



ACCEPTANCE CRITERIA FOR FIBER-REINFORCED POLYMER (FRP) COMPOSITE COLUMNS USED AS AXIAL LOAD-BEARING AND NONLOAD-BEARING ARCHITECTURAL AND DECORATIVE COLUMNS

AC265

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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.

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1.0 INTRODUCTION

1.1 Purpose: The purpose of this criteria is to establish requirements for fiber-reinforced polymer (FRP) composite columns used as axial load-bearing and nonload-bearing architectural and decorative columns to be recognized in an ICC Evaluation Service, Inc. (ICC-ES), evaluation report under the 2003 *International Building Code*[®] (IBC) and the 2003 *International Residential Code*[®] (IRC). Bases of recognition are IBC Section 104.11 and IRC Section R104.11. Applicable code sections are IBC Sections 602.3 (Construction Classification—Type III), 602.4 (Construction Classification—Type IV), 602.5 (Construction Classification—Type V), 803 (Wall and Ceiling Finishes), Chapter 16 (Structural Design), and Chapter 17 (Structural Tests and Special Inspections); and IRC Sections R301 (Design Criteria) and R315 (Flame Spread and Smoke Density).

1.2 Scope: Fiber-reinforced polymer (FRP) composite columns, axial load-bearing and nonload-bearing architectural and decorative columns. Load-bearing columns shall be used on buildings of Type V-B construction to resist gravity axial loads only and shall not be used to resist wind or earthquake loads. Nonload-bearing columns shall be used on buildings of Type III, IV and V construction, non-fire-resistance-rated. The columns shall not be used to resist uplift loads or as a component of a braced frame or lateral load resistance system.

1.3 Codes and Reference Standards: Where standards are referenced in this criteria, these standards shall be applied consistently with the code upon which compliance is based.

1.3.1 Codes:

1.3.1.1 2003 *International Building Code*[®] (IBC), International Code Council.

1.3.1.2 2003 *International Residential Code*[®] (IRC), International Code Council.

1.3.2 ASTM International:

1.3.2.1 ASTM B 117-03, Standard Practice for Operating Salt Spray (Fog) Apparatus.

1.3.2.2 ASTM C 67-03a, Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.

1.3.2.3 ASTM C 672/C 672M-03, Standard Test Method for Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals.

1.3.2.4 ASTM D 790-03, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

1.3.2.5 ASTM E 84-01, Standard Test Method for Surface Burning Characteristics of Building Materials.

1.3.2.6 ASTM G 153-00a^{e1}, Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials.

1.3.2.7 ASTM G 154-00a^{e1}, Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.

1.3.2.8 ASTM G 155-00a^{e1}, Standard Practice for Operating Xenon Arc Light Apparatus for Exposure on Non-Metallic Materials.

1.4 Definitions:

1.4.1 Fiber-reinforced Polymer (FRP) Composite Columns: Round and square, hollow, spuncast, fiber-reinforced polymer (FRP), composite columns with nominal diameters, tapered toward the top with variable wall thickness. The round columns may be produced with plain and fluted surfaces, and non-tapered. Square columns may be either tapered or non-tapered. The columns are supplied with or without caps and bases. The FRP composite material is a proprietary mixture of thermoset resin, chopped fiberglass strands and an inorganic filler substance used to provide fire resistance.

2.0 BASIC INFORMATION

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, fastener materials, and installation manual.

2.1.3 Packaging and Identification: A description of the method of packaging and field identification of the panel. Identification provisions shall include the evaluation report number and the name or logo of the inspection agency.

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 Procedure for Evaluation Reports.

2.3 Test Reports: Test reports shall comply with AC85.

2.4 Product Sampling: Products shall be sampled in accordance with Section 3.1 of AC85.

3.0 TEST AND PERFORMANCE REQUIREMENTS

3.1 Surface-burning Characteristics: The fiber-reinforced polymer (FRP) composite columns shall be tested for surface burning characteristics to document flame-spread index and smoke-developed index. The test methods are noted in Section 4.1 of this acceptance criteria.

3.2 Structural: The FRP composite columns shall be load tested to determine allowable axial gravity load capacity. The test methods are noted in Section 4.2 of this acceptance criteria.

3.3 Durability: The column material shall be tested for durability, accelerated weathering, freeze-thaw resistance, salt spray exposure and resistance to deicing chemicals. The test methods are noted in Section 4.3 of this acceptance criteria.

4.0 TEST METHODS

4.1 Surface-burning Characteristics: Surface-burning characteristics of the FRP composite columns shall be

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determined by testing in accordance with ASTM E 84. Testing shall be performed on sheets of the maximum and minimum wall thickness.

