



ACCEPTANCE CRITERIA FOR THERMOPLASTIC COMPOSITE LUMBER PRODUCTS

AC109

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PREFACE

Evaluation reports issued by ICC Evaluation Service, Inc. (ICC-ES), are based upon performance features of the International family of codes and other widely adopted code families, including the Uniform Codes, the BOCA National Codes, and the SBCCI Standard Codes. Section 104.11 of the *International Building Code*® reads as follows:

The provisions of this code are not intended to prevent the installation of any materials or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.

Similar provisions are contained in the Uniform Codes, the National Codes, and the Standard Codes.

This acceptance criteria has been issued to provide all interested parties with guidelines for demonstrating compliance with performance features of the applicable code(s) referenced in the acceptance criteria. The criteria was developed and adopted following public hearings conducted by the ICC-ES Evaluation Committee, and is effective on the date shown above. All reports issued or reissued on or after the effective date must comply with this criteria, while reports issued prior to this date may be in compliance with this criteria or with the previous edition. If the criteria is an updated version from the previous edition, a solid vertical line (|) in the margin within the criteria indicates a technical change, addition, or deletion from the previous edition. A deletion indicator (→) is provided in the margin where a paragraph has been deleted if the deletion involved a technical change. This criteria may be further revised as the need dictates.

ICC-ES may consider alternate criteria, provided the report applicant submits valid data demonstrating that the alternate criteria are at least equivalent to the criteria set forth in this document, and otherwise demonstrate compliance with the performance features of the codes. Notwithstanding that a product, material, or type or method of construction meets the requirements of the criteria set forth in this document, or that it can be demonstrated that valid alternate criteria are equivalent to the criteria in this document and otherwise demonstrate compliance with the performance features of the codes, ICC-ES retains the right to refuse to issue or renew an evaluation report, if the product, material, or type or method of construction is such that either unusual care with its installation or use must be exercised for satisfactory performance, or if malfunctioning is apt to cause unreasonable property damage or personal injury or sickness relative to the benefits to be achieved by the use of the product, material, or type or method of construction.

Acceptance criteria are developed for use solely by ICC-ES for purposes of issuing ICC-ES evaluation reports.

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1.0 INTRODUCTION

1.1 Purpose: The purpose of this acceptance criteria is to establish requirements for solid cross-sectional thermoplastic composite lumber (TCL) products to be recognized in an ICC Evaluation Service, Inc. (ICC-ES), evaluation report under the 2003 *International Building Code*[®] (IBC), the 2003 *International Residential Code*[®] (IRC), the BOCA[®] *National Building Code/1999* (BNBC), the 1999 *Standard Building Code*[®] (SBC) and the 1997 *Uniform Building Code*[™] (UBC). Bases of recognition are Section 104.11 of the IBC, Section R104.11 of the IRC, Section 106.4 of the BNBC, Section 103.7 of the SBC and Section 104.2.8 of the UBC. The reason for development of this criteria is to provide a guideline for the evaluation of materials identified in Section 1.2 of this criteria for use in deckboards and guardrails, since the codes do not contain information on the materials.

1.2 Scope: Solid rectangular cross-sectional thermoplastic composite lumber products are recognized for use as a flooring, guardrail (guard), or nonstructural trim component for exterior balconies, porches, decks, and other exterior walking surfaces.

1.3 Reference Documents:

1.3.1 2003 *International Building Code*[®], International Code Council.

1.3.2 2003 *International Residential Code*[®], International Code Council.

1.3.3 BOCA[®] *National Building Code/1999* (BNBC).

1.3.4 1999 *Standard Building Code*[®] (SBC).

1.3.5 1997 *Uniform Building Code*[™] (UBC).

1.3.6 ICC-ES Acceptance Criteria for Quality Control Manuals (AC10).

1.3.7 ICC-ES Acceptance Criteria for Structural Composite Lumber (AC47).

1.3.8 ICC-ES Acceptance Criteria for Test Reports and Product Sampling (AC85).

1.3.9 ASTM D 1413-99, Test Method for Wood Preservatives by Laboratory Soil-block Cultures, ASTM International.

1.3.10 ASTM D 2565-99, Practice for Operating Xenon Arc-type Light-exposure Apparatus With or Without Water for Exposure of Plastics, ASTM International.

1.3.11 ASTM D 2915-98, Practice for Evaluating Allowable Properties for Grades of Structural Lumber, ASTM International.

1.3.12 ASTM D 2990-95, Test Methods for Tensile, Compressive, and Flexural Creep and Creep-rupture of Plastics, ASTM International.

