

MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
ALTERNATE REINFORCEMENT FOR CONCRETE CURB AND GUTTER

STR:BMW

1 of 3

APPR:JAB:CRB:11-16-23
FHWA:APPR:11-21-23

a. Description. This work consists of the use of glass fiber reinforced polymer (GFRP) or basalt fiber reinforced polymer (BFRP) reinforcement in accordance with section 802 of the Standard Specifications for Construction, and as modified on the plans and this special provision. GFRP or BFRP number 3 size reinforcement are acceptable alternatives to epoxy coated number 4 size conventional steel reinforcement shown on Standard Plans R-27 Series, R-30 Series, R-31 Series, and R-33 Series. Do not use GFRP or BFRP for lane ties, or any other transverse reinforcement.

b. Materials. Furnish materials in accordance with subsection 802.02 of the Standard Specifications for Construction except as modified by this special provision. Furnish GFRP or BFRP reinforcement that meet the following material specifications and requirements. Furnish GFRP or BFRP reinforcement in accordance with the details shown on the plans. Do not mix reinforcement types.

1. **Fibers.** Use fibers in the form of unidirectional rovings of given size and weight with fiber sizing and coupling agents that are compatible with the resin system used to impregnate them. The GFRP reinforcement must contain 70 percent, minimum, by weight of glass fiber in accordance with *ASTM D7957/D7957M, Standard Specification for Solid Round Glass Fiber Reinforced Polymer Bars for Concrete Reinforcement*. The BFRP reinforcement must contain 70 percent, minimum, by weight of basalt fiber in accordance with *ASTM D2584, Standard Test Method for Ignition Loss of Cured Reinforced Resins*.

2. **Resin Matrix.** Use commercial grades of epoxy, polyurethanes, or vinyl ester resins. Thermo-set resin systems or their blending are permitted. Ensure the base polymer in the resin system does not contain any polyester. Blending of vinyl ester and epoxy resins is permitted. Ensure the glass transition temperature (T_g) of the resin is not less than 212 °F in accordance with the Differential Scanning Calorimetry (DSC) method described in *ASTM E1356, Standard Test Method for Assignment of the Glass Transition Temperatures by Differential Scanning Calorimetry*.

3. **Fillers.** Inorganic fillers and secondary fibers may be used, but their quantity must not exceed 20 percent by weight of the base polymer resin specified. Commercial grade additives and process aids such as release agents, low profile shrink additives, initiators, promoters, hardeners, catalysts, pigments, fire-retardants, and ultraviolet inhibitors are permitted and depend on the process method. If used, limit shrink additives to less than 20 percent by weight of the polymer resin.

4. **Mechanical Properties.** Furnish GFRP or BFRP bars with the following minimum requirements:

A. Tensile Strength. The minimum tensile resistance required for #3 GFRP or BFRP reinforcement is 140 ksi. Test in accordance with *ASTM D7205/D7205M, Standard Test Method for Tensile Properties of Fiber Reinforced Polymer Matrix Composite Bars*.

B. Tensile Modulus. Ensure the nominal tensile modulus of elasticity averages not less than 6,000 ksi in accordance with *ASTM D7205/D7205M*.

C. Transverse Shear. Ensure the minimum transverse shear strength is not less than 20 ksi, as tested in accordance with *ASTM D7617/D7617M, Standard Test Method for Transverse Shear Strength of Fiber-Reinforced Polymer Matrix Composite Bars*.

D. Moisture Absorption. Test moisture absorption in accordance with *ASTM D570, Standard Test Method for Water Absorption of Plastic*. The maximum value for this test must follow ACI recommendations and be less than 1.0 percent.

E. Bond Strength. The bond strength for all bars must follow ACI recommendations of *ACI 440.6-08*, and be at least 1.4 ksi. The manufacturer must report the test method used for testing bond strength. Follow *ACI 440.3R test method B3* or a method approved by the Engineer.

F. Ultimate Tensile Strain. Ensure the ultimate tensile strain is at least 1.1 percent.

G. Provide GFRP as manufactured by:

(1) Neuvokas Corp., *GatorBar*, 3206 Number 6 Road, PO Box 220, Ahmeek, MI 49901, Phone: (906) 934-2661.

