MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
CONCRETE CURB, AND GUTTER, WITH __ FIBER REINFORCED POLYMER, DETAIL __

STR:MJC 1 of 4 APPR:JAB:JFS:02-19-21
FHWA:APPR:03-05-21

a. Description. This work consists of constructing concrete curb, gutter, and dividers, using 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. At the Contractors option the number 3 size GFRP or BFRP may be substituted for longitudinal epoxy coated number 4 conventional steel reinforcement shown on Standard Plans R-27 Series, R-30 Series, R-31 Series, and R-33 Series. Do not use GRFP or BFRP for lane ties, or any other transverse reinforcement.

b. Materials. Provide 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. Provide 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 D258, 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 (Tg) of the resin is not less than 212 degrees Fahrenheit 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 strength of #3 GFRP or BFRP reinforcement is 140 kips per square inch (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 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 of 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*, 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, Ph. (906) 934-2661.

(2) Owens Corning Infrastructure Solutions, LLC, PinkBar, 123 S 9th street, Seward, NE, 68434. Ph. (402) 202-5379.

(3) Approved equal.

H. Provide BFRP as manufactured by:

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

(2) Raw Energy Materials Corp., 1190 South Dixie Hwy Southeast, Pompano Beach, FL 33060, Ph: 954-803-9206, Alt: 954-270-9000.

(3) Approved equal.

c. Acceptance. Provide the Engineer a General Certification from the GFRP or BFRP reinforcement manufacturer stating the materials furnished meet the specifications as described herein.

The Department will sample three 4 foot in length quality assurance samples for informational purposes, of GFRP or BFRP bar at the beginning of each project.

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. Provide GFRP or BFRP reinforcement in accordance with the details shown on the plans. Field fabrication, except for tying and cutting, and gradual bending in accordance with manufacturer's recommendations, of GFRP or BFRP reinforcement is prohibited. 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 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 expense 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 ultraviolet (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. The completed work, as described, will be measured and paid for at the contract unit price using the following pay items:

Pay Item	**Pay Unit**
Curb and Gutter, Conc, with GFRP Reinf, Det __	Foot
Valley Gutter, Conc, with GFRP Reinf	Foot
Curb and Gutter, Bridge Approach, with GFRP Reinf, Det __	Foot

Curb and Gutter, Conc, with BFRP Reinf, Det __ .....Foot
Valley Gutter, Conc, with BFRP Reinf.....Foot
Curb and Gutter, Bridge Approach, with BFRP Reinf, Det __ .....Foot

Curb and Gutter, Conc, with GFRP Reinf, Det __; **Valley Gutter, Conc, with GFRP Reinf**; **Curb and Gutter, Bridge Approach, with GFRP Reinf, Det __**; **Curb and Gutter, Conc, with BFRP Reinf, Det __**; **Valley Gutter, Conc, with BFRP Reinf**; and **Curb and Gutter, Bridge Approach, with BFRP Reinf, Det __** include the provision of documentation certifications and submittal of informational samples.