MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
**PRESTRESSED CONCRETE BEAM, SPECIAL (CARBON FIBER COMPOSITE CABLE)**

CFS:MJF 1 of 7 APPR:JAB:POJ:12-19-18

**a. Description.** This work consists of providing all labor, equipment, and materials necessary to transport carbon fiber composite cable (CFCC) materials, and to fabricate, furnish, and install the prestressed concrete beams as detailed on the plans and as specified in the standard specifications, except as modified herein.

**b. Materials.** Provide materials in accordance with subsection 708.02 of the Standard Specifications of Construction except as specified below.

1. Carbon Fiber Composite Cable Reinforcement. Provide carbon fiber composite cable reinforcement in accordance with the contract.

2. Buffer Materials.

A. Polinet Sheets and Stainless-Steel Mesh. Polinet sheets consist of polinet sheets and stainless meshes. Make the polinet sheets of open meshed synthetic fiber cloth with abrasive grains (#400, Aluminum Oxide). The stainless steel mesh will be made of stainless steel SUS304 (in accordance with *Japanese Industrial Standards* (*JIS) G 4309*).

B. Braid Grips. Use stainless steel wires conforming to SUS403W1 (in accordance with *JIS G 4309*).

3. Anchoring Devices. The Department will provide anchoring devices for a single casting bed.

A. Wedges. Use steel for wedges conforming to SCM415 (in accordance with *JIS G 4053*) with machining and heat treatment.

B. Sleeves and Couplers. Use steel for sleeves and couplers conforming to S45CH (in accordance with *JIS G 4051*) with machining and heat treatment.

The anchoring system consists of a wedge, sleeve, coupler, mesh sheet, and braid grip as shown in Figure 1. The details of these components are shown in Figure 2. The configuration of the mesh sheet is shown in Figure 3. The appearance of the braid grip is shown in Figure 4. Similar anchoring devices can be viewed at Lawrence Technological Institute by contacting Dr. Nabil Grace.

**c. Construction.** Construct the prestressed concrete beams in accordance with subsection 708.03 of the Standard Specifications for Construction, except as specified below.

1. Submit shop drawings for approval in accordance with subsection 708.03.A.2 of the Standard Specifications for Construction, with the following additions and exceptions:

A. Provide shop drawing files electronically in portable document format (PDF).

B. Show the CFCC tensioning and cutting sequence.

C. Provide detailed drawings and specifications for the stressing bed and tensioning system used for the initial jacking operations.

D. Include a layout of the anchoring devices used to transfer load from the CFCC to the steel tendons as well as a detail for support of these elements during prestressing activities on the shop drawings.

E. Include force and elongation calculations (including all losses) on the plans for the first pour using assumed thermal corrections to demonstrate the Contractor's ability to correctly perform the calculations. Limit the initial pull stress to a stress not higher than 0.65 times the guaranteed ultimate tensile strength of the CFCC.

F. Ensure the shop drawings and calculations are sealed by a Professional Engineer licensed in the State of Michigan.

The Department requires 14 calendar days for each shop drawing review cycle and additional review cycles may be required following each review. No extension of time or additional compensation will be granted to the Contractor due to delays in preparing the final shop drawings, calculations, and specifications or securing approval from the Department. An exception may be granted for an extension of time only in the case that the Department review of plan submittals exceeds 14 calendar days, if it can be shown that such a delay impacts the final project completion date.

2. Pick up the CFCC materials from the manufacturer's facility. Pick up the CFCC anchoring devices used for prestressing the beams from the MDOT Bridge Crew Warehouse, located at 7575 Crowner Drive, Dimondale, MI 48821 and deliver to the fabrication facility. Contact John Belcher at (517) 937-7400 4 weeks prior to arrange pick up.

3. Handling and Storing CFCC. Ensure handling and care of the CFCC is in accordance with this special provision and the current version of the manufacturer's handling manual. CFCC used as prestressing strands must be given special consideration. In order to ensure to all parties that the CFCC material is of appropriate quality and condition to be utilized in this installation, it will be necessary as a condition of this Contract that representatives of the Department and the Contractor be present to inspect the condition of the CFCC prior to being used for the fabrication of the prestressed beams. The Contractor is responsible for any costs associated with storage, installation, and other special requirements for CFCC. Take extra care in handling and placing all CFCC to prevent surface damage. In general, CFCC is susceptible to abrasion damage caused by rough handling and improper storage. Scoring by sharp edges and similar abrasions will reduce the cable's strength, possibly resulting in serious accidents when subjected to high stresses. Do not store CFCC directly on the ground and provide covering. Store the CFCC indoors, free from dust and protected from damage, deformation, or deterioration. Do not drop tools and other hard objects on the CFCC. Prevent the CFCC from coming into contact with hot objects and do not apply shearing forces to the cables during installation. Cover CFCC reinforcement placed in the prestressed concrete to

prevent exposure to the sun's ultraviolet rays when the concrete for beams will not be cast within 2 weeks from the time of placing the reinforcement. Perform burning or welding operations in the vicinity of the reinforcement only with protection in place to prevent exposure of the reinforcement to elevated temperatures, welding sparks, or ground currents. Personnel must not smoke in the vicinity of the CFCC materials. Keep CFCC prestressing strands free of any oil, grease, chemical substances, or foreign matter.

