structural Glued Laminated Timber

ANSI A190.1-2022 結構用集成材產品標準



美國國家標準

若要通過美國國家標準，需要經過ANSI的審查，標準的開發機構已通過必要程序、共識要求和其他的規定。ANSI標準審查委員會判斷直接且有實質影響的利益團體以達成實質性協議和共識。實質性協議的意義遠超過簡單多數決，但並不一定是一致同意。共識的要求則包含所有觀點和反對意見的考慮，並協同努力解決這些觀點和反對意見。美國國家標準的使用是完全自願的；在任何方面，都不排除任何製造、銷售、購買或使用不符合標準的產品、過程或程序。

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This publication is a translation from the English version of the standard. In case of a discrepancy, the English version will prevail.

本出版品翻譯源自英文版標準，若翻譯有任何出入之處，應以英文版本優先。

前言（本前言非美國國家標準 ANSI A190.1-2022 的一部分）

本標準是由美國工程木材協會（APA - The Engineered Wood Association）發起，並根據美國國家標準協會（ANSI）的規定撰寫，以作為美國國家標準《木製品標準—結構用集成材》（Standard for Wood Products - Structural Glued Laminated Timber）（ANSI A190.1-2017）的修訂版。詳見附錄（十一）的專案歷史記錄。

自2013年1月1日起，美國工程木材協會承攬為這項標準的秘書處，並將其重新命名為 ANSI A190.1。本標準是經ANSI認定，由美國工程木材協會根據共識發展標準的程序，進行編撰維護。

如有關於本標準的疑問或改進建議，請洽詢美國工程木材協會（地址：7011 South 19th Street, Tacoma, WA 98466；網址：www.apawood.org）。

目錄

美國國家標準	ii	11. 端接	17
前言	iv	11.1 組裝與膠合	17
ANSI A190.1-2022 結構用集成材產品標準	1	11.2 接合厚度公差	17
1. 範圍	1	11.3 在內部或靠近端接的結疤	17
2. 參考文獻	2	11.4 鄰近層壓材的端接間隔	18
2.1 美國標準	2	11.5 相同層壓材的端接間隔	19
2.2 其他標準	2	11.6 修復時的端接	19
3. 專業術語	3	12. 外觀分級	20
3.1 定義	3	12.1 框架外觀級	20
3.2 本標準特定術語	3	12.2 L框架外觀級	20
4. 一般規定	8	12.3 工業外觀級	20
4.1 次要變異	8	12.4 L工業外觀級	21
4.2 等級組合	8	12.5 建築外觀級	21
4.3 品質系統	9	12.6 特選外觀級	22
5. 公差	9	13. 品質管制系統	23
5.1 尺寸公差	9	13.1 工廠和程序認證	24
5.2 預拱或直度公差	9	13.2 膠合劑批次測試	34
5.3 矩形截面公差	9	13.3 日常品質管制	35
5.4 其他量測的公差	9	13.4 認證查驗機構的查驗	41
6. 膠合用木材	10	13.5 工廠手冊	41
6.1 樹種	10	13.6 品質管制紀錄	42
6.2 含水率	10	14. 標記	42
6.3 板材分等	10	14.1 非客製化構件	42
6.4 製材	11	14.2 客製化構件	43
6.5 結構用複合木材 (SCL)	11	14.3 防火等級	43
7. 層壓材	12	14.4 最高印章要求	43
7.1 接合表面	12	14.5 符合性認證	43
7.2 閃皮	12	14.6 雙重製造標記	43
7.3 層壓材厚度	12	14.7 標記桁架構件	44
7.4 尺寸公差	13	14.8 撤銷標記	44
8. 膠合劑	14	15. 技術審查委員會 (TRB)	44
8.1 標籤	14	15.1 範圍	44
8.2 填縫膠	14	15.2 成員	44
9. 木嵌件	14	15.3 服務申請	45
9.1 最大嵌入深度	14	15.4 會議的舉行	46
10. 面和端接	15	15.5 費用	47
10.1 膠合劑混合和應用	15	附錄十一: 專案歷史記錄	
10.2 面接組裝和膠合	16	(非強制性資訊)	48
10.3 端接組裝和膠合	16		
10.4 固化時間表	16		

ANSI A190.1-2022 結構用集成材產品標準

1. 範圍

本標準的宗旨是（1）建立國家公認的結構用集成材的生產、查驗、測試和認證要求，以及（2）為材料供應商、生產商、分銷商和使用者提供訊息共同瞭解本產品的特性。

本標準說明生產集成材的最低要求，包括尺寸公差、等級組合、木材、膠合劑、外觀分等和製造。並說明製造廠商所需要的品管系統，包括工廠認證、日常品管、認證查驗機構的工作和產品標記。

這些要求旨在允許使用任何合適的製造方法，以生產在品質和性能上等於或優於規定的產品，但前提是該方法是根據本標準的要求取得核准的。

本標準中包含的附註和附錄是非強制性的。本標準包含美國的慣用單位以及國際單位制（SI）。以美國慣用單位表示的數值為標準，寫在括號中SI值僅供參考。如尺寸測試發生爭議，以美國慣用測試方法為優先。

2. 參考文獻

本標準的參考文獻皆有註明日期。針對這些參考文獻的後續修訂，僅在通過修訂或修訂已併入本標準時，才適用本標準。

2.1 美國標準

ANSI 117-2020, 針葉樹應用於結構用集成材的標準規範 Standard Specification for Structural Glued Laminated Timber of Softwood Species

ANSI 405-2018, 應用於結構用集成材的膠合劑 Adhesives for Use in Structural Glued Laminated Timber

ANSI/AWC NDS-2018, 木結構國家設計規範 National Design Specification for Wood Construction

ASTM D2555-17a, 建立清材強度值的標準方法 Standard Practice for Establishing Clear Wood Strength Values

ASTM D3737-18e1, 建立結構用集成材(膠合樑)容許值的標準方法 Standard Practice for Establishing Allowable Properties for Structural Glued Laminated Timber (Glulam)

ASTM D4444-13(2018), 實驗室標準化及手持溼度計量測的標準方法 Standard Method for Laboratory Standardization and Calibration of Hand-Held Moisture Meters

ASTM D5456-21e1, 結構用複合木製產品評估的標準規範 Standard Specification for Evaluation of Structural Composite Lumber Products

ASTM D7341-21, 建立實尺寸結構用集成材的撓曲特徵值的標準方法 Standard Practice for Establishing Characteristic Values for Flexural Properties of Structural Glued Laminated Timber by Full-Scale Testing.

2.2 其他標準

AITC Test T102-2007, 膠合劑噴塗量測 Adhesive Spread Measurement

AITC Test T103-2007, 工廠加壓系統的校準: 螺栓或螺旋千斤頂
Calibration of Plant Pressure System: Bolts or Screw Type Jacks

AITC Test T104-2007, 扳手的力矩校準 Calibration of Torque Wrenches

AITC Test T105-2007, 指接品質的判定試驗 Diagnostic Tests for Finger Joint Quality

AITC Test T107-2007, 剪力試驗 Shear Test

AITC Test T110-2007, 循環剝離試驗 Cyclic Delamination Test

AITC Test T115-2007, 指接的機械試驗 Machining Test for End Joints

AITC Test T116-2007, 機械分等木材在靜載重的抗彎彈性模數 Modulus of Elasticity for E-Rated Lumber by Static Loading

AITC Test T118-2007, 指接的抗彎校証載重 Bending Proof Loading for End Joints

AITC Test T119-2007, 實尺寸端接的拉力試驗 Full Size End Joint Tension Test

AITC Test T121-2007, 端接的抗拉校証載重 Tension Proof Loading for End Joints

AITC Test T122-2007, 膠合劑自動混合機的混合比例檢查 Mix Ratio Check for Automatic Adhesive Mixing Machines

AITC Test T123-2007, 木材抗拉性能的取樣，測試和數據分析 Sampling, Testing and Data Analysis to Determine Tensile Properties of Lumber

AITC 401-2005, 用於結構用集成材的製材標準 Standard for Manufactures Lumber for Use in Structural Glued Laminated Timber

AITC 402-2005, 用於結構用集成材的結構複合木材(SCL)標準 Standard for Structural Composite Lumber (SCL) Used in Structural Glued Laminated Timber

AITC 403-2005, 用於層壓材修復的端接標準 Standard for End Joints for Use in Lamination Repair

AITC 404-2005, 徑向加固彎曲集成材的抗徑向張力標準 Standard for Radially Reinforcing Curved Glued Laminated Timber Members to Resist Radial Tension

AITC 406-2005, 集成材的分級木材檢驗標準 Standard for Proof-Graded Lumber for Glued Laminated Timber

AITC 407-2005, 用於結構用集成材的替代木材等級標準 Standard for
Alternate Lumber Grades for Use in Structural Glued Laminated Timber

3. 專業術語

3.1 定義

請參閱參考文件以取得本標準中所用術語的定義。

3.2 本標準特定術語

認證查驗機構 Accredited Inspection Agency：符合以下要求的機構：

- a. 經過專業訓練的人員可認證產品的分等、測試、樹種、製造、膠合、工序和其他特性是否符合本標準規定的所有適用要求；
- b. 有專業人員執行查驗時應遵循的書面程序，
- c. 未在被查驗產品的任何單一公司取得財務利益，或在財務上不依賴任何單一公司；
- d. 並非由任何相關公司擁有、營運或控制，以及
- e. 由ISO/IEC17020認可的機構

組裝時間 Assembly Time：將膠合劑噴塗在層壓材上並施加壓力到整個組件之間的間隔時間，可以分為開放式和閉合式組裝時間

閉合式組裝時間 Assembly Time, Closed：膠合劑塗佈在層壓材表面的組裝及加熱/或施加壓力以完全固化膠合劑的間隔時間

開放式組裝時間 Assembly Time, Open：膠合劑噴塗於層壓材或端點與膠合組裝之間的間隔時間

抗彎構件 Bending Members：表面的層壓材，其分等高於中間層板的層壓材

塊狀膠合 Block-gluing：使用填縫膠將集成材加工膠合成塊狀集成材的過程

膠合層 Bond Line：膠合兩層壓材或指接的膠合層

預拱 Camber：內置於集成材中的少量曲率，以抵抗預期的撓曲變形或加強屋頂排水

認證證明 Certificate of Conformance：由認證機構頒發的證明書，認證產品符合某一標準或多項標準。

固化時間 Curing Time：膠合劑達到特定程度固化所需的時間

曲型構件 Curved Members：設計和製造的曲型集成材構件（如曲樑和拱型樑），其設計用於負載產生變形後仍存在相應的曲度

客製化構件 Custom Members：為符合個別工程規範而製造，並按照第14.2節的要求標示的構件

註 1：無論集成材大小，以ANSI 117規定的組合製造並根據第14.1節標記的集成材，不被視為客製化構件。

剝離 Delamination：由於膠合劑本身的劣化破損或在膠合劑與層壓材之間的界面破損，而導致集成材中各層的脫膠剝離

乾燥使用條件 Dry-Service Condition：導致構件含水率低於16%的環境暴露條件

導角 Eased Corner：構件邊角加工為稍微圓形的表面，以消除尖銳的邊緣

平衡含水率 Equilibrium Moisture Content：木材的含水率不受周遭大氣環境而改變時的含水率

具有75%的可信度之第5百分位數公差 Five Percent Tolerance Limit with 75% Confidence：統計術語，說明第五百分位數的統計下限，確保母體第五百分位數出現機率等於或超過估計之百分之七十五。

填縫膠 Gap-Filling Adhesive：填充兩個相應表面之間至多1/16英寸（2毫米）空隙的膠合劑

集成材 Glulam：結構用集成材，俗稱膠合樑。

附加集成材 Glulam, Add-on：在預製集成材加上一個或多個單獨的層壓材，並符合集成材成品的層壓材要求（見第7.3.2節）

塊狀膠合集成材 Glulam, Block-glued：由2個或多個矩形截面集成材組成，且以填縫膠和集成材成品所需的集成材單元膠合在一起（見第7.3.4節）

再膠合集成材 Glulam, Re-glued：將2種集成材單元膠合在一起的集成材。集成材單元使用相同製作程序及填縫膠，並預先膠合集成材成品所需的疊加層壓材（見第7.3.3節）

