

CITY OF FORT WORTH
SPECIAL PROVISION
FOR
**BASALT FIBER REINFORCED POLYMER (BFRP) FOR CONCRETE
REINFORCEMENT**

OFS:SCK

1 of 4

APPR:XX,XX,0-0-00

a. Description. This work consists of furnishing and placing basalt fiber reinforced polymer (BFRP) reinforcement as detailed on the plans and specified herein.

b. Materials. Furnish BFRP reinforcement that meet the following material specifications and requirements and are fabricated in accordance with the details on the plans. The size of BFRP bars shall be consistent with typical standard sizes of steel reinforcing bars.

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 BFRP reinforcement must contain 70 percent minimum, by weight of basalt fiber.
2. **Resin Matrix.** Use commercial grades of epoxy resin or vinyl ester resin. Ensure the base polymer in the resin system does not contain any polyester. Blending of vinyl ester and epoxy resins will be permitted. Polyester based resin will not be permitted in the manufacturing process of the bar. Ensure the glass transition temperature (T_g) of the resin is not less than 212 degrees Fahrenheit (F). The glass transition temperature of the resin does not represent a service level maximum temperature, but a quality assurance tool used by the manufacturer. Test the resin matrix in accordance with the Differential Scanning Calorimetry (DSC) method as described in *ASTM E 1356*.
3. **Fillers:** Inorganic fillers and secondary fibers may be used, but their quantity shall not exceed 20% 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 ultra violet inhibitors are permitted and depend on the process method. If used, limit shrink additives to less than 20% by weight of the polymer resin.
4. **Mechanical properties.** Furnish BFRP with the following minimum requirements:
 - a. **Tensile Strength:** this property varies with bar size. The minimum tensile strength of BFRP reinforcement is listed in Table 1. Testing shall be in accordance to ASTM D7205.

Table 1. Minimum Tensile Strength Requirements

| Bar Size | Minimum Tensile Strength (ksi) |
|----------|--------------------------------|
| 3 | 140 |
| 4 | 135 |
| 5 | 130 |
| 6 | 125 |
| 7 | 120 |
| 8 | 110 |

- b. Tensile Modulus: The nominal tensile modulus of elasticity shall average 6,000 ksi according to ASTM D7205.
- c. Transverse Shear: Transverse shear is tested according to ASTM D7617. The minimum transverse shear for all bars shall be 20 ksi.
- d. Moisture Absorption: Moisture absorption tests shall be determined in accordance with ASTM D570. The maximum value of this test shall follow ACI recommendations and be less than 1.0%.
- e. Bond Strength: The guaranteed bond strength for all bars must follow ACI recommendations of ACI 440.6-08, 1.4 ksi. The manufacturer is to disclose the test method used for testing bond strength. A suggested test method is ACI 440.3R test method B3.
- f. Ultimate Tensile Strain: The ultimate tensile strain shall be calculated by dividing the guaranteed tensile strength by the nominal tensile modulus of elasticity. The nominal values obtained by this procedure should at least be 1.4%.

Provide BFRP rebar (GatorBar) as manufactured by:

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

Sudaglass Fiber Technology, Inc., 14714 Perthshire, Suite A, Houston, TX 77079 Ph: 281-496-5427

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

Smarter Building Systems LLC, Newport, Rhode Island, 02840 Ph: 401-481-8422

c. Submittals. Provide four 4 foot long quality assurance samples of each size BFRP bar at the beginning of each project or as determined by the Department.

Submit independent laboratory test reports including the following, for each size of BFRP used on the project.