1.3.13 ASTM D 3345-74 (1999), Test Method for Laboratory Evaluation of Wood and Other Cellulosic Materials for Resistance to Termites, ASTM International.

1.3.14 ASTM D 5456-99a, Specification for Evaluation of Structural Composite Lumber Products, ASTM International.

1.3.15 ASTM E 4-99, Practices for Force Verification of Testing Machines, ASTM International.

1.3.16 ASTM E 84-01, Test Methods for Surface Burning Characteristics of Building Materials, ASTM International.

1.3.17 ASTM D 6109-97, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastic Lumber, ASTM International.

1.3.18 ASTM D 7032-04, Standard Specification for Establishing Performance Ratings for Wood-Plastic Composite Deck Boards and Guardrail Systems (Guards or Handrails), ASTM International.

1.4 Definitions: All references to TCL denote wood thermoplastic composite lumber and glass-fiber-reinforced composite lumber materials. These materials are defined below:

1.4.1 Wood Thermoplastic Composite Lumber (WTCL): Wood thermoplastic composite lumber is a composite material made of wood and thermoplastic polymer plastic. The WTCL products are manufactured by an extrusion process in sizes similar to solid-sawn lumber. While WTCL has no "grain," structural properties are evaluated in both the machine direction (parallel to the length of WTCL members) and the cross direction (perpendicular to the length of WTCL members).

1.4.2 Glass Fiber Thermoplastic Composite Lumber (GFTCL): Glass fiber composite lumber is a composite material made of glass fiber and thermoplastic polymer plastic. The GFTCL products are manufactured by an extrusion process in sizes similar to solid-sawn lumber. While GFTCL has no "grain," structural properties are evaluated in both the machine direction (parallel to the length of GFTCL members) and the cross direction (perpendicular to the length of GFTCL members).

2.0 BASIC INFORMATION, REPORTS OF TESTS, AND GENERAL REQUIREMENTS

2.1 General: The following information shall be submitted:

2.1.1 Product Description: Complete information concerning material specifications, thickness, size and the manufacturing process.

2.1.2 Installation Instructions: Installation details and limitations, fastening methods, and spacing requirements.

2.1.3 Packaging and Identification: The report shall indicate how the product will be identified. Identification shall be in accordance with the following:

2.1.3.1 Decking and guardrail assemblies shall be identified by a product label. Labels shall identify the product, the manufacturer, the ICC-ES evaluation report number and the inspection agency.

2.1.3.2 Labels may be permanent or removable.

2.1.3.3 Labeling may be applied to the finished product or the product packaging.

2.1.3.3.1 When package labeling is used, packages must be labeled as sold and must be identifiable by the local building official.

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2.1.3.3.2 When not labeling the entire assembly, individual components or their packaging may be labeled.

2.1.3.4 Other methods of product identification using the ICC-ES evaluation report number must be approved by the report holder's inspection agency and ICC-ES.

2.1.4 Field Preparation: A description of the methods of field-cutting, application, and finishing.

2.2 Testing Laboratories: Testing laboratories shall comply with Section 2.0 of the ICC-ES Acceptance Criteria for Test Reports (AC85) and Section 4.2 of the ICC-ES Rules of Procedures for Evaluation Reports.

2.3 Test Reports: Test reports shall comply with AC85. Details describing the test configuration, test methods and test procedures, including load application rate, shall be identified in the test report.

2.4 Product Sampling: Test specimens shall be sampled in accordance with the product sampling requirements of Section 3.1 of AC85. Specimen sampling methods shall comply with Section 6.2 of ASTM D 5456. Measured dimensions of sampled products and test specimens shall be recorded in accordance with the degree of accuracy specified in the ASTM standards identified in Section 1.3 of this criteria. Statements shall be in the test report indicating whether specimens were produced in accordance with the minimum requirements of the approved quality control manual.

Variations in color shall be considered in the evaluation of products establishing flexural properties under Section 4.2 and UV resistance under Section 4.4, unless data is submitted indicating there is no effect.

2.5 Load measuring equipment shall have a degree of accuracy of 2 percent as determined in accordance with ASTM E 4.

3.0 TEST AND PERFORMANCE REQUIREMENTS

3.1 General: The testing and analysis provisions of ASTM D 5456 shall be used to establish design values and details of each end use of TCL formulation, with the amendments prescribed in Sections 4.1 through 4.4 of this criteria.