註 2：大尺寸集成材即使可以放入刨光機，但也可能超過機械檯面可裁切的範圍。當製造如此大的集成材時，再膠合過程可以在集成材的頂部和底部留下一面未膠合的乾燥面，以便可以再膠合到最終成品尺寸。再膠合集成材通常是為了製造更深斷面的集成材成品。再膠合集成材與塊狀集成材，最主要不同的地方是，前者的初始膠合過程非常緊實，而後者可能不這麼緊實。面接允許再膠合，亦可能適用於矩形或彎曲構件，但塊狀膠合僅限於矩形構件。由於需保持兩種集成材單元之間的緊實度，再膠合集成材僅限於再膠合兩個集成材單元。

集成材單元 Glulam Component：用來以塊狀膠合或再膠合製造成更大集成材成品的集成材

非緻密硬木 Hardwood, Non-Dense：不論在氣乾或是絕乾的條件下，任何平均比重0.42以下的硬木

木嵌件 Inserts, wood：用於集成材側面的非結構修復的木條

邊接 Joint, Edge：接合兩塊木材的邊緣到邊緣，形成更寬的層壓材

端接 Joint, End：透過膠合劑將木材端到端連接而形成的接合

面接 Joint, Face：層壓材寬面之間的接合

指接 Joint, Finger：木材的齧合指端組成的端點接合

斜接 Joint, Scarf：透過膠合劑接合傾斜面的2塊木材或結構用複合木材(SCL)的端點而形成的端接，在某些情況下，將階梯狀或鉤狀接合加工到斜接面中以方便兩端斜接，在這種情況下，由於平面是不連續的，接頭被稱為階梯形或鉤形斜接接合

膠合 Laminating：(名詞)製造集成材的過程；(形容詞)與製造集成材相關的過程

層壓材 Lamination：單層木材，寬度或長度由一塊或數塊木材組成，進而組合成集成材構件的全寬和全長

批次 Lot：為取樣目的，並在核可的條件下積累一定數量的產品或材料

膠合劑批次 Lot, Adhesives：通常由膠合劑製造商標示每一批膠合劑

製材 Manufactured Lumber：將兩個以上的木材結構性膠合，形成另一塊製材

機械分等木材 Mechanically Graded Lumber：使用機械或物理評估並結合目視分等進行分等的木材

含水率 Moisture Content：木材中含有的水分量，通常以烤箱乾燥木材的重量百分比表示

多構件層壓材 Multiple-Piece Lamination：寬度橫跨2塊以上的木材的層壓材

非客製化構件 Non-custom Member：非為個別工程規範而製造，並按第14.1節的要求標示的構件

註 3：加州建築法規定，除最大寬度為5-1/2英寸（140毫米），最大深度為18英寸（457毫米），最大長度為32英尺（9.8公尺）的非客製化集成材構件外，醫療保健和資訊部（HCAI，前身為州立健康規劃和發展辦公室或OSHDP）所使用的集成材皆須進行查驗。

偶發 Occasional：允許在符合規定或標準的生產過程中出現隨機的變異，則變異不超過5%（二十分之一）的發生機率。當「偶發」一詞用於木材分等時，應不超過10%（十分之一）的發生機率

線下測試 Off-Line Tests：從生產過程中取得代表性樣本所進行的物理測試

閃皮 Pencil Wane：限制層壓材的閃皮寬度不超過1/4英寸（6毫米）

可使用時間 Pot Life：膠合劑與催化劑、溶劑或其他配方混合後，仍然可以使用的時間段

生產查驗點 Production Check-Points：已完成單個生產步驟並查驗程序或材料是否符合本標準要求的生產查驗點

校証分等木材 Proof Graded Lumber：透過張力實驗測試每個構件並移除低張力強度構件之校証分等木材

校証負載 Proof Loading：將負載如彎矩、張力等施加於層壓材進行校証

合格應力等級 Qualification Stress Level (QSL)：將通過5%容許公差與75%可信度之端接除以1.67所建立的等級

參考設計值 Reference Design Values：在美國基於正常的負載持續時間下，乾燥使用條件和參考溫度高達100°F（38°C）的容許應力設計（ASD）

註 4：負載與抗力係數設計（LRFD）值可以根據國家木結構設計規範（NDS）並從ASD參考設計值轉換。

再膠合 Re-gluing：使用膠合劑將集成材單元膠合成再膠合集成材的過程

裁切 Ripping：裁切任何寬度木材以製作更窄木材的過程

樣品 Sample：進行測試的樣本

試體 Specimen：選擇進行測試的全部或部分樣本

結構用複合木材 Structural Composite Lumber (SCL)：工程木材產品，用於結構用途並以膠合劑膠合，同時符合ASTM D5456的定義和要求

結構用集成材 Structural Glued Laminated Timber：特別挑選和製備的層壓材，在木材加工廠以膠合劑膠合組成，並為工程用途且通過負載分等之產品。所有層壓材的纖維方向大致在縱向上平行。層壓材可以由連接任何長度的單元，或膠合邊緣到邊緣的單元組成，以便在膠合過程中使其形成更寬的片段或彎曲形式的單元

潮濕使用條件 Wet-Service Conditions：導致構件含水率為16%或以上的使用環境暴露條件

木材破損 Wood Failure：膠合層持續脫膠或強度測試中出現破裂木纖維而非膠合層破損的膠合表面

4. 一般規定

本標準的集成材應符合本文指定的所有要求，但需遵守第4.1節所述的細節變化。

用於製造集成材的基本元素應符合第6、7和8節的要求。製造應符合第9、10、11和12節以及工廠程序手冊的要求。所有生產應根據第13節進行查驗和測試。符合本標準要求的產品應按照第14節標記。工廠應經過第3節規定的認證查驗機構的定期查驗。

4.1 次要變異

在非關鍵位置存在有限程度的微小變化，或已修復結構損壞或缺陷的情況下，構件符合本標準，並且在合格人員的判斷中，該構件在結構上足夠用於預定的用途。構件的認證和輕微變化的性質應被記錄下來。合格查驗者需熟悉工作規格和適用的設計要求，並對製造過程有第一手知識。

4.2 等級組合

等級組合及其相應的設計值應根據ASTM D3737制定，或根據ASTM D7341進行性能測試和分析以獲得撓曲性能。等級組合應由認證查驗機構核准，但允許將ANSI 117中說明的分等組合及其相應設計值與本標準一起使用。允許使用替代等級的木材來取代根據ASTM D3737或ASTM D7341開發的等級組合中的標準集成元等級，前提是替代等級須符合AITC 407的認證。

4.2.1 集成材的防火等級

製作一小時防火等級的客製化或非客製化構件時，應為特定製作的集成材。移除內部一層核心層壓材並將外部受張層壓材向內一層移動，並於最外側額外膠合相當於標稱2英寸（38毫米）厚度的外部張力層壓材。製造提供兩小時防火等級的構件時，則應移除兩層核心層壓材，並將外部受張層壓材往內移動，同時於最外側額外膠合兩層相當於標稱2英寸（38毫米）厚度的外部張力層壓材。防火等級的集成材應根據第14.3節進行標記。

4.3 品質系統

製造商有責任對生產操作持續的品質管制並確保產品符合本標準，並由認證查驗機構進行定期查驗。此品質控制系統包括：

- a. 查驗生產過程的每個步驟，
- b. 對完成生產的樣品進行物理測試，
- c. 進行完成生產後的目視查驗，以及
- d. 由第3節中定義的認證查驗機構進行的定期查驗。

5. 公差

集成材的大小和形狀應由買方和賣方共同商定。

5.1 尺寸公差

製造時允許的尺寸公差如下：

寬度：加或減1/16英寸（2毫米）。

深度：每英尺（305毫米）深度允許超過1/8英寸（3毫米）。每英尺深度允許減少3/16英寸（5毫米）或1/16英寸（2毫米），以尺寸較大者為準。

長度：最長達20英尺（6.1公尺）時，加或減1/16英寸（2毫米）。超過20英尺（6.1公尺），每20英尺（6.1公尺）的長度或其部分，加或減1/16英寸（2毫米）。

5.2 預拱或直度公差

預拱公差適用於製造生產時，但不允許靜載重時有偏差。長度達20英尺（6.1公尺）時，公差為正負1/4英寸（6毫米）。超過20英尺（6.1公尺），每增加20英尺（6.1公尺），公差允許超過1/8英寸（3毫米），但應小於3/4英寸（19毫米）。

公差只適用於直度或略微彎曲的構件，不適用於弧形構件，如拱門。

5.3 矩形斷面公差

除非有指定特殊形狀的斷面，否則矩形公差應為每英尺（305毫米）指定深度正負1/8英寸（3毫米）。應將矩形斷面之頂面或底面置於平行面上來量測，並從底面(或頂面)的端點量測至頂面(或底面)的垂直相對應端點之偏移量。

5.4 其他量測的公差

第5.1節、第5.2節和第5.3節未涉及的量測公差應由買方和賣方商定。

6. 膠合用木材

6.1 樹種

就本標準而言，硬木或軟木的分類應按照ASTM D3737所述的應力值和木結分布，木材種類則符合ASTM D7341要求的層疊或組合，或技術審查委員會確定其他擬議標準符合本標準再核准於膠合用木材中使用。

6.2 含水率

膠合時木材含水率不超過16%。當已知使用的集成材平衡含水率為16%以上時，則例外：膠合時的層壓材含水率不得超過20%。含水率超過16%的木材端接和面接膠合程序均需認證查驗機構核准。

木材的含水率應以整個斷面和沿著構件長向所求得平均含水率。

所有用於木材的含水率量測計都應根據ASTM D4444進行校正。

6.3 板材分等

鋸材可進行目視分等、機械分等或認證分等。所有木材在膠合之前應確定其等級。多件層壓材的木材（寬度由2塊以上木材組成的層壓材）應視為單個木材進行分等，但第6.4節所述的製材除外。

6.3.1 目視分等木材

木材應根據美國木材標準委員會（ALSC）審查委員會核准的標準分等規則或特殊層壓材分等規則進行分等。此類木材等級應根據需要進行修改，以使該樹種符合層壓材規格中規定的額外要求。

6.3.2 機械分等木材

機械分等木材應根據ALSC審查委員會核准的標準分等規則或技術審查委員會確定符合本標準的特殊規則進行分等。E等級、機械應力等級（MSR）和機械評估木材（MEL）是機械分等木材的三個商業名稱。此類木材等級應根據需要進行修改，以符合該樹種層壓材規格中規定的額外要求。

6.3.3 校証分等木材

校証測試應在認證查驗機構的監督下進行。此類校証等級的木材應根據AITC 406中規定的實尺寸張力測試進行品質管制。校証等級應僅限於無端接的個別木材。

6.3.4 欲進行裁切的木材等級

欲裁切的木材應進行分等，以使取得的木材符合所有適用的等級要求，包括木結尺寸、木纖維斜率和密度或生長速率。

- a. **機械分等木材**：當機械分等木材被裁切時，應使用決定等級的機械或物理特性以及適用的目視要求進行再分等。如果認證查驗機構核准的品質管制程序可有效監測被裁切件的彈性模數和抗拉強度，則允許免除對機械分等木材的評級要求。
- b. **校証分等木材**：校証分等木材應在裁切後進行校証測試，以符合裁切尺寸的要求。如果透過認證查驗機構核准的品質管制程序可有效監測被裁切件的彈性模數和抗拉強度性能，則允許免除對校証級別木材的評級要求。
- c. **端接後裁切**：允許在指接後的層壓材和已完成膠合的構件上裁切。裁切時應按照認證查驗機構核准的程序進行。

6.4 製材

由2件以上的木材膠合在一起，並符合AITC 401的要求。根據第6.3節的規定，邊接的多件式層壓材不被視為製材，應區分為單獨的構件。

6.5 結構用複合木材（SCL）

SCL應根據ASTM D5456定義，並符合AITC 402的要求。

7. 層壓材

7.1 接合表面

所有膠合面，包括表面、邊緣和端接，應平順光滑，除局部微小變化外，應無凸起木紋、扭曲木紋、凹陷、燒痕、嵌入它物或其他有損表面平整的缺陷，這些缺陷可能會影響木紋表面的完整膠合。所有膠合表面不得有影響良好膠合的灰塵、異物和滲出物。對於需要在膠合之前再刨光的樹種，其再刨光和膠合的時間間隔不得超過24小時，除非間隔時間有被要求並在工廠手冊中記錄。

