

SPECIAL SPECIFICATION

ITEM 4038

GLASS FIBER REINFORCED POLYMER (GFRP) FOR CONCRETE REINFORCEMENT

4038.1 DESCRIPTION.

This Item shall govern for furnishing and placing glass fiber reinforced polymer (GFRP) reinforcement as shown on the Contract Documents and specified herein.

4038.2 REFERENCES.

- A.** ACI 440.3R "Guide Test Methods for Fiber-Reinforced Polymers (FRPs) for Reinforcing or Strengthening Concrete Structures"
- B.** ACI 440.6-08 "Specification for Carbon and Glass Fiber-Reinforced Polymer Bar Materials for Concrete Reinforcement"
- C.** ASTM D570 "Standard Test Method for Water Absorption of Plastics"
- D.** ASTM D7205 "Standard Test Method for Tensile Properties of Fiber Reinforced Polymer Matrix Composite Bars"
- E.** ASTM D7617 "Standard Test Method for Transverse Shear Strength of Fiber-reinforced Polymer Matrix Composite Bars"
- F.** ASTM D7957 "Standard Specification for Solid Round Glass Fiber Reinforced Polymer Bars for Concrete Reinforcement"
- G.** ASTM E1356 "Standard Test Method for Assignment of the Glass Transition Temperatures by Differential Scanning Calorimetry"

4038.3 MATERIALS.

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

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.

Resin Matrix. Use commercial grades of resin. Ensure the base polymer in the resin system does not contain any polyester. 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 E1356.

Fillers. Inorganic fillers and secondary fibers may be used, but their quantity shall 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 ultra violet 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.

Mechanical Properties. Furnish GFRP reinforcement with the following minimum requirements:

- A. **Tensile Strength.** This property varies with bar size. The minimum tensile strength of GFRP reinforcement is listed in Table 1. Testing shall be in accordance to ASTM D7205.

TABLE 1

TENSILE STRENGTH REQUIREMENTS

BAR SIZE	MINIMUM TENSILE STRENGTH (ksi)
3	155
4	155

- B. **Tensile Modulus.** The nominal tensile modulus of elasticity shall average 6,500 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 percent.

- E. Bond Strength.** The guaranteed bond strength for all bars must follow ASTM D7957, 1.1 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 percent.

Provide GFRP reinforcement bars as manufactured by:

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

4038.4 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. GFRP 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.

Field Fabrication. Composite reinforcement shall be provided in accordance with the details shown on the Contract Documents. The minimum bending radius is two feet and must utilize the necessary tying and stabilization methods to ensure reinforcement remains in the proper position before and during concrete placement. Field cut reinforcement may be accomplished using high-speed grinding cutter, fine blade saw, diamond blade, or masonry blade.

Handling. Reinforcement shall be handled similar to steel reinforcement. Minor scratches and chipping that do not impact performance may be permitted with approval of the Engineer.

Storage of GFRP Reinforcement. Store reinforcement above the surface of the ground on platforms, skids, pallets, or other supports. If stored outside for an extended period of time, GFRP reinforcement bars will yellow which does not affect the overall strength. Reinforcement may be covered if desired.

Placing and Fastening. All reinforcement shall be placed within the tolerances recommended in the CRSI "Manual of Standard Practice" unless otherwise specified on the Contract Documents. Tie wire, bar chairs, supports or clips shall be plastic coated steel, stainless steel, galvanized steel, plastic, or plain steel. Placing and fastening reinforcement shall conform to the following requirements:

- A. Place all reinforcement in designated position and securely hold in position while placing and consolidating concrete.
- B. Provide the same cover clearances for splices that is shown or specified for the reinforcement.
- C. Fasten bars together with ties at all intersections for both top and bottom mats.
- D. Use appropriate ties (plastic or wire) to support the top mat of deck reinforcement.
- E. When pre-cast mortar blocks are used provide blocks that have cast-in wires ties.
- F. Provide nylon or plastic wire ties (zips), or pneumatically installed injection molded ties (Kodi Klips).
- G. 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.

Reinforcement shall be secured firmly with fasteners while placing and consolidating concrete. Suspend concrete placement and take corrective action if it is observed that the reinforcement is not adequately supported or tied to resist settlement, floating upward, or movement in any direction during concrete placement.

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.

4038.5 SUBMITTALS.

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

- A. The fiber and percentage by weight in the reinforcement;
- B. The resin matrix material, composition percentage of filler material, and the resin glass transition temperature (Tg);
- C. Guaranteed bond strength, including the test method use.
- D. Results of moisture absorption testing;
- E. Average tensile strength and average tensile modulus, and;
- F. Average transverse shear strength and average shear modulus.

4038.6 MEASUREMENT AND PAYMENT.

The work performed, materials furnished, equipment, labor, tools, and incidentals shall not be measured or paid for directly but shall be subsidiary to pertinent Items.

There are no item code(s), description(s), or_unit(s) for this Item.

END OF ITEM 4038

SUMMARY SHEET

ITEM 4038

Other Specifications Required.

None

Reference Standards.

- A. ACI 440.3R "Guide Test Methods for Fiber-Reinforced Polymers (FRPs) for Reinforcing or Strengthening Concrete Structures"
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Description.

This Item discusses the furnishing and placing of glass fiber reinforced polymer (GFRP) reinforcement.

Payment.

No Payment.

DO NOT INCLUDE THIS SHEET IN THE CONTRACT SPECIFICATIONS.