



**DEVELOPMENTAL SPECIFICATIONS
FOR
FIBER REINFORCED POLYMER REPAIR
FOR CONCRETE CONTAINMENT OF COLLISION DAMAGED
PRETENSIONED PRESTRESSED CONCRETE BEAMS**

Effective Date
April 18, 2006

THE STANDARD SPECIFICATIONS, SERIES OF 2001, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE DEVELOPMENTAL SPECIFICATIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

01080.01 DESCRIPTION.

These specifications describe a Fiber Reinforced Polymer (FRP) repair system which shall comprise the materials system specified, including the fiber material, physical form of the fiber material, resin, primer, and adhesive as applicable; installation process; system manufacturer; supplier; and installer.

01080.02 MATERIALS.

The FRP laminate system shall conform to the following requirements:

PROPERTIES AT 72 ± 2°F (22 ± 1°C)	VALUE	ASTM EST METHOD*
Minimum Ultimate Tensile Strength in Primary Fiber Direction	500 lb per inch of width (87.6 kN per meter of width)	D 3039
Minimum Ultimate Tensile Strength at 90° to Primary Fibers	500 lb per inch of width (87.6 kN per meter of width)	D 3039
Minimum Tensile Modulus of Primary Fibers, ksi (MPa)	2000 ksi (13,790 Mpa)	D 3039

* Subject to approval of the Engineer. Other test methods, such as those published by Suppliers of Advanced Composite Materials Association (SACMA), or manufacturer's published Quality Control Procedures may be used when equivalency and suitability have been documented.

The following FRP laminate systems are approved for use:

- Sika SikaWrap Hex 106G
- Sika SikaWrap Hex 113C
- Wabo MBrace CF 120B
- Tyfo BC
- Or approved equal

Storage and handling of materials shall be in accordance with the manufacturer's recommendations, except as modified by this specification. Materials shall be protected from dirt, moisture, chemicals, extreme temperatures, and physical damage. Components exceeding their shelf life shall not be used. In case of conflict between manufacturer's recommendations and the requirements listed in this specification, the Engineer will determine which governs.

01080.03 CONSTRUCTION.

A. Surface Preparation.

Where shown on the plans, corners shall be rounded and smoothed to a surface finish in conformance with these specifications prior to the application of fibers. Surface finish shall consist of finishing the surfaces of the structure to produce smooth even surfaces of uniform texture and appearance that are free of unsightly bulges, depressions, and other imperfections. Power sanders or other approved abrasive means shall be used to achieve a smooth even surface of uniform texture and appearance. Defects in the base concrete such as spalls, chips, and hollow areas shall be repaired as shown in the contract documents.

Surfaces to receive FRP laminate shall be free from fins, sharp edges, and protrusions that will cause voids or depressions behind or within the installed FRP laminate or that, in the opinion of the Engineer, will damage the fibers. Voids or depressions are defined as volumes greater than 1/2 inch (12.5 mm) in diameter by 1/8 inch (3 mm) deep. Existing uneven surfaces to receive FRP laminate, including voids or depressions, shall be filled with an FRP system compatible epoxy or epoxy-based filler.

B. Application Conditions.

The contact surfaces at any stage of installation shall be completely dry and free of dust and other contaminants at the time of application of the FRP laminate. The ambient and epoxy resin components temperatures shall be between 45°F (7°C) and 95°F (35°C) at time of mixing and application. The FRP laminate shall be applied when the relative humidity is less than 90% at the site and the surface temperature is more than 5°F (3°C) above dew point.

Damage by the elements to the FRP laminate shall be replaced or repaired by the Contractor at no additional cost to the Contracting Authority.

Subject to written approval by the Engineer, the Contractor may provide suitable enclosures to permit application and curing of the FRP laminate during inclement weather. Provisions shall be made to control atmospheric conditions artificially inside the enclosures within limits specified for application and curing of the FRP laminate.

During application of the FRP system, the Contractor shall maintain a Daily Installation Log. The Daily Installation Log shall be available for review by the Engineer, and a copy furnished to the Engineer at completion of each day's work. The daily log shall provide materials certification data and application records for each installation. This log shall at a minimum include the following information:

- Installation identification with beam number, construction and installation requirements, including plans and drawings, or references thereto.
- Materials information including product description, date of manufacture, and lot or batch numbers.
- Fabrication, inspection, and verification data for the manufacturing and construction operations including a list of materials and quantities used during each work shift; number of layer counts; FRP laminate thickness measurements; installation time per beam; ambient temperature and humidity readings at beginning, middle, and end of each work shift; curing processes including full documentation of time and temperature relationship for curing and at final curing temperature; and thickness measurements of any protective coating applied to the completed FRP laminate following installation.