3.2 Qualification: Qualification testing for each product evaluated shall be provided. If multiple facilities are utilized to manufacture the product, each manufacturing facility shall provide qualification testing for each product evaluated. Samples for qualification, test procedures, and analysis of qualification testing shall conform to Section 6 of ASTM D 5456, except as prescribed in Section 4.5 through 4.8 of this criteria.

3.3 End Use Adjustment:

3.3.1 Temperature: Testing of TCL members shall include verification that allowable design stresses are applicable at a range of temperatures that would be expected in service. For purposes of this criteria, the upper range of sustained ambient temperature is judged to be 125°F (52°C).

3.3.2 Ultraviolet (UV) Resistance: Testing of the TCL members shall include UV as indicated in Section 4.4, and adjustments shall be made accordingly.

3.4 Determination of Allowable Design Stresses:

3.4.1 General: Determination of allowable design loads for each TCL product shall be in accordance with Section 6 of ASTM D 5456; except that the method of flexural testing may be in accordance with ASTM D 6109.

3.4.2 Volume Effects: Allowable design values shall be developed for the sizes tested, including length, and no further adjustment for volume is required. These design values shall be applicable within the limited range of extrapolation provided in ASTM D 5456, Section A1.2 (flexure) and Section A1.3 (tension).

3.4.3 Code-prescribed Loading Conditions: Calculations, utilizing the determined allowable design properties and section properties, shall be provided for each product and application, establishing the ability to adequately resist the code-prescribed loads. The individual preparing such documents shall be competent and qualified in the application of the structural design principles involved, and shall possess a registration or license in accordance with appropriate professional registration laws. Refer to Section 6.1 of this criteria, where the evaluation is to be limited to reporting the allowable design properties of the product.

4.0 TEST METHODS

4.1 Conditioning: The TCL test material shall be conditioned as indicated in ASTM D 5456. Alternatively, if data shows that the TCL will not gain moisture, even under extreme moisture conditions such as submersion, the TCL shall be permitted to be tested without special conditioning.

4.2 Mechanical Properties: Mechanical properties of TCL products shall be determined for each stress mode for which allowable stresses are proposed. If properties are not proposed for certain stress modes, such as tension, a listing of accepted product applications shall be provided by the report applicant, and justification shall be provided for the omission of this property.

4.3 Surface-burning Characteristics: Surface-burning characteristics shall be determined in accordance with UBC Standard 8-1 (UBC) or ASTM E 84 (IBC, IRC, NBC, and SBC). Materials shall have a flame-spread index no greater than 200 when tested in accordance with UBC Standard 8-1 or ASTM E 84.

4.4 Durability: Durability of TCL shall be determined using test procedures ASTM D 1413 and ASTM D 2565, except that GFTCL products are not required to be tested in accordance with ASTM D 1413. Visual examination of test blocks used in the ASTM D 1413 testing shall reveal no evidence of distortion, shrinkage, softening, or other evidence of decay.

The resistance to UV exposure of materials used to fabricate deck boards and components of guardrail systems (guards and handrails) shall be evaluated in accordance with Section 4.5 of ASTM D 7032, except that adjustment factors for stiffness also shall be considered. Alternatively, evaluation is permitted to be conducted in accordance with ASTM D 2565, Cycle 1.

WTCL shall be termite-resistant. Testing in accordance with ASTM D 3345 for resistance to termites shall demonstrate no evidence of termite attack.

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4.5 Sample Size: Specimen sampling methods shall comply with Section 6.2 of ASTM D 5456 (or D 6109), except that the minimum sample size for calculating tolerance on the fifth percentiles shall be 28. Upon completion of testing of 28 specimens, calculations shall be performed to confirm the distribution is normal and the standard error is 5 percent or less. Analysis and presentation of results, complying with ASTM D 2915, shall confirm if this has been achieved. If not, additional specimens shall be tested until compliance is achieved.

When utilizing ASTM D 6109 for bending stress, the PTL of the MOR shall be determined utilizing the practices outlined in Section 6 of ASTM D 5456, except the minimum sample size shall be 28.

4.6 Duration of Load Effects: The following minimum test requirements are required to qualify the TCL product to resist loads that are in place for durations longer than those imposed in the qualification testing:

4.6.1 A minimum number of specimens, equal in number to those required for calculating tolerance limits on fifth percentiles, shall be loaded in flexure to a bending stress that exceeds the allowable design bending stress by a minimum of 100 percent.

