



**ICC Evaluation Service, Inc.**  
**www.icc-es.org**

**Business/Regional Office** ■ 5360 Workman Mill Road, Whittier, California 90601 ■ (562) 699-0543  
**Regional Office** ■ 900 Montclair Road, Suite A, Birmingham, Alabama 35213 ■ (205) 599-9800  
**Regional Office** ■ 4051 West Flossmoor Road, Country Club Hills, Illinois 60478 ■ (708) 799-2305

### Legacy report on the 1997 *Uniform Building Code*™ and the 2000 *International Building Code*®

#### **DIVISION: 03—CONCRETE**

#### **Section: 03930—Concrete Rehabilitation**

#### **CONCRETE STRENGTHENING USING THE FIBERBOND™ FIBER-REINFORCING POLYMER LAMINATE**

**EDGE STRUCTURAL COMPOSITES, LLC**  
**21881 EAST 8<sup>TH</sup> STREET**  
**SONOMA, CALIFORNIA 95476**

#### **1.0 SUBJECT**

FiberBond™ Fiber-reinforced Polymer Laminate System.

#### **2.0 DESCRIPTION**

##### **2.1 General:**

The FiberBond™ Fiber-reinforced Polymer Laminate System, referred to as the FiberBond™ System, is comprised of high-strength fibers and a polymer matrix. The system is used to strengthen normal-weight concrete structural elements as an alternative to those systems covered in the 1997 *Uniform Building Code*™ (UBC) and the 2000 *International Building Code*® (IBC).

##### **2.2 Materials:**

**2.2.1 Velacarb 335 Fabric Sheets:** The Velacarb 335 fabric sheets consist of fabric sheets made from carbon fibers which are used to resist tensile stresses. Material properties are as follows:

- 650,000 psi (4,478 MPa) ultimate tensile strength
- 34,000,000 psi (34 GPa) tensile modulus of elasticity; 1.9% elongation

Standard rolls of fabric are available in widths of 6, 12, 24 and 48 inches (152, 305, 610 and 1220 mm) and in lengths up to 100 yards (91.4 m); the rolls of fabric are shipped in boxes.

**2.2.2 Polymer Matrix:** FiberBond™ Veloxx is a two-component, 100 percent solids, two-phase epoxy matrix used for impregnating the dry fabric sheets and binding the fibers together for the transfer of stresses. Veloxx epoxy matrix is an ambient cure epoxy and is solvent-free.

Components A and B of the matrix are shipped in 1-, 5- or 55-gallon (3.79, 18.9 or 208.18 L) containers, and are mixed at the jobsite prior to application.

**2.2.3 FiberBond™ Composite Laminates:** The composite laminate consisting of materials described in Sections 2.2.1 and 2.2.2 has the following properties: In the primary (0°

direction, the laminate has a minimum ultimate tensile strength of 140 ksi (965 MPa), a minimum tensile modulus of 9.6 Msi (66.5 GPa), and an elongation of 1.4 percent. The layer thickness is 0.023 inch (0.58 mm).

**2.2.4 Storage Recommendations:** The materials must be stored in a clean, dry area with an ambient temperature between 40°F (4.4°C) and 90°F (32.2°C). When properly stored under these conditions, the products have an unlimited shelf life.

##### **2.3 Design:**

Design of the composite laminate is based on ultimate strength design (USD) in accordance with Chapter 19 of the UBC or the IBC. The owner and design engineer (UBC) or the registered design professional (IBC) are responsible for determining, through analysis, the strengths and demands of the structural elements to be enhanced by FiberBond™ system.

**2.3.1 Design Details:** Design of the FiberBond™ System is based on test results and principles of structural analysis. The basis of design includes strain compatibility and limit states. All designs follow procedures as detailed in the FiberBond™ System Design Criteria Report (Design Manual), dated July 3, 2003. A copy of the Design Manual must be submitted to the building official for approval of each project that uses the FiberBond™ system.

**2.3.2 Factors of Safety:** Strength reduction factors shall comply with Chapter 19 of the UBC or the IBC, as applicable.

##### **2.3.3 Columns:**

**2.3.3.1 Potential Applications:** Concrete circular columns can be strengthened to enhance ductility, and axial and shear strength. The FiberBond™ System can be utilized to improve the confinement of circular concrete columns.

**2.3.3.2 Structural Design Requirements:** Concrete circular column design shall comply with the Design Manual and with Sections 1907, 1909, 1910, 1911, 1912 and 1921 of the UBC, or Sections 1901, 1907, 1908 and 1910 of the IBC, as applicable.

