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Specification for Carbon Fiber-Reinforced Polymer Bar Material for Concrete Reinforcement

Reported by ACI Committee 440

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Specification for Carbon and Glass Fiber-Reinforced Polymer Bar Materials for Concrete Reinforcement

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American Concrete Institute
38800 Country Club Drive
Farmington Hills, MI 48331
Phone: +1.248.848.3700
Fax: +1.248.848.3701

www.concrete.org

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Specification for Carbon Fiber-Reinforced Polymer Bar Material for Concrete Reinforcement

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Reported by ACI Committee 440

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*Contributing authors.
†Task group Chair.
The committee also thanks Nick Carino, Bernard Drouin, Jack Lesko, and Ralph Parretti for their contributions.

This Material Specification covers provisions governing testing, evaluation, and acceptance of carbon fiber-reinforced polymer (FRP) bars used as reinforcement for concrete.

Keywords: carbon fiber; concrete; concrete construction; FRP reinforced concrete; fiber-reinforced polymer reinforcement; specification.

CONTENTS

ACI SPEC-440.6-08 was adopted May 19, 2008, and published June 2008.

SECTION 1—SCOPE

1.1 This specification describes permitted constituent materials, limits on constituent volumes, and minimum performance requirements for carbon fiber-reinforced polymer (FRP) bars to be used as reinforcement for nonprestressed concrete.

1.2 Only carbon FRP bars are covered by this specification.

1.3 FRP bars made of more than one fiber type (hybrid FRP) are not covered by this specification.

1.4 Pultruded FRP bars with no external surface enhancement (that is, plain or smooth bars) to facilitate bond with concrete are not covered by this specification. Similarly, hollow FRP bars are not considered due to lack of documented performance as reinforcement for concrete.

1.5 Plain FRP bars used as dowels (that is, devices that transfer shear across concrete joints) where the intended function requires slip of the dowel are not covered by this specification.

1.6 This specification does not cover premanufactured grids and gratings made with FRP materials. FRP mats resulting from assembly of deformed FRP bars, however, are covered by this document.

1.7 This specification does not cover FRP bars when used for external and near-surface-mounted strengthening applications.

1.8 The text of this specification references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the specification.

SECTION 2—REFERENCED DOCUMENTS

2.1—ASTM standards

A615/A615M-16 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

C904-01(2012) Standard Terminology Relating to Chemical-Resistant Nonmetallic Materials

D570-98(2010) Standard Test Method for Water Absorption of Plastics

D2584-11 Standard Test Method for Ignition Loss of Cured Reinforced Resins

D3171-15 Standard Test Methods for Constituent Content of Composite Materials

D4475-02(2016) Standard Test Method for Apparent Horizontal Shear Strength of Pultruded Reinforced Plastic Rods by the Short-Beam Method

D5117-17 Standard Test Method for Dye Penetration of Solid Fiberglass Reinforced Pultruded Stock

D5229/D5229M-14 Standard Test Method for Moisture Absorption Properties and Equilibrium Conditioning of Polymer Matrix Composite Materials

D7205/
D7205M-06(2016) Standard Test Method for Tensile Properties of Fiber Reinforced Polymer Matrix Composite Bars

D7617/
D7617M-11(2017) Standard Test Method for Transverse Shear Strength of Fiber-reinforced Polymer Matrix Composite Bars

D7705/
D7705M-12 Standard Test Methods for Alkali Resistance of Fiber Reinforced Polymer (FRP) Matrix Composite Bars used in Concrete Construction

D7913/
D7913M-14 Standard Test Method for Bond Strength of Fiber-Reinforced Polymer Matrix Composite Bars to Concrete by Pullout Testing

D7914/
D7914M-14 Standard Test Method for Strength of Fiber Reinforced Polymer (FRP) Bent Bars in Bend Locations

E1356-08(2014) Standard Test Methods for Assignment of the Glass Transition Temperatures by Differential Scanning Calorimetry

E1640-13(2018) Standard Test Method for Assignment of the Glass Transition Temperature by Dynamic Mechanical Analysis

2.2—ACI report

The following test method from ACI 440.3R,* "Guide Test Methods for Fiber-Reinforced Polymers (FRPs) for Reinforcing or Strengthening Concrete Structures," is referenced. Because this test method is not written in mandatory language, purchaser and manufacturer shall agree on the protocols to be used.

B.12 Test method for determining the effect of corner radius on tensile strength of FRP bars

SECTION 3—TERMINOLOGY

3.1—Definitions

For definitions of terms used in this specification, refer to ASTM C904.

3.2—Definitions of terms specific to this specification

commercial-grade material—a material formulated for and used in industrial (not consumer) applications.

production lot—any lot of FRP bar produced from start to finish with the same constituent materials used in the same proportions without changing any production parameter, such as cure temperature or line speed.

property, guaranteed—a characteristic value provided by the manufacturer no greater than the mean minus three standard deviations of at least the required number of samples tested according to a specified test method. This definition is applicable to tensile strength, shear strength (perpendicular to the bar), bond strength, and strength of bent bars.

*ACI Committee 440, 2004, "Guide Test Methods for Fiber-Reinforced Polymers (FRPs) for Reinforcing or Strengthening Concrete Structures (ACI 440.3R-04)," American Concrete Institute, Farmington Hills, MI, 40 pp.