7.2 閃皮

在乾燥使用條件下，某些等級組合允許內部層壓材的閃皮不超過寬度的1/6。閃皮只能在不會讓含水率激增的潮濕條件下出現。對於多件層壓材（寬度），無論膠合與否，邊接都不允許有閃皮。

7.3 層壓材厚度

7.3.1 除非使用填縫膠進行表面和邊緣膠合，否則層壓材不得超過2英寸（51毫米）的淨厚度。例外：由認證查驗機構認證和許可的層壓材程序，允許非填縫膠用於膠合厚度大於2英寸（51毫米）的層壓材板。

7.3.2 附加集成材

7.3.2.1 將淨厚度不超過2英寸（51毫米）的附加層壓材膠合起來時，不需要填充填縫膠。

7.3.2.2 附加集成材應使用與原始集成材中相同淨厚度的附加層壓材製造。對於每個附加集成材，層壓材的膠合表面應符合第7.1節中規定的表面要求。

7.3.2.3 附加集成材應符合集成材成品組合的要求。

7.3.3 塊狀膠合集成材

7.3.3.1 塊狀膠合集成材應使用填縫膠製造。應允許2種以上集成材單元的塊狀膠合。集成材單元應限於矩形直立集成材。

7.3.3.2 每個集成材單元皆應符合本標準。對於每個塊狀膠合集成材，集成材單元的膠合表面應符合第7.1節中規定的表面要求。不允許使用集成材單元進行端接。

7.3.3.3 塊狀集成材應符合集成材成品組合的要求。

7.3.4 再膠合集成材

7.3.4.1 再膠合集成材應使用填縫膠製造。僅限於2個集成材單元（即1層乾燥膠合介面）。

7.3.4.2 除非由認證查驗機構核准可以延長時間並記錄在工廠手冊中，否則再膠合集成材應在製造集成材單元後72小時內完成。

7.3.4.3 每個集成材單元均應符合本標準。對於每個再膠合集成材，集成材單元的膠合表面應符合第7.1節中規定的表面要求。集成材單元之間不允許進行端接。

7.3.4.4 再膠合集成材應符合集成材單元組合的要求。

7.4 尺寸公差

在膠合不同寬度的層壓材，其厚度差異不得超過正負0.008英寸（0.2毫米）。接合單一木材或層壓材長度的厚度差異不得超過正負0.012英寸（0.3毫米）。厚度變化應隨機發生在不同寬度和長度上，避免累積效應不會導致側對側深度變化大於第5.1節和第5.3節允許的變化。撓曲和凹陷不應太大，避免構件無法在膠合的壓力下變直。

7.4.1 以填縫膠膠合層壓材的厚度公差

如果使用符合第8.2節要求的填縫膠合劑，則適用第7.4節的所有要求，除了膠合層厚度的變化允許超過第7.4節規定的限制，但最大填縫膠層厚度不得超過1/16英寸（2毫米）。

8. 膠合劑

本標準要求的膠合劑應符合ANSI 405的要求。

8.1 標籤

每個膠合劑容器應標記製造商的名稱，膠合劑的產品名稱、生產批號以及膠合劑的有效日期。

每個容器上的標記與所有必需的資訊，須清楚易見。除非膠合劑製造商以書面形式重新說明，並將新的有效期貼在明顯位置，否則過期的膠合劑不得使用。

8.2 填縫膠

以厚度為1/16英寸（2毫米）的膠合層進行測試時，應符合ANSI 405和本標準的所有要求。在樣本製備期間，需使用墊片以確保維持所需的膠合層厚度。填縫膠應分別根據第7.3.3和7.3.4節用於塊狀膠合及再膠合的集成材。

9. 木嵌件

允許使用木嵌件以滿足外觀分類要求。嵌件的含水率需符合第6.2節規定。膠合劑和嵌件固著方法應適合最終使用的耐久特性。

9.1 最大嵌入深度

- a. 對於寬度小於6英寸（140毫米）的層壓材，嵌入深度應限制為1/2英寸（13毫米），對於6英寸（140毫米）或以上的層壓材，除了抗彎構件外層受張層壓材深度的5%，其嵌入深度應限制為3/4英寸（19毫米）。
- b. 位於抗彎構件外層受張層壓材深度的5%的深度應限制為1/4英寸（6毫米），寬度小於6英寸標稱（140毫米）的層壓材應限制為3/8英寸（10毫米）。

當構件乘載特定荷載時，可使用工程計算來確定抗彎構件的張力區，當該區的荷載比例少於撓曲設計強度的50%時，允許嵌件的深度為(a)中給出的深度。

在抗彎構件的張力區使用木嵌件時，其嵌件傾斜度不大於1:16。

10. 面接和端接

木材、層壓材和膠合劑的選擇和製備應按照第6、7和8節進行。用於塊狀膠合和再膠合的膠合單元在使用之前，應符合本標準的所有要求。

10.1 膠合劑混合與應用

膠合劑的混合、混合和塗佈的間隔、塗佈、組裝時間、組裝壓力、溫度和固化時間之間的間隔，應根據膠合劑製造商的建議以及隨後的認證和膠合機器的日常品質管制。

每種膠合劑混合物的比例應按重量確認。只有在重量基礎上對容器進行校正後，才允許以體積量測液體。只要混合比例在膠合劑製造商規定的限度內，允許使用自動膠合劑混合設備。混合比率應至少每天依據AITC T122中所述的程序查驗一次。

膠合劑，無論是在應用前混合或單獨使用，均應均勻地塗佈於木材表面，其用量需足以滿足本標準的性能要求。膠合劑塗佈速率應按照AITC T102程序決定。由膠合劑製造商決定儲存期或可使用效期，膠合劑超過期限則不得使用。

膠合時的木材表面溫度對於能否達成合格的膠合很重要。應根據木材溫度和環境溫度調整組裝時間、膠合劑塗佈量和固化條件。當膠合時，在最低和最高溫情況下充分調整，並進行剪力強度和膠合耐久性測試來認證。

膠合劑製造商要求的膠合劑混合和其他變因的溫度應有足夠的測試次數，以確保不超過膠合劑的使用週期。

10.2 面接組裝和膠合

面接應在任何接合點都均勻的施加壓力，並沿著構件的端點或長向持續加壓。膠合層上的組裝加壓應根據膠合劑製造商的建議。如有必要，請使用墊板或木板協助，以防止局部外層層壓材破裂。

加壓應維持足夠的時間，以確保層壓材之間的緊密接觸，而不是在膠合強度的發展過程中產生過度應力。在進行實質性固化和必要的調整之前，應查驗壓力。

不允許使用機械扣件（如釘子、螺絲等）來固定層壓材以代替夾鉗壓力。

10.3 端接組裝和膠合

除非設計師指定，否則不需要使用邊接。當需要邊接時，應以與面接相同的方式進行測試，並適用與木材破損和剪力強度相同要求。邊接應使用填縫膠，除非欲膠合的構件最大淨寬度小於或等於2英寸（51毫米）。

當邊接沒有預膠合時，至少以層壓材的淨厚度在相鄰中橫向交錯，但不得小於1英寸。若邊接有按照第10.2節的要求進行預膠合，則不必交錯。

在多片層壓材沒有邊接的情況下，各層壓材的邊緣應彼此相當接近。頂部和底部層壓材的邊緣間距允許完整長度的1/4英寸（6毫米），並允許3/8英寸（10毫米）的偶發間隙。對於內部層壓材的邊緣間距，標稱寬度為10英寸（235毫米）以下，不得超過3/8英寸（10毫米）；12英寸（286毫米）寬度為1/2英寸（13毫米）；14英寸（337毫米）寬度為5/8英寸（16毫米）。對於寬度大於14英寸（337毫米）的標稱寬度，允許的開口應與允許的標稱寬度14英寸（337毫米）的開口成比例。開口應在3件以上的多件層壓材上進行測試。

在潮濕使用條件下使用面層壓材構件時，若水分可能積聚在未膠合的邊緣，則不得允許使用未膠合的邊接。

10.4 固化時間表

製造商的程序和品管手冊應包括所使用的各類膠合劑的認證膠合程序。應為每種膠合劑、樹種和處理過程建立單獨的程序。該生產程序應包括時間溫度的關係。

11. 端接

端接應按照面接的要求進行，並對膠合劑塗佈，組裝時間，壓力施加和固化時間等方法進行適當修改。集成材之間不得使用端接。

端接應根據第13.1.3節認證。

11.1 組裝與膠合

端接應預先膠合或組裝，並與面接一起進行膠合。如果端接與層壓材的面接整體接合，則在完成面接時，它們必須正向保持對齊。並允許使用儀表量測公差進行定位和校正。除非可以透過其他方法保持端接區域的組裝厚度公差和對齊，否則生產曲線構件的端接應預膠合。

11.2 接合厚度公差

對於斜接，面接時端接的厚度公差應在端接木材厚度的0.020英寸（0.5毫米）至減去0.005英寸（0.1毫米）之內。指接，則在組裝厚度中允許加上1/32英寸（0.8毫米）的厚度公差。斜接或指接的暴露尖端的厚度，發生在層壓材的整個寬度不得超過1/32英寸（0.8毫米）。

11.3 在內部或靠近端接的木結

斜接的木結或木結孔僅限於木材等級所允許的木結或木結孔。在任何情況下，它們都不得超過層壓材標稱寬度的1/4，以及抗彎構件各向長度的10%。

指接端頭不得有木結，除非在抗彎構件外層受張層壓材深度的10%的指接中偶發出現單個針結，直徑不得超過3/8英寸（10毫米）。在其餘的抗彎構件和非規格等級構件的接合中允許偶發的單結直徑至多 1/2英寸（13毫米）。

在抗彎構件中，直徑超過3/8英寸（10毫米）的木結不得連續出現或間距要大於6英寸（152毫米）（以較小者為準）。內部和外部張力區的指接內（在任何情況下都不得少於抗彎構件深度的10%），也不得有超過1/2英寸（13毫米）直徑的木結發生在平衡層壓材的指接內。

在規格等級的構件中，指接內的一個木結直徑不得大於3/4英寸（19毫米）。

靠近端接間距的木結直徑量測應與木材的縱向軸平行。應選擇最靠近端接的木結，以此木結最靠近端接之邊緣，進行與端接最短距離之量測。

11.4 鄰近層壓材的端接間距

相鄰層壓材指接之間間距應透過量測相鄰層壓材中最接近接合處的距離來確定，該距離沿著長軸平行的方向上量測。

斜接的間距應是測量相鄰斜接膠合面的尖端之間的距離來確定。此外，與層壓材中一個斜接相交的構件的軸線成直角的平面，不得在相鄰層壓材中與另一個斜接的任何部分相交。

對於多件層壓材，當每一片的端接相距不到6英寸（152毫米）時，應以單件層壓材組成的相同方式考慮端接。如果多件層壓材只有一片在6英寸（152毫米）橫截面內具有端接，並且端接發生在接近6英寸（152毫米）的鄰近層壓材中，則該組合應與單件層壓材有相同的考量，前提是兩個端接的總寬度不超過層壓材的寬度。

在需要特定接合間距的多件層壓材的構件區域，任何6英寸（152毫米）長度內的任何2層層壓材材料中，多件層壓材材料端接的寬度總和不得超過單層層壓材的總寬度；也不得在這區域的構件出現3個或更多相鄰層壓材中相距小於6英寸（152毫米）的端接。

避免端接過度集中。此外，端接位置應按以下方式分散：

- a. 位於抗彎構件外層受張層壓材深度的1/8，外加一層層壓材的區域，其相鄰層壓材端接接合間距之相距至少6英寸（152毫米）。這個間距適用於沿著張力區中央75%的長度。張力區的其他部分沒有最小間距要求。