Conditions of Acceptance: The flame-spread index (FSI) and smoke-developed index (SDI) shall be listed for the product and the product shall be rated as either a Class A, B or C interior finish material as defined in Section 803.1 of the IBC. When the product is limited to exterior use, the FSI shall be not greater than 200 and the SDI shall not be restricted.

4.2 Structural:

4.2.1 Axial Loadings: Compression load testing of the product shall be performed using the test method described in Annex A of this criteria. The columns may be tested in a horizontal or vertical position. The columns shall be load-tested with no lateral support between the columns' top and bottom load-bearing supports. Load testing shall be performed for each column cross-section size, round and square for shortest, middle and longest column length, with a minimum of three specimens for each cross-section size and each length. The maximum length column shall be tested. The allowable load for column lengths not tested shall be based on the next longer column tested. The columns shall be subjected to eccentric load testing using a minimum eccentricity for documenting allowable concentric loadings. The minimum eccentricity shall be $\frac{1}{6}$ the column diameter and shall be measured from the centerline of the top of the column. The columns shall also be tested for a maximum eccentricity as determined by the applicant, and the maximum allowable load shall be reported in the evaluation report for this eccentricity.

Conditions of Acceptance: The columns shall be loaded to failure, with the allowable load established as the lowest failure load divided by a factor of 5.0. A load table shall be developed using the allowable loads, length and size of column. A sample load table is shown at the end of this acceptance criteria.

4.2.2 Load Duration (Creep Effects): Columns shall be load tested to document a load duration of 60 days. The load testing shall be performed using three identical samples using the smallest diameter and longest column size tested under Section 4.2.1. Compression load testing of the product shall be performed using the test method described in Annex A of this criteria. The columns shall be loaded to two times the allowable load capacity of the columns and the load shall be maintained for a period of 60 days. The bearing surfaces of the columns shall be inspected prior to load testing. The load shall be removed after the 60-day duration and bearing surfaces of the columns shall be inspected for damage. Deformations shall be recorded to document change in column length.

Conditions of Acceptance: The columns shall sustain the test load for the duration of the test without failure. Bearing surfaces shall have no visible damage after load testing.

4.3 Durability: The column material shall be tested under the following procedures:

4.3.1 Accelerated Weathering: A minimum of five samples, using the minimum thickness produced, shall be tested for a minimum of 2000 hours of exposure in

accordance with Section 4.3.1.1, 4.3.1.2 or 4.3.1.3. Weathered samples and a minimum of five control samples at minimum thickness shall be subjected to flexural loading in accordance with D 790.

4.3.1.1 Tests shall be in accordance with ASTM G 153. The operating schedule shall be Cycle 1 set forth in Table X1.1 of ASTM G 153.

4.3.1.2 Tests shall be in accordance with ASTM G 154. The operating schedule shall be Cycle 1 set forth in Table X2.1 of ASTM G 154.

4.3.1.3 Tests shall be in accordance with ASTM G 155. The operating schedule shall be either Cycle 1, 5, or 9 as set forth in Table X3.1 of ASTM G 155.

Conditions of Acceptance: The average flexural strength of the weathered samples shall be at least 90 percent of the average flexural strength of the control samples tested.

4.3.2 Freeze-thaw Resistance: A minimum of five samples, using the minimum thickness produced, shall be tested in accordance with Section 8 of ASTM C 67.

Conditions of Acceptance: The samples shall show no breakage and shall not have more than 1 percent loss in dry weight of any sample.

4.3.3 Salt Spray Exposure: A minimum of five samples, 4 inches by 6 inches (102 mm by 142 mm), using the minimum thickness produced, shall be tested in accordance with ASTM B 117. The test period is 300 hours.

Conditions of Acceptance: The test samples shall have no deleterious effects.

4.3.4 Resistance to Deicing Chemicals: A minimum of five samples, using the minimum thickness produced, shall be tested in accordance with Section 9 of ASTM C 672, 50 cycles. A minimum of five control samples at minimum thickness are compared to exposed samples.

Conditions of Acceptance: The exposed samples shall be visually rated as either no scaling or very slight scaling [$\frac{1}{8}$ inch (3 mm) depth, maximum] and shall be compared to control samples.

5.0 QUALITY CONTROL

5.1 The products shall be manufactured under an approved quality control program with inspections by an inspection agency accredited by the International Accreditation Service (IAS) or 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

The following are conditions of use for fiber-reinforced polymer (FRP) composite columns covered by this acceptance criteria:

6.1 Structural design calculations shall be submitted to the code official when a permit is applied for. The calculations shall be signed, sealed and dated by a registered design professional when required by the statutes of the jurisdiction in which the project is to be constructed.

