SECTION 00566 - CARBON FIBER REINFORCED POLYMER STRENGTHENING - NEAR SURFACE MOUNTED

(Follow all instructions. If there are no instructions above a subsection, paragraph, sentence, or bullet, then include it in the project. The specifications may be modified to include project specific specifications, but all additions, deletions, or modifications must be sent to the ODOT Technical Resource and State Specifications Engineer for review and approval.)

Section 00566, which is not a Standard Specification, is included in this Project by Special Provision:

Description

00566.00 Scope - This work consists of designing and installing a complete, near surface mounted, carbon fiber reinforced polymer (CFRP) strengthening system meeting the loading and design requirements shown. The system is comprised of CFRP reinforcement ("bars") embedded in saw-cut grooves with epoxy.

00566.01 Abbreviations:

CFRP - Carbon Fiber Reinforced Polymer
FRP - Fiber Reinforced Polymer
NSM - Near Surface Mounted

00566.02 Design Standards - Design the NSM-CFRP system according to the requirements of this Section and the requirements of ACI 440.2R or AASHTO Guide Specifications for Design of Bonded FRP Systems for Repair.

00566.03 Required Submittals:

(a) Materials Certifications - At least 21 Calendar Days before starting Work, submit the manufacturer's material certifications for the CFRP strengthening system. Include the supplier's name and ranges of the properties listed below, including test methods used, for CFRP and epoxy resin.

Material	Properties to be Furnished
CFRP	Tensile Strength Elongation Tensile Modulus Rupture Strain Surface Finishes Cross-Sectional Area Width Thickness

High Strength Epoxy Resin	Tensile Strength Elongation Tensile Modulus Coefficient of Thermal Expansion Mix Ratio Pot Life Shelf Life UV Resistance

(b) Test Results - At least 21 Calendar Days before starting Work, conduct longitudinal tensile property testing on five samples of the CFRP bar according to Part 2 of ACI 440.3R, ASTM D7205, or ASTM D3039 and submit test results. Sample CFRP bars shall have the same physical properties as and be from the same manufacturer as the bars that will be installed in permanent Work.

(c) Personnel Qualifications - Submit personnel qualifications at the pre-construction conference.

(1) CFRP Application Advisor Certification - Submit the CFRP materials manufacturer's certification of the Contractor's designated CFRP Application Advisor.

(2) CFRP Application Advisor Certification Experience - Submit documentation showing that the Contractor's designated CFRP Application Advisor has experience as CFRP Application Supervisor, CFRP Application Advisor, or lead worker on three bridge or building projects using near surface mounted CFRP bars in the last 5 years. The CFRP material used on projects submitted for experience does not need to be from the same manufacturer as material proposed for this Project.

For each project submitted, include:

- Project name
- Contract number
- Location
- Owner, including contact person's name and telephone number
- Installation work duration (month and year)
- Material used and material manufacturer

(3) Applicators Certification - Submit certification(s) from the CFRP material manufacturer, or from the Contractor's designated CFRP Application Advisor, affirming that all applicators who will install the CFRP system have been trained in the installation of CFRP.

(d) Working Drawings and Calculations - At least 21 Calendar Days before starting Work, submit stamped Working Drawings and design calculations from the manufacturer of the CFRP system according to 00150.35(b) except as modified by this subsection. Include the following in the Working Drawings:

- All information required for proper construction of the CFRP system

- Material properties of CFRP bars
- Spacing and length of CFRP bars
- Dimensions of saw-cut groove
- Furnished epoxy resin

Include the following in the design calculation:

- Design specifications
- Design criteria
- Material properties
- Calculations
- Installation guide

As-constructed plans of the existing structure(s) are available from the Engineer.

Materials

00566.10 Pre-Approved CFRP Manufacturers and Material List - Furnish rectangular or circular CFRP bars from one of the following list of pre-approved manufacturers.

Manufacturer	Material
Owens Corning Infrastructure Solutions 210 N. 13th Street Seward, NE 68434 Contact: Doug Gremel Phone: (800) 869-0359 or (402) 643-2991 Fax: (402) 643-2149	Aslan™ 500 CFRP Tape Aslan™ 200 CFRP Rod
BASF Building Systems, LLC 5185 Linn Lane West Linn, OR 97068 Contact: Bruce Jackson Phone: (503) 722-4101 or (503) 887-4402 FAX: (503) 722-4131	MBrace® S&P Laminate
Fyfe Co., LLC 3940 Ruffin Road, Suite C San Diego, CA 92123 Contact: Scott Arnold Phone: (858) 642-0694 FAX: (858) 444-2982	Tyfo® NSM Composite Laminate Strip System

All bars shall have a textured, deformed, or roughly sanded surface and shall be marked at regular intervals along the length, spaced not more than 6 feet, showing the manufacturer's mark, size designation and production lot number.