當構件乘載特定荷載時，可使用工程計算來確定抗彎構件的張力區，當該區的荷載比例少於撓曲設計強度的50%時，則最小間距要求不適用於這些區域。

- b. 當端接根據AITC T118或T121進行試驗時，則沒有端接的最小間距要求。

- c. 當構件張力側的層壓材按照AITC403說明的程序進行修復時，修復的方式為，使外層壓材或下一個內層壓材沒有端接在修復尖端的兩側6英寸（152毫米）內發生。
- d. 拱門不需要特定的端接間距。

11.5 相同層壓材的端接間距

- a. 相同層壓材的端接位於抗彎構件之張力側外部10%的總深度時，則間距至少6英尺（1.8公尺）。偶爾發生的沿著層壓材長度兩個端接相距小於6英尺（1.8公尺）的情況是允許的。其餘非位於張力側外部10%的抗彎構件，其層壓材內的端接間距可以小於6英尺（1.8公尺）。
- b. 只要層壓材的全長依據AITC T121在張力測試下進行試驗，且在端接後將層壓材表面重新處理到符合第6.4節規定的公差，則不適用同一層壓材內端接間距的規定。

11.6 修復時的端接

使用端接作為修復時，其修復之膠合程序，應由認證查驗機構進行與生產端接的相同測試標準和製造公差的評估。應遵循AITC 403中的測試和評估程序。

如果對已經通過試驗的層壓材使用端接進行結構修復，則不應將含有修復的層壓材構件納入已經通過試驗的端接構件。

12. 外觀分級

除非買方和賣方另有約定，否則集成材成品應進行分類：L框架級(L-Framing)、工業級(Industrial)、L工業級(Industrial-L)、建築級(Architectural)或特選級(Premium)。

12.1 框架外觀級

12.1.1 層壓材特性

允許層壓材具有木材等級要求的自然生長特性。

12.1.2 無效修復

出現在層壓材邊緣的空隙不需要填縫。暴露在目視可見的層壓材寬面上的木結不需要填補。暴露在目視可見的層壓材板寬面上出現的邊接間隙不需要填補。

12.1.3 閃皮

所有組合均允許閃皮，且長度不受限制，但受第12.1.4節的規定約束。閃皮的出現頻率不得超過所使用的木材的十分之一。在所有組合中，應允許約一英尺（305毫米）長且不超過底部層壓材允許深度的偶發閃皮，而不考慮第12.1.4節中指出的累積效應。在特定層壓材組合中允許的閃皮高達每側木材寬度的1/6，且長度不受限制。

12.1.4 刨光

要求刨光構件的兩側來搭配傳統的框架木材尺寸。下列外觀要求僅適用於這兩側。允許出現分岔、底部層壓材和閃皮之累積。對於任何膠合層，分岔、底部層壓材和閃皮的累積深度不得超過構件寬度的10%，但允許更多閃皮並相應減少設計值的組合除外。低度膠合的最大面積不得超過側面表面積的25%

12.2 L框架外觀級

除了SCL用於層壓材的「L」型框架，這種外觀分類與框架外觀分類相同。所有其他特徵與框架外觀分類中所列的特徵相同。

12.3 工業外觀級

12.3.1 集成元特性

允許層壓材具有木材等級的自然生長特性。

12.3.2 孔洞修復

出現在層壓材邊緣的孔洞不需要填補。暴露在目視可見的層壓材寬面上的木結不需要填補。暴露在目視可見的層壓材寬面上出現的邊接間隙不需要填補。

12.2.3 閃皮

所有組合均允許閃皮，且長度不受限制，但受第12.3.4節的規定約束。閃皮的發生頻率不得超過所使用的木材的十分之一。在所有組合中，應允許約一英尺（305毫米）長且不超過下層層壓材允許深度的偶發閃皮，而不考慮第12.3.4節中指出的累積效應。在特定層壓材組合中允許的閃皮高達每側木材寬度的1/6，且長度不受限制。

12.3.4 刨光

要求刨光構件的兩側。外觀要求僅適用於這兩側。允許在一個累計基礎上出現分岔、低集成元和閃皮。對於任何膠合線，分岔、低級成員和閃皮的累積深度不得超過構件寬度的10%，但允許更多閃皮並相應減少剪力設計值的組合除外。下層集成元的最大面積不得超過一側表面積的5%，而且相鄰的下層集成元，不得超過兩個。

12.4 L工業外觀級

除了SCL用於層壓材的「L」工業外觀級，這種外觀級與工業外觀級相同。所有其他特徵與工業外觀級中所列的特徵相同。

12.5 建築外觀級

12.5.1 層壓材特性

目視可見的層壓材寬面應無拔節。除此之外，層壓材被允許具有木材等級的自然生長特性。SCL不得用於本外觀分級的任何層壓材。

12.5.2 孔洞修復

暴露且目視可見的表面，長度超過3/4英寸（19毫米）的孔洞應由製造商填充木色調的填縫劑，該填縫劑與最終成品理想地融合一體，或選擇與相鄰木材的顏色相似的木材嵌件。例外：孔洞（未修復）允許長度超過3/4英寸（19毫米），如果其面積不超過1/2平方英寸（3.23平方公分）。應在暴露且目視可見的層壓材寬面上填充開放結孔。

12.5.2.1 細閃皮

不論長度，所有閃皮皆應修復。允許使用最大長度為8英寸（203毫米）的填料修復閃皮。若細閃皮超過203毫米（8英寸），則應使用木嵌件進行修復。

12.5.2.2 邊接

暴露且目視可見的層壓材的寬面上出現大於1/16英寸（2毫米）寬的邊接的孔洞，應填充與最終成品理想混合的木色調填縫劑。

12.5.3 刨光

暴露面應為光滑。不允許有分岔、閃皮弧邊和低度膠合集成元。允許偶發修復的閃皮弧邊，但應遵守第12.5.2.1節的限制。

12.5.4 平滑導角

暴露且目視可見的最終結構成品，應有至少1/8英寸（3毫米）的導角或等同的導角。

12.6 特選外觀級

12.6.1 層壓材特性

層壓材的選擇應以表面最少的鬆散結、不牢固結、結孔、邊角缺陷、樹皮內含物和空隙等為標準。在成品構件中暴露在外的層壓材板的寬面上，結應限制在層壓材板淨面寬度的20%，並且不超過最大尺寸的兩個結或其等效物，不得在6英尺（1.8公尺）內同時發生。否則，此集成元應被歸類為自然生長的木材等級。SCL不得使用此外觀分類的任何層壓材。

12.6.2 孔洞修復

在暴露的表面上，長度超過3/4英寸（19毫米）的孔洞應由製造商填充木色色調的填充物，該填充物與最終產品理想地融合一體，或選擇與相鄰木材的紋理和顏色相似的透明木材嵌件。例外：孔洞（未修復）允許長度超過3/4英寸（19毫米），如果其面積不超過1/2平方英尺。（3.23 平方公分）。

允許偶發發生在分等過程中未被檢測到的鬆節、不健全的節、節孔等孔洞，但應符合前款的修復要求。

12.6.2.1 細閃皮

無論長度如何，所有細閃皮皆應修復。應允許使用最大長度為8英寸（203毫米）的填料修復細閃皮。若細閃皮超過203毫米（8英寸），則應使用木嵌件進行修復。

12.6.2.2 邊接

暴露在視野中的層壓材的寬面上出現大於1/16英寸（2毫米）寬的邊接的孔洞，應填充與最終產品合理混合的木色色調填充物。

12.6.3 刨光

暴露面應為光滑。不允許有分岔、邊角缺陷和低度膠合層壓材。應允許偶發修復的閃皮，但應遵守第12.6.2.1節的限制。

12.6.4 平滑導角

在最終結構中暴露在視線中的構件的角落應以1/8英寸（3毫米）或等效導角的最小半徑。

13. 品質管制系統

製造廠商的品管系統應由製造廠商建立、實施和維護，並由認證查驗機構核准。

品管系統至少應包括：

- a. 工廠和程序認證，包括第13.1節中要求的認證測試以及認證查驗機構對此類流程的認證。
- b. 根據第13.2節的要求進行膠合劑批次測試。
- c. 第13.3節中要求的日常品管包括：
 1. 在生產查驗站對程序的每個步驟進行持續的詳細檢驗，包括線上測試。
 2. 代表性樣本的物理測試。
 3. 完成生產的目視查驗。
- d. 由認證查驗機構進行定期審計（見第13.4節）。
- e. 工廠手冊（參見第13.5章）。
- f. 品管記錄（見第13.6節）。

13.1 工廠和程序認證

所有影響集成材品質或評估品質的程序應取得測試合格，且生產前經過認證查驗機構核准。工廠認證要求如下：

- a. 第13.1.1節中說明的接合認證。
- b. 第13.1.2節中說明的面接和邊接認證。
- c. 第13.1.3節中說明的端接認證。
- d. 工廠使用特殊材料的認證，例如符合AITC 407的替代木材等級，符合AITC 402或ASTM D5456的SCL，以及符合AITC 401的製材。
- e. 工廠使用特殊程序的認證，例如根據AITC 406進行分等木材，根據AITC 403進行層壓材修復，以及根據AITC 404進行徑向加強。
- f. 如第13.1.5節所示，工廠用於日常品管的物理測試。
- g. 測試設備和生產儀表的電流校正。認證測試的總結如表1所示。

表 1					
品質檢驗列表					
測試項目	最小樣本數	每個樣品的 最小試體數	AITC 測試項目	要求或限制	標準參考
面接與邊接(c)	2 支膠合樑(a,b) -	每支組裝有 10 膠合層	T107 剪力	強度與木材破壞	13.1.1 13.1.2
	1 支開放性組裝				
	1 支封閉性組裝				
	2 支膠合樑(a,b) -	每支組裝取 3 塊試體樣 品	T110 循環剝離	膠合線開口	13.1.1 13.1.2
	1 支開放性組裝				
	1 支封閉性組裝				
端接	1(a)	30	T119 張力	強度與木材破壞	13.1.1 13.1.3
	1(a)	5	T110 循環剝離	膠合線開口	13.1.1 13.1.3
當工廠使用這些製程和/或材料時，除了上述要求外，還需要進行以下測試。					
證明已完成端接	2	30	T118 抗彎或 T121 張力	強度	13.1.3.3
用於修復的端接	10 修復件	2	T119 (修改的)張力	強度與木材破壞	13.1.3 13.1.3.4
	1(d)	5	測試樑		AITC 403
製材	1	102	T123 拉伸性能	強度	AITC 401
結構用複合材 (SCL)	根據 ASTM D5456 和 AITC 402 的適用要求	根據 ASTM D5456 和 AITC 402 的 適用要求	T123 張力及參考 ASTM 測試,T107, T110	強度 結構用複合材/結構 用複合材 + 結構用複 合材/木材	ASTM D5456, AITC 402
			T116	長跨距 E	AITC 402
徑向加強彎曲構件	1	10			AITC 404
已證明分等材	1	102	T123 拉伸性能	強度	AITC 406
			T116	長跨距 E	AITC 406
塊狀膠合(邊和面) 或再膠合樑(只有 面)	2 支膠合樑(e) -	每支二次膠 合的 9 塊試 體	T107 剪力	強度與木材破壞	13.1.2.1, 13.1.2.2 13.1.2.3
	1 支開放性組裝				
	1 支封閉性組裝				
	2 支膠合樑(e) -	每支二次膠 合的 3 塊試 體	T110 循環剝離	膠合線開口	13.1.2.1 13.1.2.2 13.1.2.3
	1 支開放性組裝				
	1 支封閉性組裝				

- a. 針對所使用的每種黏合劑-種類-處理組合。結構用複合材(SCL)是被要求須單獨測試的種類。
- b. 當邊接膠合有結構上的要求。
- c. 用於面接黏合的樣本中允許有端接。
- d. 除了 AITC T119 測試 之外，還必須透過補充全尺寸樑測試來驗證端接修復程序的充分性。
- e. 請參閱 13.1.2.1, 13.1.2.2 或 13.1.2.3 中規定的採樣要求（如適用）。