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6.2 Columns installed on the interior shall be listed for use as interior finish and shall be labeled with either a Class A, B or C classification by an accredited third-party inspection agency.

6.3 Design loads on the columns shall be determined in accordance with Chapter 16 of the code and shall not exceed the allowable loads shown in Table(s). [see example of table, below].

6.4 The columns shall not be used to resist uplift or lateral loads resulting from seismic or wind applications.

6.5 Details of top and bottom connections shall be provided in the evaluation report.

6.6 The load-bearing columns shall only be used on buildings of Type V-B construction. Nonload-bearing columns shall only be used on buildings of Type III, IV and V construction, non-fire-resistance-rated. ■

**[EXAMPLE]
TABLE [#]
ALLOWABLE LOADS
COLUMNS**

COLUMN TYPE AND NOMINAL SIZE (in)	WALL THICKNESS (in)		MAXIMUM LENGTH (ft-in)	ALLOWABLE LOAD (lbs) MINIMUM ECCENTRICITY	ECCENTRIC LOADINGS	
	Bottom	Top			Maximum "e" (in)	Allowable Load (lbs)

Table 1 Notes:

1. SI Units conversion: 1 in. = 25.4 mm, 1 ft = 0.3 m, 1 lbf = 4.5 N.
2. Round columns include plain and fluted.
3. **Maximum "e" (in)** is eccentricity measured in inches from the center line of the top of the column.

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ANNEX A

COMPRESSION TEST PROCEDURE

A1.0 SCOPE

Eccentric loads are applied to the columns in a specialized steel test frame capable of producing a maximum axial load of 200,000 pounds (900 000 N). The loads shall be applied via a hydraulic pump and hydraulic ram, or equivalent load-producing system. The applied load shall be measured using a calibrated test gauge and/or the combination of a load cell and a digital weight indicator, or equivalent load-measuring system.

A2.0 TERMINOLOGY

A2.1 Definitions of terms specific to this procedure:

A2.1.1 Eccentric Loading: The loading condition upon a structural column such that the base of the column is flush against the end plate of the load frame while the top of the column is loaded to simulate a roof truss resting over the top of the column at some specified offset distance.

A2.1.2 Failure: The point at which the column is no longer capable of carrying increased loads or when significant physical damage to the column occurs.

Note 1: The highest load maintained for 1 minute shall be recorded as the ultimate load. If the column does not fail before reaching capacity of the load frame, the report will reflect the maximum load achieved.

A3.0 SUMMARY OF TEST PROCEDURE

This test procedure consists of loading a column into a compression load frame, using a load-producing system, such as a hydraulic pump and hydraulic ram, to apply an axial load at specified load increments, and holding each incremental load for a period of time until failure occurs.

A4.0 TEST PROCEDURE—GENERAL

A4.1 Unwrap the column from any and all packing material.

A4.2 Inspect column for damage or any unusual conditions.

A4.3 Unless otherwise specified, orient the column on the floor in front of the load frame so that the base of the column is in front of the movable crosshead of the load frame.

A4.4 Place a permanent mark to label the top and the base of the column.

A4.5 Photograph the top and the base of the column.

A4.6 Measure the column length, size, and wall thickness at the top and the base and record the thicknesses on a data sheet. The wall thickness at the top and base shall be determined as the average of three equally spaced measurements around the diameter of round columns, or four measurements for square columns where one measurement is obtained at the center of each face.

Note 2: For a round column, three thickness measurements shall be recorded. The measurements shall be taken at equal spaces around the perimeter of the column end. For a square column, four thickness measurements shall be recorded, one on each side.

A5.0 TEST PROCEDURE—ECCENTRIC LOADING

A5.1 Position the column in the load frame and support the column such that the geometric center of the base and the top is in the center of the end plates. Place a spacer of specified size in between the top of the column and the top end plate at a designated offset distance.

A5.2 Permanently mark the column identification on the shaft of the column.

A5.3 Photograph the column in the load frame, making sure that the column identification is visible.

A5.4 Check the connections of all equipment and measuring devices and zero the load-indicating system.

A5.5 Unless otherwise specified, load the column to one-half the rated load and hold the load for a period of not less than 1 minute.

A5.6 After the first load time period has expired, increase the load in 1000-pound (4500 N) increments until failure occurs. Each increment shall be held for not less than one minute.

A5.7 Record the ultimate load [truncated to next lowest 1000-pound (4500 N) increment] and the failure mode on the data sheet.

A5.8 Photograph the failure mode of the column.

Note 4: In the instance where the rated load of the column is not specified or unknown, the initial load shall be 5000 pounds (22 500 N). The load shall then be increased in 1000-pound (4500 N) increments until failure occurs. Each increment, as described above, shall be maintained for not less than 1-minute.