Handle CFCC with care not to introduce bends or kinks in the material. Ensure no loops are presented when pulling CFCC taught, as this will introduce kinks when straightened.

Do not pull the cable against steel edges during installation as they may cause damage to the cable. Do not step on the cables at any time during storage and installation. If necessary to bend the CFCC during work other than tensioning, do not go below the minimum bending radius specified by the manufacturer.

Discard any CFCC prestressing strand found to be damaged on the surface, bent, or subjected to high temperatures.

Should the CFCC become damaged during shipping, handling, fabrication, or any other process, it will be the Contractor's responsibility to replace the materials at no cost to the Department. No extension of time will be granted to replace damaged materials.

4. Unpacking the CFCC Spools. Lift and carry the package containing the cables using slings and a crane or a fork-lift. Remove panels of the wooden crate and set the spindle in a position to be used for fabricating the proposed beams in accordance with the current version of the manufacturer's handling manual. Take caution not to damage the CFCC when removing the panels of the wooden box or the cardboard cover, or while uncoiling.

5. Spreading/Uncoiling the CFCC. Before uncoiling and/or dragging CFCC, spread a vinyl sheet on the ground to avoid scratches and stains to the CFCC. Ensure that the vinyl sheet is secured and is long enough to protect the entire length of the cable. Spread the vinyl materials along the prestressed beam form bottom to ensure CFCC materials are not dragged along the bottoms of the forms, or across the sole plate, or sole plate anchor device. Carefully inspect the condition of the materials as it is unspooled, and ensure the materials are handled appropriately during the coupling process.

6. Installing the CFCC. The CFCC prestressing materials provided by the Department will include a specific number of steel transfer couplers (anchoring devices). Additional couplers, if needed, are the responsibility of the Contractor. Support of these anchoring devices and layout at the beam anchorages is the responsibility of the Contractor.

7. Tensioning the CFCC. Establish and verify the initial prestressing force by measuring cable elongation and gage pressure. Ensure all values are in agreement and reported to the MDOT quality assurance inspector (QAI) prior to "lock off" of a tendon. The coefficient of thermal expansion for CFCC is different from steel and must be taken into account in the initial jacking force calculations.

8. Notifying the Engineer. Provide the Engineer with an accurate 2 weeks' notice prior to beginning work in the shop.

9. Placing Concrete. Encase internal vibrators with a protective polyurethane sheath. External vibrators are acceptable. Extreme care is to be taken to avoid damage to CFCC prestressing for internal vibrators. Damage resulting in “nicks” or “gouges” within the CFCC prestressing will require replacement of the CFCC and may result in rejection of the beam by the Engineer. Cure concrete at temperatures from 70 degrees Fahrenheit (F) to 150 degrees F until concrete attains the release strength shown on the shop plans.

10. Cutting CFCC. Cut CFCC prestressing only with prior approval and under the supervision of the Engineer. Use abrasive wheels, grinders, or other similar methods in strict compliance with the Manufacturer’s written recommendations. Do not use heat cutting under any circumstances. Do not score the CFCC for any reason. Discard any CFCC found to be damaged on the surface, bent, subjected to high temperatures, or stored out of doors for long periods. Handle the CFCC using systems that have padded contact areas. Keep CFCC free of any oil, grease, or foreign matter.

11. Schedule. If a beam is subject to rejection by the Engineer for any reason, no extension of time or additional compensation will be granted to the Contractor due to the associated delays and material costs. The Contractor is responsible for procuring the required CFCC materials for the replacement beam. Test additional CFCC materials under the presence of Dr. Nabil Grace, Lawrence Technological University (LTU). Provide a minimum of 2 weeks notification to the Engineer prior to testing of CFCC materials.

12. All repairs to the beams required for acceptance by the Department must meet the approval of the Engineer.

13. Upon completion of fabrication contact John Belcher at 517-937-7400 to schedule pick up of wedges, sleeves, couplers, and all excess CFCC materials.