13.1.1 膠合品質

對於每種膠合劑、樹種群和用於面接、邊接或端接處理的組合，在生產前應根據本節的規定合格使用。廠驗的樣品則應以具有代表性的產品製造程序製作。

13.1.1.1 基本樹種群

以下分組中的樹種或樹種群不需要單獨進行認證。

第1組 – 花旗松 (Douglas Fir-Larch)*

第2組 – 南方松(Southern Pine)

第3組：鐵杉(Hem-Fir)、美國西部鐵杉(Mountain Hemlock)、花旗松(Douglas Fir South)、北美雲杉(Sitka Spruce)

第4群：軟木樹種包括英格曼雲杉(Englemann Spruce)、美國黑松(Lodgepole Pine)、黃松(Ponderosa Pine)、雲杉-松-冷杉(Spruce-Pine-Fir)和其他西方樹種。

第5組 – 加州紅木(California Redwood)

第6組 – 阿拉斯加扁柏(Alaska cedar)、美國扁柏(Port-Orford Cedar)

第7組 – 紅橡(Red Oak)、白橡(White Oak)

*落葉松因其木脂醣類含量，如果認證查驗機構認為有必要，應要求面接的單獨檢驗。

13.1.1.2 樹種群修改認證：

- 如果工廠有合格膠合劑面接第1類樹種，則第3、4和5類無須另外再認證。
- 若花旗松和鐵杉的端接已分別合格，進行更嚴格要求控制端接固化循環時，無須對合併樹種進行認證。
- 如果端接符合第1類樹種2400psi（16.5MPa）以上應力等級（QSL）的認證，則對於2000psi（13.8MPa）以下的QSL，不需要單獨認證第3類樹種。如果端接符合第1和第2類樹種認證，則2000psi（13.8MPa）以下的QSL不需要單獨認證第4類樹種。

如果需要對第3、4、5或6類樹種的端接進行認證，且先前已使用相同的配置和接合程序對第1或2類樹種的更寬度進行認證，則AITC T119只需要在標稱的6英寸（140毫米）寬度上進行。但是，更寬的寬度仍須要有連續的日常品管測試。

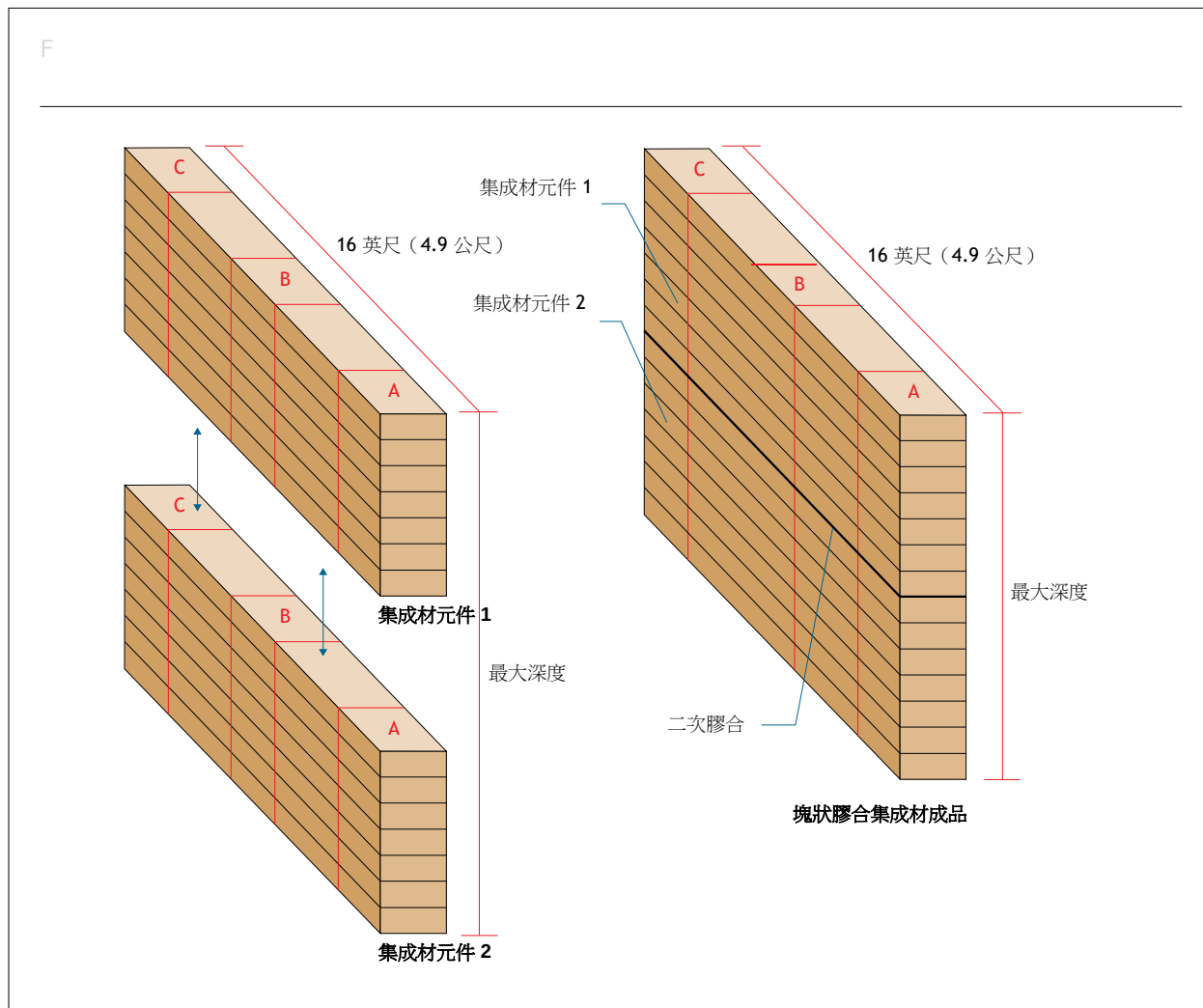
13.1.2 面接和邊接認證

- a. 面接和邊接應符合第10節以及工廠程序和品質手冊的要求。評估填縫膠時，應從使用填隙木片或類似方法特別製作的樣品中切割樣本，以保持相當於待核准的最大厚度的膠合層厚度。
- b. 應使用AITC T107進行兩支樑的測試，每支樑需至少有10條膠合層。每支樑所有樣品的平均剪力強度應等於或超過ASTM D2555所認定的平行於木紋的平均清材 (clear wood) 剪力強度的90%。以樹種群表示時，各數值認定程序應使用ASTM D2555中以樹種群分類之認定數值。或者，來自每根樑的所有樣品的平均剪力強度應等於或超過表2中提供的值。12%含水率的剪力值應用於含水率為12%或以下的含水率。以每根樑的所有採取樣本進行膠合劑的評估認證或批次認證測試而言，木材受剪力或破損表面的平均破壞率，應等於或超過80%與軟木和非緻密硬木使用的膠合劑，或應等於或超過60%與緻密硬木使用的膠合劑。
- c. 按照AITC T110準備和進行至少三個循環剝離樣品測試。經過一個完整的循環後，每一個樣本，軟木不應超過5%的剝離，硬木則不超過8%的剝離。

表 2						
黏合接點的剪力強度要求						
樹種或樹種群 ^(a)	含水量的平均剪力強度					
	12%或以下		14%		16%	
	psi	Mpa	psi	Mpa	psi	Mpa
阿拉斯加扁柏	1020	7.0	980	6.8	930	6.4
加州紅木 ^(b)	850	5.9	820	5.7	790	5.4
花旗松	1020	7.0	980	6.8	940	6.5
南方花旗松	1360	9.4	1270	8.8	1180	8.1
東部雲杉	1080	7.4	1010	7.0	950	6.5
鐵杉	1040	7.2	980	6.8	930	6.4
美國黑松	790	5.4	760	5.2	730	5.0
羅森檜	1230	8.5	1140	7.9	1060	7.3
紅橡	1600	11.0	1500	10.3	1420	9.8
軟木樹種群 ^(c)	790	5.4	760	5.2	730	5.0
南方松	1250	8.6	1150	7.9	1040	7.2
糖楓	2100	14.5	1950	13.4	1820	12.5
西部鐵杉	1160	8.0	1110	7.7	1050	7.2
西部落葉松	1220	8.4	1160	8.0	1100	7.6
白橡	1800	12.4	1680	11.6	1560	10.8
a. 根據 ASTM D2555 或木材手冊中提供的數據和流程，對於其他樹種或樹種群，該數值應基於平行紋理的剪力強度的 90%。 b. 加州紅木再生林及原始林的平均剪力值。 c. 基於軟木群中剪力強度最低的樹種。						

13.1.2.1 塊狀膠合集成材的面接認證

塊狀膠合集成材面接膠合劑的條件，所使用的面接應包含至少兩個塊狀膠合集成材成品（測試樑）、1個開放組件和1個閉合組件中取得，如圖1所示。



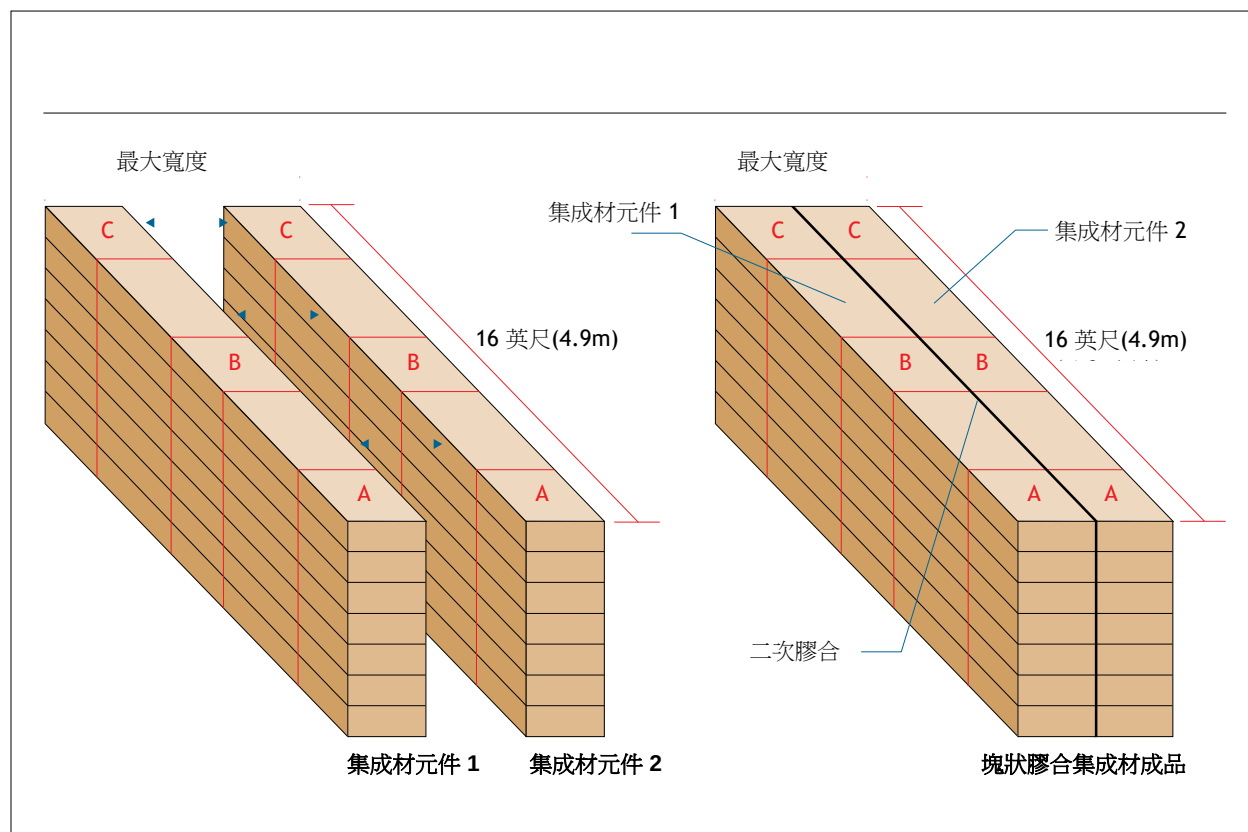
塊狀膠合集成材的面接膠合劑應符合以下條件：

1. 如圖1所示，每個測試樑（塊狀集成材）的製造應具有認可的最大深度，並將第二次加工膠合劑噴塗在成品樑的中間。每個測試樑的長度應至少為16英尺（4.9公尺）。
2. 應從每個測試樑的兩端和中心共三個部分（圖1中的A、B和C）進行取樣，以準備AITC T107和T110的樣品。

