



## *Florida Department of Transportation*

**RICK SCOTT**  
GOVERNOR

605 Suwannee Street  
Tallahassee, FL 32399-0450

**JIM BOXOLD**  
SECRETARY

### **MEMORANDUM**

**DATE:** November 24, 2015

**TO:** Specification Review Distribution List

**FROM:** Daniel Scheer, P.E., State Specifications Engineer

**SUBJECT:** Proposed Specification: **9320300 Nonmetallic Accessory Materials for Concrete Pavement and Concrete Structures.**

In accordance with Specification Development Procedures, we are sending you a copy of a proposed specification change.

The changes are proposed by Charles Boyd of the State Structures Design Office to incorporate specification language for stainless steel and FRP reinforcing and prestressing strand into the Standard Specifications.

Please share this proposal with others within your responsibility. Review comments are due within four weeks and should be sent to Mail Station 75 or online at <http://www2.dot.state.fl.us/ProgramManagement/Development/IndustryReview.aspx> . Comments received after **December 22, 2015**, may not be considered. Your input is encouraged.

DS/ot  
Attachment

**NONMETALLIC ACCESSORY MATERIALS FOR CONCRETE PAVEMENT AND CONCRETE STRUCTURES.**

(REV 11-~~61623~~-15)

The following new Article is added after SUBARTICLE 932-2.6.4:

**932-3 Fiber Reinforced Polymer (FRP) Reinforcing Bars.**

**932-3.1 General:** Use only solid round thermoset pultruded glass fiber reinforced polymer (GFRP) or carbon fiber reinforced polymer (CFRP) reinforcing bars. All FRP reinforcing bars shall meet the requirements of ACI- 440.6 following the test methods from ACI 440.3. Use only GFRP bars manufactured using glass fibers classified as E-CR or R that meet the requirements of ASTM- D578. Meet the additional requirements of this Section following the sampling frequency and number of specimens required by ACI- 440.6.

**932-3.2 Additional Requirements for Bar Size and Strength:** The nominal diameter of FRP bars shall be in ~~one-eighth~~ 1/8 -inch increments as described in Table 3-1.

The measured cross-sectional area of FRP bars, including deformations, lugs, sand coating or any bond enhancing surface treatment shall be measured according to ASTM D7205 via the Archimedes method.

The minimum bar diameter, derived from the actual cross sectional area and calculated based on a circular cross section including any surface treatment, shall be greater than or equal to ~~or greater than~~ the nominal bar diameter given in Table 3-1.

The maximum bar diameter, derived from the actual cross sectional area and calculated based on a circular cross section including any surface treatment, shall be less than or equal to the maximum bar diameter derived from the maximum cross section area given in Table 3-1.

The nominal diameter and nominal cross-sectional area of an FRP bar shall be used as the bar size designation and for reinforced concrete design calculations and minimum mechanical properties.

Table 3-1  
Size and Strength of FRP reinforcing bars

Bar Size Designation	Nominal Bar Diameter (in)	Nominal Cross Sectional Area (in <sup>2</sup> )	Maximum Cross Sectional Area (in <sup>2</sup> )	<i>f</i> <sup>*fu</sup> , Guaranteed Ultimate Tensile Strength (ksi)	
				GFRP Bars	CFRP Bars
2	1/4	0.049	0.058	125	210
3	3/8	0.110	0.132	120	190
4	1/2	0.196	0.234	110	170
5	5/8	0.307	0.367	95	160
6	3/4	0.442	0.529	92.5	160
7	7/8	0.601	0.721	90	-
8	1	0.785	0.942	85	-
9	1-1/8	0.994	1.192	82.5	-
10	1-1/4	1.227	1.472	80	-

**932-3.3 Additional Requirements for Strength of Bar Bends:** Meet the requirements of ACI 440.6, Section- 10.2, except substitute Sections- 10.2.2.1 and 10.2.2 with the following:

Extract straight portions from bent bars of sufficient length to be tested according to ASTM D7205. The tensile strength and tensile modulus of each specimen shall not be less than the guaranteed strength reported by the producer for a bar of that diameter, with minimum values as shown in Table 3-1.

When the bent shape does not allow for the tensile testing of one of its straight portions, a test specimen produced at the same time, during the same production lot, but of sufficient length to perform the required testing, may be used.

**932-3.4 General Additional Requirements:** Meet the applicable requirements of the Materials Manual and the additional requirements of Table 3-2 for qualification of producers of FRP reinforcing bars seeking approval to be placed on the Department's Production Facility Listing. Producers seeking evaluation of a product in accordance with this Specification must submit test reports conducted by an independent laboratory, qualified by an ISO- 17025 accreditation agency, using personnel with actual experience running the test methods for FRP reinforcing bars. Submit the test reports to the State Materials Office.