4.6.2 This load level shall be maintained for a minimum of 90 days. Deflections are monitored at regular intervals during this period.

4.6.3 Acceptance is indicated by zero failures and no evidence of tertiary creep. Refer to Appendix X2 of ASTM D 2990 for a definition of tertiary creep.

4.7 Creep Relaxation: A minimum of three specimens shall be loaded in flexure to a bending stress equal to $1.0 \times F_b$. Testing shall be conducted at the same reference conditions used for the qualification testing. The specimens are loaded for 24 hours and allowed to recover with no superimposed load for 24 hours. After the total elapsed time of 48 hours, the average percent recovery shall be at least 75 percent of the total deflection.

4.8 Fasteners: The test procedures and method of analysis of Section 3.2 of AC47 shall be used for laterally loaded mechanical connections in TCL. The procedure shall be required for each fastener type under consideration, such as nails, bolts, staples or wood screws. The test report shall include descriptions of minimum end and edge distances utilized in the test procedures that are consistent with the manufacturer's published installation instructions.

5.0 QUALITY CONTROL

5.1 Quality control shall comply with Sections 8, 9, and 10 of ASTM D 5456. The TCL products shall be manufactured under an approved quality control program with inspections by an inspection agency accredited by the International Accreditation Service (IAS), or as otherwise acceptable to ICC-ES.

5.2 A quality control manual complying with the ICC-ES Acceptance Criteria for Quality Control Manuals (AC10) shall be submitted.

6.0 EVALUATION REPORT RECOGNITION

6.1 General: In the case were the evaluation report is limited to reporting the allowable design properties, a

statement shall be included in the report that requires calculations establishing the ability of the product to resist the code-prescribed loads for the specific application to be submitted along with the permit application. The calculations shall be prepared by an individual who is competent and qualified in the application of the structural design principles involved, and who possesses a registration or license in accordance with appropriate professional registration laws.

6.2 Deck Boards: If the evaluation report specifies a maximum allowable deck board span, the value shall be reported as described in Item 6.2.1 of this report.

6.2.1 Maximum Span: The report shall contain a maximum center-to-center spacing (inches or mm) of the joists and the allowable load capacity (lbf/ft² or kPa). In addition, the report shall identify the maximum loading and the span condition (i.e., single span, two-span, three or more spans) that was utilized in determining this value. The maximum span shall be determined by the most restrictive of following:

a. The determination of the maximum span shall limit the deflection to $L/180$ of the support center-to-center spacing. The report shall specify the number of minimum spans used for determining the deflection.

b. The maximum span shall be the span at which deck plank can support the associated load without showing signs of failure.

In the case were the applicant requests that the information in the report be limited to the allowable design properties, a statement shall be included in the report that requires calculations to be submitted along with the permit application, the calculations to be prepared by an individual who shall be competent and qualified in the application of the structural design principles involved, and who possesses a registration or license in accordance with appropriate professional registration laws.

6.2.2 Spacing: The report shall contain the maximum allowable end and edge spacing required to allow the thermal expansion of the product as installed.

6.3 Stair Treads: The evaluation report shall specify the maximum span based on the most restrictive of the following criteria:

a. The maximum deflection of $1/8$ inch (3.2 mm), as calculated utilizing the allowable stiffness values determined in Section 3.0 of this acceptance criteria and the code-prescribed concentrated load.

b. The maximum span that can support the code-prescribed load as determined by the allowable strength values determined in Section 3.0 of this acceptance criteria.

6.4 Guardrails: The report shall describe the maximum on-center spacing of posts. The span shall be the lesser of:

a. The maximum span at which the top rail has the ability to resist the code-prescribed loads, utilizing the allowable design values determined in Section 3.0 of this acceptance criteria.

b. The maximum span at which the post and its attachment are satisfactory to resist the tributary load resulting from the application of the code-prescribed load, utilizing the allowable design values determined in Section 3.0 of this acceptance criteria.

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Balusters included in the evaluation report shall have been determined to resist the code-prescribed loads, utilizing the allowable design values determined in Section 3.0 of this acceptance criteria.

6.5 Fasteners: The report shall contain specific descriptions of fastener size, spacing, and type(s) utilized in the submitted testing. In addition, the report shall state the

maximum allowable loads or spans that can be resisted. These shall include maximum wind uplift of the deck plank, attachment of the rails to the post and attachment of the guardrail post to the support structure. These values shall be determined by the allowable design values as determined in accordance with Section 3.0 of this acceptance criteria. ■