3. 對於AITC T107，應從二次加工膠合的每個部分（圖1中的A、B或C）製備3個剪切樣本。從每個測試樑的9個樣本中獲得的二次加工膠合劑的平均剪力強度和平均木材破損，應符合第13.1.2 (b)節規定的要求。
4. 對於AITC T110，應從每個部分（圖1中的A、B或C）製備深度為8個以上層壓材的試體，並將二次加工膠合劑放在試體深度的中心。二次膠合劑上每個試體的循環剝離應符合第13.1.2(c)節規定的要求。
5. 所有合格的製造細節應根據第13.5節記錄並包含在工廠手冊中。

13.1.2.2 塊狀膠合集成材的邊接條件

塊狀膠合集成材邊接膠合劑的條件，應包含至少兩個塊狀膠合集成材成品（測試樑）、1個開放組件和1個閉合組件，如圖1所示。



塊狀膠合集成材的邊緣膠合應符合以下條件：

1. 如圖2所示，每個測試樑（塊狀集成材）的製造應有被認可的最大寬度，並將二次加工膠合劑噴塗在成品樑的中間。每個測試樑的長度應至少為16英尺（4.9公尺）。
2. 應從每個測試樑的兩端和中心共三個部分（圖2中的A、B和C）進行取樣，以準備AITC T107和T110的樣品。
3. 對於AITC T107，應從二次膠合的每個部分（圖2中的A、B或C）的剪切面中製備3個剪切試體。從每個測試樑取得的共9個試體中，二次加工膠合劑的平均剪力強度和平均木材破損率，應符合第13.1.2 (b)節規定的要求。
4. 對於AITC T110，從每個部分（圖2中的A、B或C）製備6個或以上膠合層壓材的試體，並將二次膠合劑放在試體寬度的中心。二次膠合劑上每個試體的循環剝離應符合第13.1.2(c)節規定的要求。
5. 所有合格的製造細節應根據第13.5節記錄並包含在工廠手冊中。

13.1.2.3 再膠合集成材的面接條件

再膠合集成材，面接膠合的條件應至少包含兩個再膠合集成材成品（測試樑）、1個開放組件和1個閉合組件中，如圖1所示。再膠合集成材的面膠合應符合第13.1.2.1節的要求，但以下例外：

- a. 集成材單元的半徑應以用於再膠合的最小半徑表示，且
- b. 除非已認證更長的時間，製造後，集成材單元在至少72小時後，才能進行再膠合。

13.1.3 端接條件

- a. 實尺寸端接樣品應符合第11節的要求以及工廠程序和品管手冊的要求。任何寬度的端接認證均可符合所有較窄寬度的端接認證標準。在生產中同時使用標稱1英寸（19毫米）和標稱2英寸（38毫米）厚的木材時，當認證查驗機構判斷接合幾何形狀顯著不同時，每個木材皆應單獨取得合格認證。

- b. 應使用AITC T119進行至少30個樣本的張力測試。所有測試樣本的平均木材破損率應等於或超過軟木或非緻密硬木的80%，或緻密硬木的60%。平均實驗值應符合具有75%的可信度之第5百分位數公差信賴度。程序上QSL的強度值為具有75%的可信度之第5百分位數公差值除以1.67後的強度值。
- c. 應使用AITC T110進行至少5個樣本的耐久性測試。經過一個完整的循環後，每個樣本中軟木應具有不超過5%的剝離，硬木應具有不超過8%的剝離。

13.1.3.1 最小QSL

- a. **多個等級構件** – QSL應滿足或超過參考抗彎設計值，前提是透過使用每個等級的平均彈性模數進行轉換斷面分析確定的外纖維應力不超過設計應力的10%。若轉換斷面分析確定的外纖維應力超過設計值10%以上，QSL應滿足或超過轉換斷面分析確定的外纖維應力的90%。QSL也應達到參考張力設計值的1.25倍以上。
- b. **同一等級構件** – 對於同等級集成材和其他計算的外纖維應力小於參考抗彎設計值10%的異等級集成材，QSL應滿足或超過經轉換斷面分析確定的外纖維應力的90%。QSL也應達到參考張力設計值的1.25倍以上。

其所需強度適用於標稱2x6（38毫米x140毫米）木材。對於標稱2英寸（38毫米）厚的木材中的其他寬度，允許所需的強度乘以表3中列出的因素。

註 5：例如，當用302-24花旗松張力層壓材製成2x8端接以進行認證時，亦即在具有75%的可信度之第5百分位數公差條件下之所需張力測試值，為當端接在2x8的全寬度下進行張力測試時，要求2x6端接的4,000psi（27.6MPa）乘以表3中提供的0.95的強度調整因子，或3,800psi（26.2MPa）。若每個端接被分成2塊2x4進行張力測試，請參閱章節13.1.3.5。

表 3		
AITC 試驗 T119 中使用大於 2 x 6 木材的強度調整係數		
尺寸	所有樹種 (除了南方松)	南方松
2 x 8 (38mm x 184mm)	0.95	0.98
2 x 10 (38mm x 235mm)	0.90	0.95
2 x 12 (38mm x 286mm)	0.85	0.93

13.1.3.2 抗彎構件內部層壓材QSL

在抗彎構件的內部受張和受壓區域，端接QSL允許低於外部張力層壓材所需值，前提是：

- 每個層壓材的邊緣應清楚地標記強度等級，以識別直到樑表面的強度，除非在目視端接配置之層壓材時，較低等級QSL的層壓材可清楚地被區分出與使用在外層較高等級QSL層壓材之不同。
- 較低等級QSL的強度值應為端接部之最大容許應力值。
- 較低等級QSL的端接不得在外部張力區域使用，也不得在張力側深度的外部10%內之區域使用，以較大者為準。
- QSL小於外張力區QSL75%的端接，不得在抗彎構件的外壓力區使用。
- 最低端接強度所需的強度值應透過從外部張力層壓材到構件中間深度的直線插值來確定。對於此程序，外部張力層壓材處的應力應為樑組合載重下之參考抗彎應力的1.67倍，而構件中間深度的應力應為零。

13.1.3.3 負載端接認證

當使用驗證強度之接頭時，此類接頭應透過AITC T118的抗彎加載認證；或透過AITC T121的張力加載認證。

13.1.3.4 修復層壓材中使用的端接

用於層壓材修復的端接應根據AITC 403中給出的程序透過測試進行認證。

13.1.3.5 分離端接

如果端接大於2x6（38mmx140mm），並且在張力試驗之前分割成2個等寬件以適應小容量張力試驗機器，則與所需的拉伸強度相比，這2個分割件的平均值應乘以表4中列出的校正因子。

表 4 分離端接拉伸測試結果的修正係數				
尺寸	調整至實際尺寸 2x6(38mmx 140mm) 的校正係數		調整至裂縫前的寬度的校正係數	
	所有樹種 (除了南方松)	南方松	所有樹種 (除了南方松)	南方松
分割 2x8 (38mm x 184mm)	0.95	0.99	0.90	0.97
分割 2x10 (38mm x 235mm)	0.97	0.99	0.87	0.94
分割 2x12 (38mm x 286mm)	1	1	0.85	0.93

註 6：例如，當用302-24花旗松張力層壓材製成2x8端接以進行認證時，但製造工廠的張力試驗機無法破壞全寬端接時，每個2x8端接可以分成2個2x4。從每個2x8端接的兩個2x4分離端接獲得的平均張力值應透過表4中提供的0.90的校正因子進行調整，以表示2x8端接的拉伸強度。根據註5，將所有2x8端接在75%的可信度之第5百分位數公差極限下的調整張力試驗值與2x8端接的張力要求3,800psi（26.2MPa）進行比較。

或者，可以透過表4中提供的0.95校正因子來調整從每個2x8端接的兩個2x4分裂端接獲得的平均張力值，以表示標準2x6端接的拉伸強度。然而，應將標準2x6端接在75%的可信度之第5百分位數公差之調整後測試值與的2x6端接的4,000psi（27.6MPa）的張力要求進行比較。

13.1.4 其他認證測試

認證程序應執行第13.2節中要求的所有日常品管查驗和測試程序。

13.2 膠合劑批次測試

使用根據第13.1.1節規定合格的新膠合劑時，在出貨之前，每批生產構件應進行強度、木材破損和耐久性測試。此測試的樣品應在生產中使用膠合劑之前或從第一次生產運行中採取之前分開製作。檢測應對用於生產集成材的樹種製造的樣本進行，並使用相同的膠合劑固化程序。測試一批新的面接合膠合劑將滿足使用相同膠合劑的邊接膠合要求。

評估填縫膠時，應從使用填隙木片或類似方法特別製作的樣品中切割樣本，以保持相當於待核准的最大厚度的膠合層。

13.2.1 面接膠合：強度和木材破損

應根據AITC T107對每批新膠合劑進行剪力測試。每根樑的所有樣品的平均剪切強度應等於或超過ASTM D2555所確定的平行於木紋的平均無節木材剪切強度的90%。以樹種群表示時，應使用ASTMD 2555中說明的群組分配值程序。12%含水率的剪力值應用於含水率為12%以下的含水率。以每根樑的所有採取樣本進行膠合劑的評估認證或批次認證測試而言，木材受剪力或破損表面的平均破壞率，應等於或超過80%與軟木和非緻密硬木使用的膠合劑，或應等於或超過60%與緻密硬木使用的膠合劑。

13.2.2 端接膠合：強度和木材破損

端接樣本應使用與生產過程相同的膠合劑固化程序製備。端接膠合劑應按照AITC T119進行強度和木材破損評估。至少應測試4個端接以進行膠合劑批次測試。所有測試樣本的平均木材破損率應等於或超過軟木或非緻密硬木的80%，或緻密硬木的60%。所有測試的樣本所需的平均強度應由第13.1.3節中要求的認證測試確定。

13.2.3 膠合劑的耐久性：面和端接膠合

面接和端接的耐久性應按照AITC T110對每批新的膠合劑進行測試。經過一個完整的循環後，每個樣本中軟木應具有不超過5%的剝離，硬木應具有不超過8%的剝離。面接和端接樣本應使用與生產過程相同的膠合劑固化程序製備。

13.3 日常品質管制

基於品管目的，8小時的工作班次或其區段應構成一天。每日測試要求應適用於每個工作班次或其區段。日常品管應包括線上評估、代表性樣本的線下測試和成品生產的查驗。

13.3.1 線上評估

線上評估應在工廠品管手冊中指定的生產查驗站進行。評估應包括但不限於含水率的測試；表面品質的評估；溫度的量測；觀察端接/邊接/面接的接合過程；膠合劑混合比率的測試；膠合劑塗佈的測試和觀察；以及組裝時間，壓力和固化條件的監測。

13.3.2 線下測試

面、邊緣和端接的強度和耐久性應每天透過代表樣本的線下測試進行監測。端接的機械加工和裝配也應作為日常品管的一部分進行。塊狀膠合和再膠合集成材的二次膠合劑應進行線下測試。日常品管測試的摘要如表5所示。