**d. 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** |
|---|---|
| Prest Conc Bulb-Tee Beam, Furn, __ inch by __ inch, Special | Foot |
| Prest Conc Bulb-Tee Beam, Erect, __ inch by __ inch, Special | Foot |

1. **Prest Conc Bulb-Tee Beam, Furn, __ inch by __ inch, Special** will be measured based on the nominal length of the unit and includes transporting the CFCC, picking up the anchoring devices, providing buffer materials, custom couplers, providing all typical steel items used in prestressed beams, including but not limited to sleeve for steel strands, wedges for steel strands, steel strands, and epoxy coated reinforcement, fabrication of beams using CFCC and epoxy coated steel reinforcement, and transportation of the beams.

2. **Prest Conc Bulb-Tee Beam, Erect, __ inch by __ inch, Special** will be measured based on the nominal length of the unit and includes the cost of erecting the beams, placing position dowels, shimming to provide full bearing contact, and bracing and blocking.

The Engineer will measure and the Department will pay for the elastomeric bearings in accordance with subsection 707.04 of the Standard Specifications for Construction.

The Department will not allow additional compensation for costs incurred in the certification of prestressed concrete plants, or claims by the Contractor for delays or costs associated with prestressed concrete fabrication plant certification.

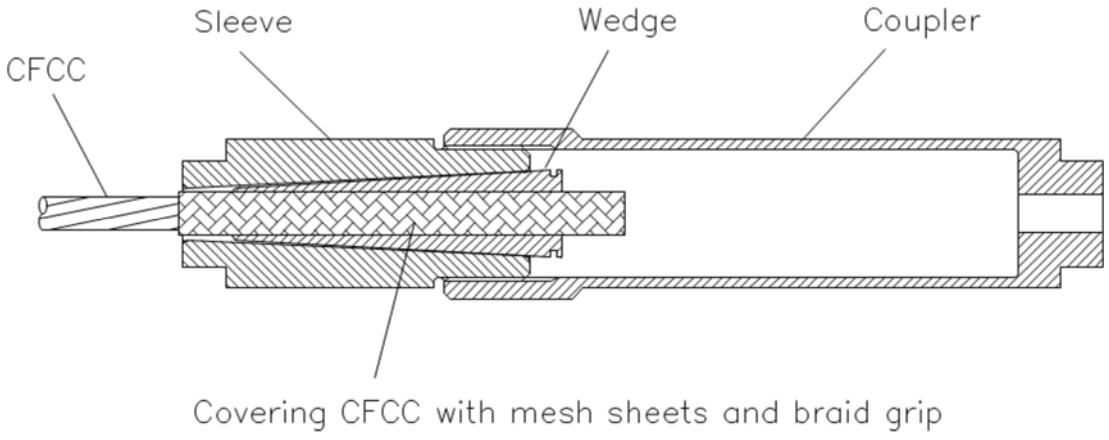
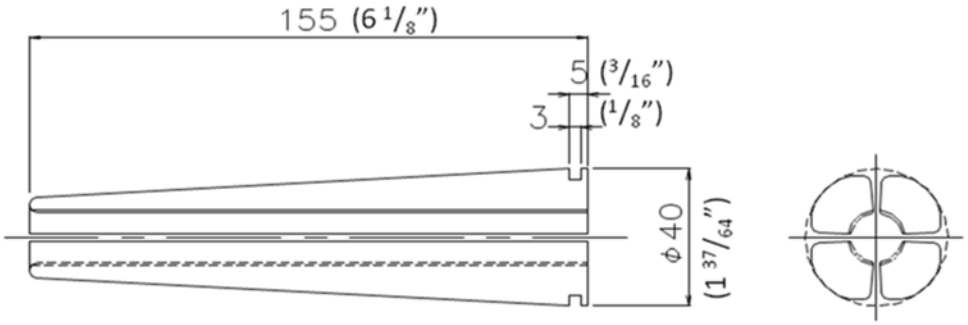
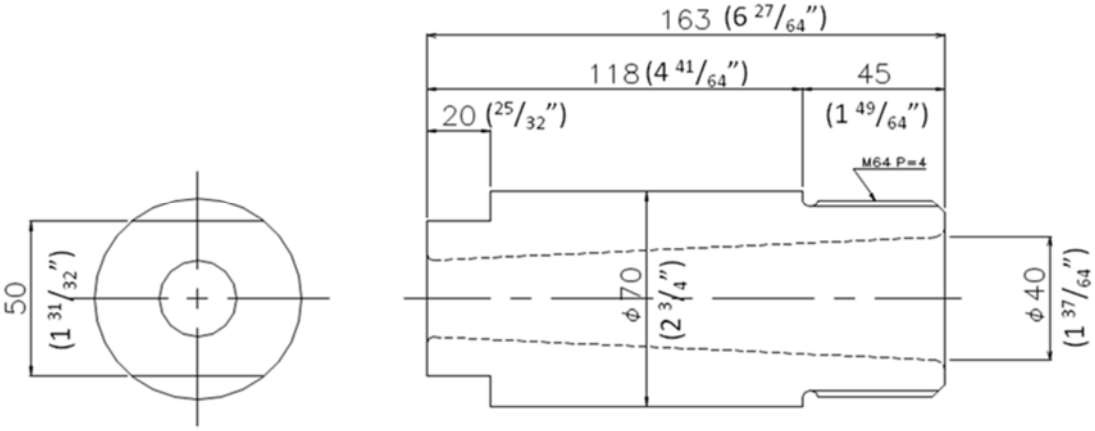