<i>Table 3-2 Additional Requirements for Qualification of Producers of FRP Reinforcing Bars</i>		
<i>Property</i>	<i>Test Method</i>	<i>Requirement</i>
<i>Fiber Content</i>	<i>ASTM D2584 or ASTM D3171</i>	<i>&gt;55% - volume  &gt;70% - weight</i>
<i>Moisture adsorption</i>	<i>ASTM D570</i>	<i>≤0.75% (long term immersion to full saturation) at 122°F</i>
<i>Resins Glass transition temperature (T<sub>g</sub>)</i>	<i>ASTM E1640 – DMA or ASTM E1356 - DSC</i>	<i>≥230°F  ≥212°F</i>
<i>Total enthalpy of polymerization (resin)</i>	<i>ASTM E2160</i>	<i>Report value for each resin system used</i>
<i>Minimum Mean Tensile Modulus of Elasticity</i>	<i>ASTM D7205</i>	<i>≥6,500 ksi - GFRP ≥18,000 ksi - CRFP</i>
<i>Alkali resistance without load</i>	<i>ASTM D7705</i>	<i>Tensile capacity retention ≥78% of ultimate tensile stress (UTS) after 90 days</i>
<i>Alkali resistance with load</i>	<i>ASTM D7705; set sustained tensile stress to induce tensile strain of 3000 micro-strain</i>	<i>Tensile capacity retention ≥70% of ultimate tensile stress (UTS) after 90 days</i>
<i>Strength of bent portion of a bar</i>	<i>ACI 440.3, Method B.5</i>	<i>&gt;60% of straight portion of bar</i>
<i>Transverse Shear Strength</i>	<i>ASTM D7617</i>	<i>&gt;22 ksi</i>
<i>Bond Strength</i>	<i>Block pull-out by ACI 440.3R, Method B.3</i>	<i>&gt;1.1 ksi</i>

**932-3.4.1 Certification:** Meet the testing requirements of Table 3-3 for product acceptance on the project. The Contractor shall ~~provide~~submit to the Engineer ~~with~~a certification

from the producer of the FRP bars, confirming that the requirements of this Section are met. The certification shall conform to the requirements of Section -6. Submit one certification per LOT of FRP reinforcing bars. The Contractor shall ensure that the test results meet the requirements of Table 3-3 using an independent ISO- 17025 accredited laboratory with actual experience running the test methods for FRP reinforcing bars.

**932-3.4.2 Sampling:** A minimum of six samples of reinforcing bars per LOT will be selected by the Engineer. The minimum sample length is seven feet. A LOT will be sampled only after the entire LOT is delivered to the project site or in an offsite storage facility. Furnish additional bar footage to account for samples selected for testing. FRP reinforcing bars shall be available for sampling a minimum of three weeks prior to their installation.

<i>Table 3-3 Additional Requirements for FRP Reinforcing Bar Product Acceptance on the Project</i>		
<i>Property</i>	<i>Test Method</i>	<i>Requirement</i>
<i>Degree of cure</i>	<i>ASTM E2160</i>	<i>≥95% of total polymerization enthalpy</i>
<i>Fiber content</i>	<i>GFRP – ASTM D2584 or ASTM D3171 CFRP - ASTM D3171</i>	<i>GFRP - Glass fiber weight fraction ≥70% when ASTM D2584 is used GFRP &amp; CFRP - Volume fraction ≥55%</i>
<i>Void content</i>	<i>ASTM D2734</i>	<i>≤1%</i>
<i>Moisture absorption</i>	<i>ASTM D570</i>	<i>≤0.25% in 24 hours at 122°F</i>
<i>Bar Size - Actual Cross Sectional Area</i>	<i>ASTM D7205</i>	<i>See Table 3-1</i>
<i>Minimum &amp; Maximum Bar Diameter</i>	<i>Calculated from Actual Cross Sectional Area</i>	<i>See Table 3-1</i>
<i>Guaranteed Ultimate Tensile Strength (<math>f_{tu}^*</math>)</i>	<i>ASTM D7205</i>	<i>See Table 3-1</i>
<i>Minimum Mean Tensile Modulus of Elasticity</i>	<i>ASTM D7205</i>	<i>≥6,500 ksi GFRP ≥18,000 ksi CFRP</i>

**932-4 FRP Spirals for Concrete Piling.**

Spirals for reinforcing in concrete piling shall be CFRP conforming to the requirements of ACI 440.6, following the test methods from ACI 440.3 and the material requirements of 932-3.