1. Results of the tensile test of BFRP reinforcement, for each size of reinforcement used, including the following:
 - a. Diameter(s);
 - b. Breaking load;
 - c. Tensile modulus, and
 - d. Strain at ultimate tensile load

2. Results of the transverse shear test of BFRP reinforcement, including the following:
 - a. Diameter(s)
 - b. Breaking load, and;
 - c. Shear modulus

Provide the Engineer a certification stating the materials furnished meets the specifications as described herein. The certification shall include:

1. The basalt fiber and percentage by weight in the reinforcement;
2. The resin matrix material, composition percentage of filler material, and resin glass transition temperature (T_g);
3. Guaranteed bond strength, including the test method used, and;
4. Results of moisture absorption testing

The BFRP reinforcement may not be incorporated into the work until the submittal approval is received by the Engineer. Allow 10 working days for approval.

c. Construction. Before ordering material, submit approved drawings and specifications to manufacturer for quotation. This should include: bar size, length, bent shape and radius of bends, and quantities in linear feet. BFRP reinforcement bars shall be uniform in diameter/ size and free of defects that would be injurious to the mechanical and durability properties. Defects include: cracks, kinks, and surface pitting. Slight discoloration over time is typical and is not cause for concern.

1. Field fabrication. No field fabrication is permitted except tying of BFRP reinforcing bars, field cutting in accordance with the plans, or both. Field cut BFRP reinforcement only when specifically permitted using high speed grinding cutter, fine blade saw, diamond blade, or masonry blade. When BFRP bars are cut in the field, shear cutting is not permitted. All surface damage due to cutting shall be inspected by the Engineer and repaired or replaced at the Contractor's expense.
2. Handling. BFRP bars can be handled similar to their steel counterparts. If lifting long sections, use two or three pickup points. Minor scratches and chipping are allowed and do not affect performance. More than .04 inch of chipping should be repaired or replaced. When more than 2% of the surface area of the bar is excessively chipped or cracked it must be replaced.
3. Storage of BFRP reinforcement. Store reinforcement above the surface of the ground on platforms, skids, pallets, or other supports as close as possible to the point of placement. If stored outdoors for more than two (2) months, the BFRP bars shall be covered with a tarp or other protective cover. Protective cover must be at least opaque in color.
4. Placing and Fastening. Place all reinforcement within the tolerances recommended in the CRSI "Manual of Standard Practice" unless otherwise specified. Hold reinforcement firmly during the placing and setting of the concrete. If BFRP reinforcement is not adequately supported or tied to resist settlement, floating upward, or movement in any direction during concrete placement, concrete placement shall be halted until corrective measures are taken.
5. Ties and Supports: All accessories for use with the BFRP bars such as tie wires, bar chairs, supports or clips can be either steel or plastic variances or other tie specialties. Keep reinforcement properly positioned during placement of concrete according to the following:
 - a. use appropriate ties (plastic or wire) to support the top mat of deck reinforcement

- b. When pre-cast mortar blocks are used provide blocks that have cast-in wires ties
 - c. Provide nylon or plastic wire ties (zips), or pneumatically installed injection molded ties (KodiKilps).
 - d. Place all reinforcement in designated position and securely hold in position while placing and consolidating concrete
 - e. Fasten bars together with ties at all intersections for both top and bottom mats
 - f. Do not use pebbles, pieces of broken glass, stone or brick, metal pipe or wooden blocks as bar supports or to separate layers of bars
 - g. Provide the same cover clearances for splices that is shown or specified for the reinforcement
6. Lap Splices: Lap splice is the only approved method to tie bars together to make a continuous bar. Mechanical splices are not allowed. Lap length and spacing shall be (20X bar diameter) or as specified on the plans.

d. Measurement and Payment. The completed work, as described, will be measured and paid for at the contract price using the following pay item:

| Pay Item | Pay Unit |
|---|-----------------|
| Curb and Gutter, Conc with Basalt Fiber Reinforced Polymer, Detail __, Modified | |
| Foot | |

Curb and Gutter, Conc with Basalt Fiber Reinforced Polymer, Detail __, Modified includes the provision of documentation certifications and quality assurance samples for submittal. Delays caused by the review and resubmittal process, or due to replacement of defective or damaged BFRP reinforcement, will not be paid for, and no extension of time will be given.