00566.11 Epoxy Resin - Furnish high strength epoxy resin from the QPL and according to the CFRP manufacturer's recommendations. Furnish epoxy resin having a viscosity appropriate for the installation, as determined by the CFRP manufacturer.

00566.12 Material Sampling – Provide five samples per lot of CFRP bar materials for testing by the Agency. Samples shall be from the same lot(s) used in the permanent work. Provide the samples at least 21 Calendar Days before starting CFRP installation work. Prepare samples' length and end anchors in accordance with ASTM D7205 or ASTM D3039.

Allow the Engineer to select six additional samples per lot of CFRP bar materials delivered to the site for testing by the Agency. Samples will be a minimum of 8 feet in length.

Labor

00566.30 Personnel Qualifications - Provide a certified and trained CFRP Application Advisor to provide technical assistance prior to and during CFRP Work. Ensure the CFRP Application Advisor remains available for consultation until the completion and acceptance of all CFRP Work.

Provide trained personnel to install the CFRP system.

Construction

00566.40 Existing Reinforcement Location and Concrete Cover - Use rebar detectors or other approved devices, capable of locating existing reinforcement within 0.1 inch, to locate existing top mat reinforcement and determine the thickness of concrete cover. Before constructing grooves, provide the Engineer with a summary of top mat transverse and longitudinal reinforcement measurements.

00566.41 Saw-Cutting Grooves - Construct saw-cut grooves in the concrete at the spacing established by the design submitted according to 00566.03(d), and to the designed width and depth ± 1/8 inch. Make grooves deep enough to allow the CFRP bar to be installed at least 1/8 inch below the surface in all locations along the length of CFRP bars. Where practicable, do not cut into existing rebar during construction of saw-cut grooves. Visually inspect all existing rebar locations after saw-cutting grooves. When existing reinforcement is cut, inform the Engineer before installation of CFRP bars.

Groove spacing may be adjusted in the field as necessary to avoid existing reinforcement or other unforeseen conflicts; however, the average spacing of all grooves over any 2-foot long section may not be more than the spacing required by the submitted design. Maintain a minimum clear spacing greater than twice the depth of the groove and a minimum clear edge distance of four times the depth of the groove.

00566.42 Groove Preparation - Prepare saw-cut grooves for CFRP bar installation as follows:

(a) Surface Cleaning - Clean the groove according to the manufacturer's recommendations. If the manufacturer has not provided recommendations, thoroughly clean the groove with high-pressure water and a non-metallic brush. Before the groove

dries out, blow it free of water and debris with compressed air. Ensure that all dust, sand, laitance, grease, curing compounds, and any other bond-inhibiting matter is removed from the groove. The concrete surface of grooves shall be clean and structurally sound prior to installing CFRP bars.

(b) Moisture on Groove Surfaces - Before installation of CFRP bars, dry groove surfaces using a drying method approved by the Engineer and according to the epoxy manufacturer's recommendations. Do not directly apply a flame to the groove surfaces.

00566.43 Compressed Air - When using high-pressure air for cleaning or blowing down, use adequate separators and traps to ensure that the air is free of water, oil, or any other material detrimental to the CFRP system. Compressed air cleanliness may be tested by the Engineer according to ASTM D4285.

00566.44 CFRP Bar Installation - Begin installation only after all groove preparation work is complete.

Install the CFRP bars according to the manufacturer's recommendations and to the embedment depths shown.

Do not install CFRP bars and epoxy resin when the concrete temperature is below 50 °F, unless otherwise advised by the resin manufacturer's recommendations.

Provide temporary containment, as required, to contain epoxy resin in the groove. Mask the concrete adjacent to the groove to prevent excess epoxy from adhering to the concrete outside the groove.

Center the CFRP bar in the groove using approved centering devices at one-third points along the CFRP. Centering devices shall not have less than 1/8 inch resin cover when installed. Place nylon or polyethylene spacer material between the CFRP bars and exposed, existing steel reinforcing.

Level epoxy resin flush with the surface of the adjacent concrete.

00566.45 Surface Cleanup - Remove excess epoxy resin outside the groove.

Measurement

00566.80 Measurement - No measurement of quantities will be made for work performed under this Section. The estimated length of required CFRP bars is shown below.

(Obtain structure number and quantities from the Bridge Designer. ~~Fill in the blank with the estimated length of CFRP bar. Check with the bridge designer.~~)

~~The estimated length of required CFRP bars is _____ feet.~~

Structure	Quantity (Feet)
Bridge No. _____	
Bridge No. _____	

Payment

00566.90 Payment - The accepted quantities of installed CFRP strengthening will be paid for at the Contract lump sum amount for the item "CFRP Strengthening - Near Surface Mounted".

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.