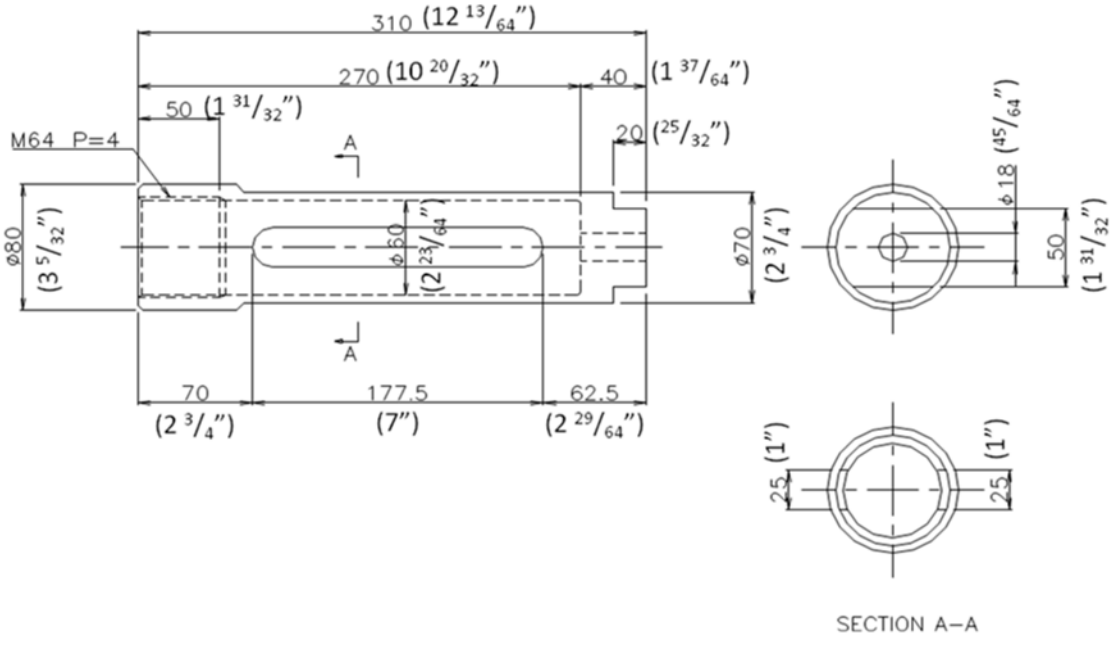

**Figure 1: Schematic of Anchoring Device**




Wedge (4 Pieces in 1 Set)




Sleeve




Coupler

**Figure 2: Shapes of Anchoring Wedge, Sleeve, and Coupler mm (inches)**

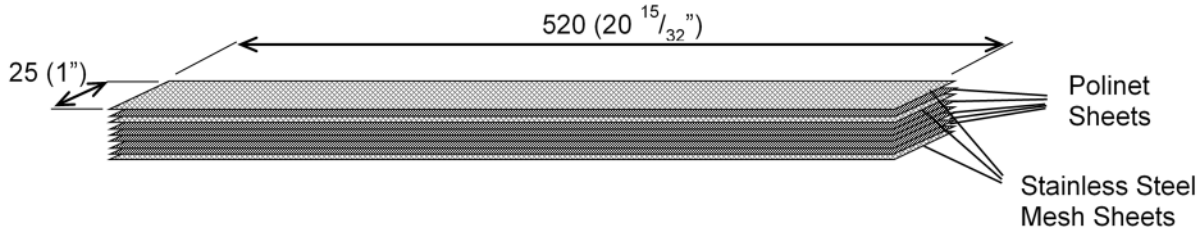



**Figure 3: Configuration of Mesh Sheets mm (inches)**

**Figure 4: Appearance of Braid Grip**