##### **2.3.4 Beams and Slabs:**

**2.3.4.1 Potential Applications:** Concrete beams and slabs can be strengthened to enhance flexural strength for gravity loads only.

**2.3.4.2 Structural Design Requirements:** Concrete beam and slab design shall comply with the Design Manual and with Sections 1907, 1909, 1910, 1911, 1912 and 1921 of the UBC, or Sections 1901, 1907, 1908 and 1910 of the IBC, as applicable.

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## 2.4 Installation:

The FiberBond™ System is installed on structural elements as detailed in the manufacturer's document *Edge Structural Composites Installation Guide*, dated July 3, 2003; a copy of this document is included in Section 2, Appendix A of the *Edge Structural Composites Quality Control Manual (QCM)*, Issue 1, Revision 4, dated July 3, 2003. A copy of the QCM shall be submitted to the building official for approval of each project that uses the FiberBond™ system. The on-site quality control procedures are detailed in Section 2 of the QCM. Installation shall be performed by applicators certified by the manufacturer in accordance with the QCM.

**2.4.1 Saturation:** The fabric and resin matrix of the laminate are combined according to a volume or weight ratio as defined in the QCM. Saturation may be either by hand or a mechanical saturator.

**2.4.2 Application:** Hand methods are used to apply the saturated laminate to concrete members prior to cure of the epoxy. Surface preparation methods, fiber orientation, and removal of air bubbles and voids are conducted according to specifications described in the installation guide.

**2.4.3 Finishing:** The composite laminate is typically painted to satisfy aesthetic and environmental considerations.

**2.4.4 Flame Spread:** When applied to structural elements to satisfy requirements of the applicable code, the FiberBond™ System (without any finishing described in Section 2.4.3) yields a Class 1 and Class A flame-spread classification and smoke-density requirement in accordance with Section 802.2 of the UBC and Section 803.1 of the IBC, respectively. The composite is limited to a maximum of four layers; the thickness of each layer is 0.023 inch (0.58 mm).

## 2.5 Special Inspection:

Special inspection during the installation of the system shall be in accordance with the ICC-ES Acceptance Criteria for Inspection and Verification of Concrete and Unreinforced Masonry Strengthening Using Fiber-reinforced Polymer (FRP) Composite Systems (AC178), dated June 2003. Inspection shall also comply with Section 1701 of the UBC or Section 1704 of the IBC, and with Section 2 of the QCM.

## 2.6 Identification:

Components of the FiberBond™ system are labeled with the Edge Structural Composites, LLC, name and address; the product name; the expiration date; the evaluation report

number (ER-5836); and the name of the inspection agency (Testing Engineers, Inc.).

## 3.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Concrete and Reinforced and Unreinforced Masonry Strengthening Using Fiber-reinforced, Composite Systems (AC125), dated June 2003; and a quality control manual.

## 4.0 FINDINGS

**That the FiberBond™ Polymer Laminate System described in this report complies with the 1997 Uniform Building Code™ (UBC) and the 2000 International Building Code® (IBC), subject to the following conditions:**

- 4.1 Design and installation are in accordance with this report, the manufacturer's instructions, and the UBC or the IBC.**
- 4.2 Copies of the Edge Structural Composites Quality Control Manual, Issue 1, Revision 4, dated July 3, 2003, and the Design Manual, dated July 3, 2003, are submitted to the building official for approval on each project that uses the system.**
- 4.3 Fire-resistance of the assembly must comply with Chapter 7 of the UBC or the IBC, and is not reduced by the application of the FiberBond™ system. Fire-resistance of assemblies with structural load-carrying capacities increased beyond the UBC or the IBC permitted levels by the FiberBond™ system is beyond the scope of this report.**
- 4.4 Special inspection is provided in accordance with Section 2.5 of this report.**
- 4.5 Concrete members are fabricated by an approved fabricator complying with Section 1701.7 of the UBC or Section 1704.2.2 of the IBC; or are fabricated with continuous special inspection in accordance with Sections 1701.5.1 and 1701.5.3 of the UBC or Section 1704.4 of the IBC.**
- 4.6 FiberBond™ materials are manufactured by Edge Structural Composites, LLC, in Point Richmond, California, under a quality control program with inspections by Testing Engineers, Inc. (AA-532).**

**This report is subject to re-examination in one year.**