C. Application Of System.

The components of epoxy resin shall be proportioned and thoroughly mixed by automated equipment to within 5% of the specified mix ratio. Provisions shall be made for checking the accuracy of proportions and mixing.

The resin shall be applied within one hour after a batch has been mixed or as recommended by the FRP manufacturer. Both epoxy resin and fiber sheet shall be measured, and applied uniformly at the rates shown on the approved working drawings.

The fiber sheet shall be applied to the surface using methods that produce a uniform tensile force distributed across the entire width of fiber sheet.

Successive layers of FRP laminate materials shall be placed before complete cure of the previous layer of epoxy to achieve complete bond between layers. After 7 calendar days, or complete cure, a light surface sand blasting, cleaning with fresh water, and drying is required prior to placing additional layers.

The epoxy application rate for each layer of FRP laminate shall ensure complete saturation of the fiber sheet.

Undulations in the surfaces shall not exceed 1/4 inch per foot (20 mm per meter) in any direction. The cured FRP laminate shall have a uniform thickness, density, and bond between layers and lack of porosity.

Except as otherwise specified, entrapped air beneath each layer shall be rolled or squeegeed out before the epoxy sets, and each individual layer and ending of the FRP laminate shall be firmly bedded and adhered to the preceding layer.

An overlap length of 4 inches (100 mm) or that recommended by the FRP manufacturer is required for splices in the fiber direction of individual layers. No horizontal overlap is required when placing parallel sheets.

The cured FRP laminate system shall have uniform thickness, density, and bond between layers. This system shall be protected from exposure to rainfall or submersion for a period of at least 48 hours. The cured FRP systems shall be inspected for defects consisting of external abrasions or blemishes, delaminations, voids, external cracks, chips, cuts, loose fibers, foreign inclusions, depressible raised areas, or fabric wrinkles. The following criteria shall apply:

- Each layer shall have full contact with the concrete surface or subsequent layers subject to the following tolerances. All defects or voids with a dimension greater than 1 1/2 inches (40 mm), defect areas greater than 1 square inch (650 mm²), or defect areas with any dimension greater than 1 inch (25 mm) within 1 foot (300 mm) from another defect area of similar size, shall be repaired or replaced as determined by the Engineer.
- Surfaces of butted joints shall be flush with adjacent surfaces.
- All repairs shall be completed, cured, and approved by the Engineer prior to preparing surfaces for painting.

D. Painting FRP Laminates.

Exposed surfaces of FRP laminates shall be cleaned and painted in according to this specification and the FRP manufacturer's recommendations.

The surfaces to be cleaned and painted shall be lightly roughened by uniform abrasive blasting using an abrasive no larger than 80 mesh. The air pressure at the nozzle used for abrasive blasting shall not exceed 80 psi (550 kPa). The abrasive shall be of appropriate hardness to roughen the surface without damaging the fiber portion of the FRP laminate. The fiber portion of

the FRP laminate shall not be exposed by the abrasive blasting operation. Abrasive blasting will not be required if the first coat of paint is applied within 48 hours after mixing the components for the final resin coating.

Dust and blast residue shall be removed from all surfaces by flushing with clean water before painting.

All surfaces of the FRP laminate shall be completely dry before receiving a minimum of two finish coats of an exterior grade paint that is formulated to be system-compatible with the FRP in conformance with the requirements in ASTM D 3359, Method A, with a minimum rating of 4A.

The first finish coat shall be applied in a minimum of two applications. The total dry film thickness of all applications of the first finish coat shall be not less than 2 mils (50 μm).

Successive applications of paint shall be of such a shade as to contrast with the paint being covered.

Except as approved by the Engineer, a minimum drying time of 12 hours shall be allowed between finish coats.

The second finish coat color shall match Federal Standard 595B No. 26408. The total dry film thickness of all applications of the second finish coat shall be not less than 2 mils (50 μm).

The two finish coats shall be applied in three or more applications to a total dry film thickness of not less than 4 mils (100 μm) or more than 8 mils (200 μm).

01080.04 METHOD OF MEASUREMENT.

The Contractor will be paid the lump sum contract price for Beam Repair, as per plan.

01080.05 BASIS OF PAYMENT.

For Beam Repair, as per plan, the Contractor will be paid the lump sum contract price. This payment shall be full compensation for furnishing all material, labor, and equipment required to complete the work according to the contract documents.