(2) Owens Corning Infrastructure Solutions, LLC, *PinkBar*, 123 S 9th Street, Seward, NE, 68434. Phone: (402) 202-5379.

(3) Pultrall V-Rod 60, 700, 9e Rue Nord, Thetford Mines (Quebec) CANADA G6G 6Z5. Phone: (418) 335-3202.

(4) Approved equal.

H. Provide BFRP as manufactured by:

(1) Neuvokas Corp., *GatorBar*, 3206 Number 6 Road, PO Box 220, Ahmeek, MI 49901, Phone: (906) 934-2661.

(2) Raw Energy Materials Corp., *RockRebar* 2681 N.E. 4th Avenue, Pompano Beach, FL 33064, Phone: 954-803-9206, Alt: 954-270-9000.

(3) Approved equal.

c. Acceptance. Furnish the Engineer a General Certification per the *MQAP Manual* from the GFRP or BFRP reinforcement manufacturer stating the materials furnished meet the specifications as described herein.

d. Construction. Construct the concrete curb and gutter in accordance with the standard specifications, except as modified by the details on the plans and this special provision. Ensure

GFRP or BFRP reinforcement bars are uniform in diameter/size and free of defects. Defects include exposed fibers, cracks, kinks, and surface pitting. Slight discoloration is not cause for rejection.

1. **Field Fabrication.** Furnish GFRP or BFRP reinforcement in accordance with the details shown on the plans. Field fabrication of GFRP or BFRP reinforcement is prohibited, except for tying and cutting, and gradual bending in accordance with manufacturer's recommendations. The minimum bending radius for GFRP or BFRP reinforcement is two feet and must utilize the necessary tying and stabilization methods to ensure the GFRP or BFRP remains in the proper position before and during concrete placement. Field cut GFRP or BFRP reinforcement using a high speed grinding cutter, fine blade saw, diamond blade, or masonry blade. Ensure all surface damage due to cutting is repaired or replaced as directed by the Engineer, at no additional cost to the contract.

2. **Handling.** Ensure GFRP bars are handled and transported as to not damage or fracture the bars. Cracked or damaged GFRP bars are not to be used. BFRP bars can be handled similar to their steel counterparts. Minor scratches and chipping that do not impact performance may be permitted with approval of the Engineer.

3. **Storage of GFRP or BFRP Reinforcement.** Store reinforcement above the surface of the ground on platforms, skids, pallets, or other supports. Cover the GFRP or BFRP bars with a tarp or other protective cover if it is anticipated that the GFRP or BFRP bars will be stored outdoors for more than 2 months. Protective cover must eliminate exposure to UV light.

4. **Placing and Fastening.** Place all reinforcement within the tolerances recommended in the *CRSI "Manual of Standard Practice"* unless otherwise specified in the contract. Secure reinforcement firmly with mechanical fasteners during the placing and setting of the concrete. Suspend concrete placement and take corrective action if it is observed that the GFRP or BFRP reinforcement is not adequately supported or tied to resist settlement, floating upward, or movement in any direction during concrete placement.

5. **Ties and Supports.** Ensure all accessories for use with the GFRP or BFRP bars such as tie wires, bar chairs, supports or clips are either plastic coated steel or plastic. Place all reinforcement in locations as shown on the plans and securely hold in position while placing and consolidating concrete. Fasten bars together with ties at all intersections.

6. **Lap Splices.** Lap splices are the only approved method to tie bars together to make a continuous bar. Mechanical splices are prohibited. Ensure lap length and spacing is as specified in the contract. Provide the same cover clearances for splices that is shown or specified for the reinforcement.

e. Measurement and Payment. If the Contractor elects to provide BFRP or GFRP reinforcement as a substitute for epoxy coated reinforcement, this will be done with the understanding that the pay items in the original contract will not be changed, and the BFRP or GFRP will be provided in accordance with this special provision under the original pay items at the bid prices submitted.