如果在同一批次中使用同樹種的製造木材和鋸材，則面、邊緣和端接合的每日品質管制測試只需要在合格期間確定的具有控制測試值的材料上進行。

表 5

線下測試總結 -每日要求

測試項目	每個採樣週期每個樣品的最小樣本數量	AITC 測試號碼及測試類型	要求或限制	標準參考
面接與邊接 _(a,b,f)	10	T107 剪力	強度與木材破壞	13.3.4
	1	T110 循環剝離	膠合線開口	13.3.6
端接 _(a,c)	2	T119 張力	強度與木材破壞	13.3.5
	各異 _(d)	T105 _(e)		13.3.5
	1	T110 循環剝離	膠合線開口	13.3.6
當工廠使用這些製程和/或材料時，除了上述要求外，還需要進行以下測試。				
證明已完成端接	生產中測試所有的接合處	T118 抗彎或 T121 張力	強度	13.3.5.3
用於修復的端接	1 或	T119 張力 或	強度與木材破壞	AITC 403 13.3.5.4
	5 或	T106 張力 或		
	10 加 1	T107 剪力		
	1	T110 循環剝離	膠合線開口	AITC 403 13.3.5.4
製材	各異 _(d)	T123 拉伸性能	強度	AITC 401
結構用複合材(SCL)	根據適用測試	T107, T110	強度與木材破壞	AITC 402
		T116	長跨距 E	AITC 402
徑向加強彎曲構件	根據製造商生產流程及品管手冊			AITC 404
已證明分等材	各異 _(d)	T116	長跨距 E	AITC 406
		T123 拉伸性能	強度	AITC 406
塊狀膠合(邊和面)或再膠合樑(只有面) _(g)	每個採樣構件都有 6 個帶有二次膠合的樣本	T107 剪力	強度與木材破壞	13.3.4
	每個採樣構件都有 2 個帶有二次膠合的樣本	T110 循環剝離	膠合線開口	13.3.6
a. 針對所使用的每種黏合劑-種類-處理組合。結構用複合材(SCL)是被要求須單獨測試的種類。 b. 當邊接膠合有結構上的要求。 c. 在外部張力區。當取樣時尚未生產外部張力層壓材，請用外部張力區的材料來試驗端接。 d. 樣本大小隨每個層壓材的品質控制要求而變化。 e. AITC 試驗 T115 適用平面斜接和整體膠合的端接。 f. 用於面接膠合的樣本允許端接。 g. 如果適用，請分別參閱 13.3.4 或 13.3.6 中規定的採樣要求。				

13.3.3 採樣

本節所稱之取樣可代表在製作期間每一組合樹種、膠合劑類型和相關處理的面接、邊接和端接膠合。同時膠合所選用的樹種為如第13.1.1.1所示之樹種群分類時，若同時膠合樹種屬於同一樹種群，則對樹種群中一個樹種的測試可以適用於該群體中的所有樹種。樹種的日常取樣應與工廠中使用的每個樹種的生產量大致成比例。

13.3.4 面接和邊接

- a. 應至少採集每50,000平方英尺（118立方公尺）或每次工作班次中會膠合樣本的其中一部分。樣品應代表在生產條件下製作的生產構件。在可能的情況下，樣品應從生產構件的端點切割。

對於面接和邊接，應測試10條以上的膠合線。如果採樣斷面超過10條膠合線，則應測試所有膠合線。如果生產構件少於10條膠合線，則應至少對2個斷面進行取樣，並對每個取樣斷面中的所有膠合線進行測試。

- b. 對於塊狀集成材和再膠合集成材的二次膠合劑，應從每3個以下的生產構件的每一端取出一個部分。樣品應代表每次工作班次中在生產條件下製造的集成材。根據第13.1.2.1或13.1.2.2節（如適用）為塊狀膠合集成材或第13.1.2.3節為再膠合集成材，應製備每部分三個剪切樣本。

13.3.4.1 面接膠合的測試

- a. 應按照AITC T107在集成元間的膠合線上進行剪力測試。應評估所有樣本的剪力強度的平均值，且此平均值應等於或超過ASTM D2555所確定且與木纖維平行的無節木材剪力強度的90%。或者，應平均所有待評估樣本的剪力強度，並且該平均值應等於或超過表2中提供的值。

所有待評估樣本的剪切或破碎表面上的木材破損應為平均值，並且此平均值應等於或超過70%的由軟木和非緻密硬木一起使用的膠合劑之強度值，且應超過50%用於緻密硬木的膠合劑之強度值。

- b. 對於塊狀集成材或再膠合集成材，應按照AITC T107進行二次膠合劑剪力測試。從每個取樣生產構件取得的二次膠合劑上所有試件的平均剪切強度和木材破損應符合第13.3.4.1 (a)節規定的要求。

13.3.4.2 邊接膠合測試

如果邊接是結構要求，則面接需進行剪力試驗，並根據集成元厚度適當修改寬度。應符合第13.3.4.1節中規定的標準。

13.3.5 端接

批次尺寸應由層壓機確定，並由認證查驗機構核准。由AITC T119測試的端接數量應根據端接產品之抗彎構件外張力區（至少深度的10%）和同等級構件的完整深度的量來決定。待測試的端接數量應為每200個接頭中選用至少1個端接，但每批次、每班次、或每50,000板英尺(board feet)（118立方公尺）或其他生產部分，不得少於2個端接測試。

若在抗彎構件中沒有為外張力區生產的端接，則應測試每批、班次或每50,000板英尺(board feet)（118立方公尺）或其部分的至少兩個樣本。

測試的端接應使用符合抗彎構件張力側外部5%深度要求的最高等級木材的木材製成，以確定QSL。

此外，應以AITC T105至少測試一端接：

- a. 每次換班的開始。
- b. 追蹤端接生產變數的任何重大變化，包括固化順序。
- c. 更換端接機刀頭後。

AITC T115被允許代替AITC T105，其中使用平嵌接和疊合膠合的端接。測試樣品選擇和測試結果評估應按照認證查驗機構核准的程序進行。

13.3.5.1 獨立生產線

端接的測試要求應適用於每個端接生產程序或單獨的端接製造線。

13.3.5.2 端接膠合測試

端接應按照AITC T119每天進行強度和木材破損測試。木材破損的標準應比照第13.3.4.1節面接的規定。強度品管要求應以批次抽樣為基礎。批次品管應透過持續的品管計畫進行監控。應建立批次樣品平均強度的統計製程控制（SPC）限值，以維持所需的端接強度。

13.3.5.3 端接負載認證測試

在端接負載認證測試之測試場所，進行端接測試的所有日常生產線和端接所需的日常測試皆須查驗。此外，應遵循AITC T118或T121中規定的所有品管程序，以適用者為準。

13.3.5.4 集成元修復的端接測試

如果端接用於集成元材料的修復，則應進行AITC 403中規定的日常品質管制和測試。

13.3.6 膠合劑完整性測試

- a. 按照AITC T110進行的循環剝離測試應對面接和端接的樣品，以及使用邊接接合的邊接進行。端接允許在面接膠合的樣品中使用。在使用集成元修復程序的情況下，應將循環剝離樣品與每個所需的強度測試樣品組合製作。
一個完整循環後每個樣本的剝離率不得超過軟木的5%和硬木的8%。如果在一個循環後剝離率超過這些值，則應對同一樣品進行第二個循環測試，在這種情況下，剝離率不得超過10%。
- b. 根據第13.1.2.1或13.1.2.2節（如適用）塊狀膠合集成材或第13.1.2.3節再膠合集成材，應從每3個以下的生產構件的每端採取循環剝離樣本。樣品應代表每次工作班次中在生產條件下製造的集成材。循環剝離測試應按照AITC T110進行。從每個採樣生產構件處獲得的二次膠合劑上的每個樣品的剝離應符合第13.3.6 (a)節中規定的要求。

13.3.7 完成生產的查驗

所有生產應查驗是否符合本標準的以下要求：

- a. 尺寸（寬度、深度和長度）。
- b. 形狀，包括撓曲度和矩形斷面。
- c. 結構膠合線的類型、品質和位置。
- d. 外觀分類。
- e. 木材樹種和分等。
- f. 含水率。
- g. 膠合劑類型：如果膠合劑出現錯誤的顏色，則必須從記錄中確定類型，或者如果記錄與目視觀察不一致，則必須透過適當的測試來確定類型。
- h. 膠合線：如果膠合線厚度沒有落在0.006英寸（0.2毫米）正負0.004英寸（0.1毫米）的範圍內（允許有1/16英寸（2毫米）以下膠合線厚度的填縫劑除外），應調查生產程序以確保符合本標準的規定。應限制集成元脫膠的罕見發生（由合格的查驗員判斷）小於在膠合線上允許的集成元特性。任何膠合線分離皆需要調查記錄和生產程序，並可能需要額外的物理測試。應使用探針、增量鑽孔或其他方法評估分離程度。
- i. 採用適當的標記。

13.4 認證查驗機構的查驗

所有符合本標準的產品應在由認證查驗機構定期且未經公告進行審議的設施中製造。與此類產品生產相關的所有程序和記錄均應接受查驗。

13.5 工廠手冊

生產程序和工廠品管系統應在工廠程序手冊和品管手冊中充分說明。生產查驗點、物理測試和目視查驗程序應包含在品管手冊中。手冊應由製造工廠更新。這些手冊應經認證查驗機構核准，並由該機構定期審查。

13.6 品質管制紀錄

品管程序的記錄應由製造廠商維護。下列記錄應由製造廠商保存至少5年。

- a. 認證測試結果。
- b. 完成生產的每日測試，包括剪力測試、循環剝離測試和端接強度測試。
- c. 生產線測試結果：每日查驗表列出要查驗的每個生產階段。已查驗的項目應以姓名首字縮寫簽署，並附有表明符合規定的意見。如發現違規情況，應記錄該程序的動作和更正。
- d. 按照第4.1節執行的任何工程分析文件。

14. 標記

符合本標準的集成材應有的明確標記。

14.1 非客製化構件

非客製化構件應標明以下內容：

- a. 本標準的識別—**ANSI A190.1**
- b. 認證查驗機構的識別（見第3.2節）
- c. 膠合工廠的識別
- d. 集成材的木材樹種或樹種群
- e. 適用的集成元規格和組合符號。（若剪切（ F_v ）壓縮的設計值垂直於木纖維（ F_c ）和抗彎（ F_b ）非公佈的組合設計值，則這些設計值須包括在標記中。
- f. 由**FRAM**外框標記的外觀分類：**FRAM-L**(L型外框)、**IND**(工業用)、**IND-L**(L型工業用)、**ARCH**(建築用)和**PREM**(高級)
- g. 若構件符合要求的校証負載，則為**校証端接**
- h. 批次號碼或工作識別號碼可回溯構件的製造工廠生產和品管記錄
- i. 替代張力集成元：若使用替代張力集成元，則應在構件上加上標記，以識別所使用的替代面集成元等級（例如：C14-24）。

非客製化構件不得被要求標記為「非客製化」。

14.1.1 標記的頻率

本節要求的標記應在8英尺（2.4公尺）或更短の間隔內印製在非客製化構件上，以便從較長構件切割後的每個構件至少有一個所需標記。

14.2 客製化構件

符合個別工作規範的集成元構件（客製化構件），標記僅應包含第14.1節中的(a)、(b)、(c)、(h)和(i)。客製化構件應至少有一個標記，包含所需的識別資訊。當運送到工作的長構件後來被切割成幾個構件在結構中使用時，應遵循非客製化構件所需的標記頻率。客製化構件不得被要求標記為「客製化」。

註 7：客製化構件的標記要求不如非客製化構件嚴格，這是因為最終用途通常是已知的，相關資訊可以在特定工作的文件中說明，而非依賴於構件的標記。此外，非客製化構件每8英尺（2.4公尺）標記一次，以在安裝前切割成較短的長度，其中客製化構件只需要在一個位置標記。

14.3 防火等級

根據第4.2.1節製造時，允許使用1小時防火等級或2小時防火等級（如適用）標記防火等級。

14.4 最高印章要求

具有不平衡或撓曲度的矩形集成材構件應標記為「TOP」，字母高約2英寸（51毫米）。客製化構件應在兩端的頂部蓋章。非客製化構件應按第14.1.1節規定的間隔沿上方加蓋印章。

14.5 符合性認證

當核發符合性認證時，所認證的集成材皆須適當地標記認證查驗機構的標誌。

14.6 雙重製造標記

本標準適用於在單一工廠或部分在一個工廠和部分在另一個工廠製造的集成材。當涉及一個以上的工廠時，每個工廠必須符合本標準，並且符合性認證中應進行說明。在構件上放置的標記應是製造過程中的最後一個工廠標記。

14.7 標記桁架構件

桁架出貨時，應標記每個組件、子組件或分開的零件。

14.8 撤銷標記

如果符合以下任何一項條件，應刪除產品的標記和/或認證，並撤銷證書（如需要）。

- a. 物理測試、目視查驗和生產記錄的審查表明，標記或認證的產品不符合本標準的要求。
- b. 調查顯示該產品不符合本標準要求。

15. 技術審查委員會 (TRB)

15.1 範圍

本標準的秘書處美國工程木材協會，應設立技術審查委員會，其職能如下：

- a. 對本標準的解釋，
- b. 處理符合本標準適用性的上訴，以及
- c. 確定本標準中提及的文件接續適用性和一致性問題。

15.2 成員資格

技術審查委員會應由五名擁有投票權的委員組成。董事會成員的代表應為：

- a. 代表製造廠商的一名成員進行秘書處的測試和查驗。
- b. 代表大多數製造廠商接受秘書處以外認證機構查驗和測試的一名理事。
- c. 一位合格的集成材專家，代表教育或研究機構
- d. 一位合格的工程木材建築領域專家，且已註冊為專業工程師或建築師。該理事不得是任何從事製造集成材或其他工程木製品的公司或為製造該等產品提供原材料、設備或在職的任何公司員工。

- e. 一位合格的工程木材建築領域專家，且已註冊為專業工程師或建築師，擔任技術審查委員會的主席。主席不得是任何從事製造集成材或其他工程木製品的公司或為製造該等產品提供原材料、設備或在職的任何公司員工。
- f. 由秘書處推舉無投票權的秘書。

15.2.1 甄選

秘書處應進行甄選過程，以確保符合第15.2條的標準。每個認證機構應向TRB秘書提供TAC成員名單，以便請求提名人選和進行TRB成員的選舉。透過選舉選出理事，任期兩年，但主席除外，選出的主席任期為四年。任期從5月1日開始，到4月30日結束。

- a. 代表第15.2 (a)類的理事應由製造廠商提名並選出。應透過選舉選出該理事，其任期為兩年且由每個偶數年開始。
- b. 代表第15.2 (b)類的理事應由製造廠商提名並選出。應透過選舉選出該理事，其任期為兩年且由每個奇數年開始。
- c. 代表第15.2 (c)類的理事應由技術顧問委員會的所有認證機構提名並選出。應透過選舉選出該理事，其任期為兩年且由每個偶數年開始。
- d. 代表第15.2 (d)類的理事應由技術顧問委員會的所有認證機構提名並選出。應透過選舉選出該理事，其任期為兩年且由每個奇數年開始。
- e. 技術審查委員會主席應由技術顧問委員會的所有認證機構提名並選出。主席的任期為四年，任期從每隔兩年的奇數年開始。
- f. 如果一名理事在任期結束前辭去委員會職務或變得不合格，則應選出符合標準的新理事填補該空缺職位，以完成剩餘任期。

15.3 服務申請

向技術審查委員會要求的服務應以書面形式向秘書提出。需提供關於請求服務的至少八（8）份副本和任何支持資料給秘書，以分發給TRB成員並納入記錄。

15.4 會議的舉行

- a. **會議電話：**技術審查委員會秘書應發出所有會議電話和通知。應至少提前30天通知。
- b. **代理主席：**在當選主席缺席的情況下，技術審查委員會理事應從他們當中選出一名代理主席出席特定會議。
- c. **法定人數：**須達法定人數才能進行有效的技術審查委員會投票。法定人數應包括主席或代理主席、至少一名第15.2 (a)或(b)類理事，以及至少一名第15.2 (c)或(d)類理事。
- d. **投票：**技術審查委員會的每個成員應有一票表決權，且（1）秘書不得投票；（2）主席或代理主席不得投票，除非平局；（3）代表第15.2 (a)或(b)類的理事不得對其各自公司提出的任何事項進行投票。提出動議皆會進行投票，前提是有法定人數在場。技術審查委員會允許信件投票。
- e. **規則：**主席或代理主席應根據羅伯特的議事規則進行所有會議。
- f. **聽證會：**技術審查委員會允許邀請受影響、有興趣或專業的個人或公司在聽證會上作證或提供補充數據或資訊。聽證會應開放給所有利害關係人。
- g. **審議：**聽證會後，技術審查委員會應開會討論和審議案件。除TRB理事和秘書以外，審議應不對其他人開放。認證查驗機構代表應得觀察審議情況。
- h. **挑戰：**當TRB達成決定時，聽證事項的支持者應被允許對TRB決定提出異議。其他審議應由技術審查委員會主席酌情決定。
- i. **決定：**技術審查委員會的決定應具有約束力且為最終版本。
- j. **記錄和報告：**秘書應保存技術審查委員會的信件、會議記錄和其他記錄的檔案。應民眾要求，應將會議記錄公開。未經所有者明確書面同意，不得提供專有資訊。

15.5 費用

技術審查委員會的管理費用應按以下方式分攤：

- a. 直接行政費用應由秘書處負擔。
- b. 會議費用應由要求召開技術審查委員會的一方或多方負擔，包括：
 - 1. 委員會成員參與會議所需的交通、膳食及住宿費用。
 - 2. 第15.2(c)、15.2(d)及15.2(e)類技術審查委員會會議的一日酬金。金額應由秘書處決定。
 - 3. 會議室和會議所需視聽設備的出借。
 - 4. 供應會議的食物或飲料。

附錄十一：專案歷史記錄（非強制性資訊）

商業標準CS253:63（結構用集成材）是根據美國木材建築學會（AITC）的要求開發的，並於1963年發布。

1970年，AITC要求國家標準局根據《自願產品標準開發程序》啟動CS253:63的修訂。常務委員會於1972年6月核准修訂提案。建議修訂於1972年7月發行以尋求公眾接受。此次發行的回應表明，對標準進行某些變更是必要的。1972年10月，常務委員會核准新的提案。新建議標準於1973年1月發行。對此次發行表明，生產商、分銷商和使用者之間已按照公佈的程序達成共識。這一版本的標準被命名為PS 56-73結構用集成材，並於1973年7月1日生效。

本標準也透過ANSI被命名為ANSI A190.1- 1973。本標準的第一修訂版是根據商務部自願產品標準制定程序制定，並於1976年7月19日生效。1982年，AITC要求將本標準修訂為美國國家標準ANSI/AITC A190.1-1983。此修訂是在ANSI程序下完成的，並於1983年6月3日獲得ANSI標準審查委員會的核准。

1991年，AITC要求將本標準修訂為美國國家標準ANSI/AITCA190.1-1992。這項修訂再次通過ANSI的遊說程序，並於1992年3月16日獲得ANSI標準審查委員會的核准。

2002年，AITC要求將本標準修訂為美國國家標準ANSI/AITCA190.1-2002。這項修訂再次通過ANSI的遊說程序，並於2002年10月10日獲得ANSI標準審查委員會的核准。

2007年，AITC要求將本標準修訂為美國國家標準ANSI/AITCA190.1-2007。這項修訂再次通過ANSI的遊說程序，並於2007年4月30日獲得ANSI標準審查委員會的核准。

2012年，AITC要求將本標準修訂為美國國家標準ANSI/AITCA190.1-2012。此修訂再次根據美國木材建築協會共識標準開發程序完成，並於2013年1月23日獲得ANSI核准。

2013年1月1日，美國工程木材協會擔任這項標準的秘書處，並將其重新命名為ANSI A190.1-2012。

2017年，本標準被修訂為ANSI A190.1-2017，並於2017年1月24日獲得ANSI核准。

2022年，本標準修改為ANSI A190.1-2022，並於2022年2月17日獲得ANSI核准，標題從木材產品標準：結構用集成材改為結構用集成材產品標準。本標準的主要變更包括加入附加、塊狀膠合和再膠合的新的認證和品質保證要求，以及增加分離端接張力測試結果的校正因子（見表4），這些因子多年來一直被集成材工業所使用，但未包含在本標準中。此外，本標準認可ANSI 117中說明的集成材組合，並列出膠合劑接合所需的平均剪力強度（見表2）。本標準的格式也透過將定義部分再定位到本標準的前部分來更新，以與大多數國家和國際標準保持一致。

本標準發佈時 ANSI A190.1 委員會成員名單如下。

委員會的最新成員名單可根據要求向委員會秘書處索取。

Name	Affiliation	Note
DeepaReddy Akula	Vinside Capital	
Linda Brown	Southern Pine Inspection Bureau	
Kevin Cheung	Western Wood Products Association	
Mark Clark	Hexion, Inc.	ExSub Member
David Conner	Timber Products Inspection, Inc.	
Brad Douglas	American Wood Council	
Julie Frappier	Nordic Structures	
Bill Gareis	Ashland Chemical	
William Gould	ICC-ES	
Jim Henjum	SmartLam N.A.	
Benjamin Herzog	University of Maine	
Levi Huffman	DR Johnson Wood Innovations	
Jessica Jennings	Georgia-Pacific Chemicals, LLC	
Henry Morris	Pacific Lumber Inspection Bureau	ExSub Member
Jeff Morrison	Rosboro LLC	Chair
Brent Olson	PFS TECO	
Steven Reiersen	Akzo Nobel Coatings, Inc.	
Andreas Rhude	Consultant	
Glen Robak	Weyerhaeuser	
Sheldon Shi	University of North Texas	
Jeffrey Stefani	Anthony Canfor	
Robert Taylor	Boise Cascade	
Leif Van Cott	Unalam	
Travis Van De Vliert	Western Archrib	
Chris Whelan	Henkel Corporation	
Tom Williamson	Timber Engineering, LLC	Vice-Chair
Clay Winje	Kalesnikoff Lumber	
B.J. Yeh	APA - The Engineered Wood Association	Secretariat
Larry Zhou	Universal Timber Structures Inc	

如對本標準的改進有任何疑問或建議，請直接聯繫：

秘書處，ANSI A190.1

美國工程木材協會

7011 South 19th Street

Tacoma, WA 98466

ANSI A190.1-2022

結構用集成材產品標準

ANSI A190.1-2022 Product Standard for Structural Glued Laminated Timber

APA HEADQUARTERS

7011 So. 19th St. ■ Tacoma, Washington 98466 ■ (253) 565-6600 ■ Fax: (253) 565-7265

PRODUCT SUPPORT HELP DESK

(253) 620-7400 ■ help@apawood.org

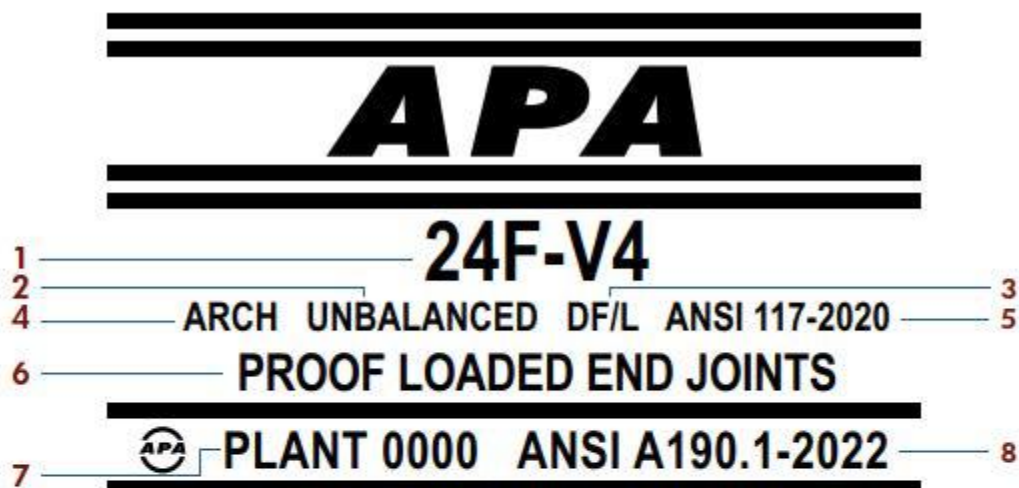
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1. APA-The Engineered Wood Association



1. Combination symbol.
2. Unbalanced layup.
3. The species or species group of lumber in the timber.
4. Designation of appearance grade.
5. Applicable design and manufacturing specification.
6. Indicates the member has the required laminations proof loaded.
7. Mill number.
8. Identification of ANSI A190.1, *Product Standard for Structural Glued Laminated Timber*.

2. AITC—American Institute of Timber Construction

A Typical Non-Custom** Product Quality Mark

