FRP-COMPOSITE BRIDGE BEAM IMPLEMENTATION MEETING

Date & Time: October 3, 9-11am

Location: Tallahassee – Florida Department of Transportation, Room 315, Haydon Burns Building (605 Suwannee St, Tallahassee FL. 32399)

Agenda

9:00	Welcome & Introductions;
9:10	Overview of FDOT current procurement options:
	- Design Bid Build (Alternate Designs, CSIP);
	- Design-Build (RFP performance based criteria, Added Value Points, ATCs);
	- Understanding the role of the Contractor's Engineer of Record;
9:30	Insight from Manufacturers - What works in other states *(5 minutes each – Please come prepared to respond)*;
10:00	FDOT Manufacturer Approval Overview (MAC QC plans, APL components?);
10:15	Acceptance Criteria, Bridge Size/Volume limitations, Benefits and Limitations of Standardization;
10:30	Manufacturer Discussion - Preferences and priorities for CBB procurement, Load Rating & Inspection;
10:50	RoadMapping next steps for CBB implementation (initial structure type, pilot procurement preference, assignment of tasks).

Invited Industry Participants

1. ACMA
2. AIT (Composite Tub Girders and Composite Arch Bridge System)
3. Composite Advantage (Pedestrian Bridges)
4. Creative Pultrusion - Pedestrian Bridges & SuperStructural
5. HCB – Hillman Composite Beams
6. Strongwell – EXTREN DWB
7. WagnersCFT composite beam system

Academia

Prof. Jeff Brown (Embry-Riddle Aeronautical University)

Invited Industry Participants

1. ACMA Composites Growth Initiative
2. AIT (Composite Tub Girders and Composite Arch Bridge System)
3. Composite Advantage (Pedestrian Bridges)
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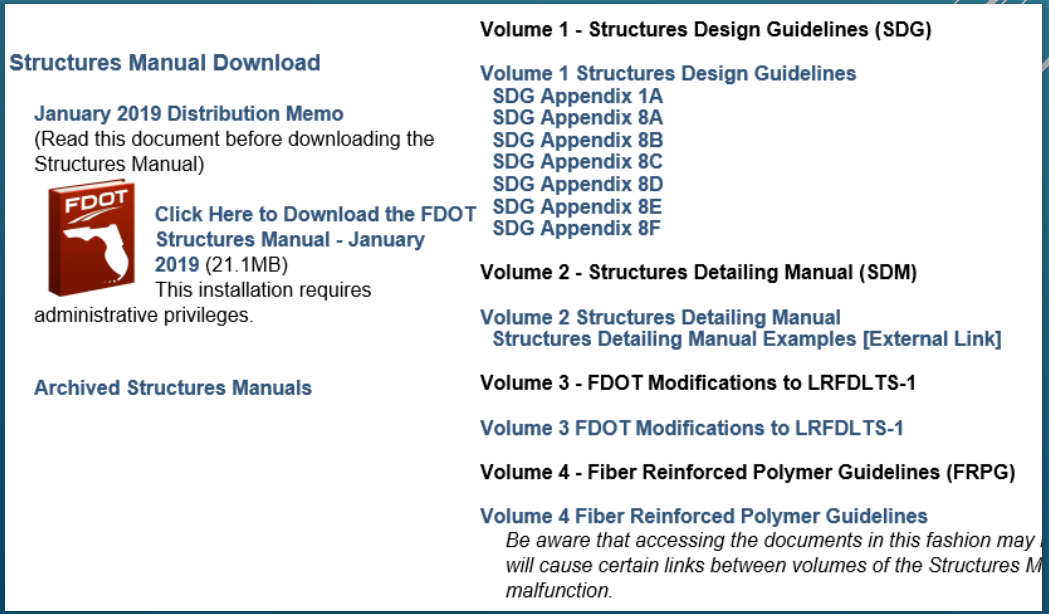
Vehicular Bridges

- ***SDG*** Chapter 1 to 9
- Concrete Deck & Traffic Railings
- Spans 25 – 80 ft
- Tidally affected water crossings

Pedestrian Bridges

- ***SDG*** Chapter 10
- Concrete, Plastic lumber, or FRP grating/panels
- Any location



STRUCTURES OF INTEREST

https://www.fdot.gov/structures/structuresmanual/currentrelease/structuresmanual.shtm

PREFERRED CBB BRIDGE PARAMETERS

Vehicular Bridge

- Location in corrosive environment
- Non-interstate, Lower Volume Highways for now.
- $\leq$ 80 feet single span to begin
- Low-level may be beam-depth limited for hydraulic clearance
- 30-60 ft spans compete with FSBs
- 50-80 ft spans compete with Type II AASHTO Girders

Pedestrian/Bicycle Bridges

- Any environment – compete with steel on cost basis.
- Truss or Beam Type configuration
- Multiple spans possible
- Top Down Construction
- FDOT existing Prefabricated Steel Bridge **"invitation to bid"** process is possible, but burdensome on CBB industry

CONTRACTING MODELS

Conventional Bid-Build

- For CBB Designated projects: Predesigned, all contents in plans.
- Potential for Equivalent Alternate Designs (Contractor bids one option)

  or

- Partial Design of Superstructure Beam Component (CBB) by the Contractor/Producer/Specialty Engineer
- Load Rating Responsibility???

Design-Build

- Concept Plans Provided "blank box"
- Complete Design by Consultant-Contractor Team
- Load Rating required for vehicular bridge

INSIGHT FROM MANUFACTURES

What Works in other States?

- AIT
- Composite Advantage
- Creative Pultrusion
- HCB, Inc.
- Strongwell
- WagnersCFT

What does not work well?

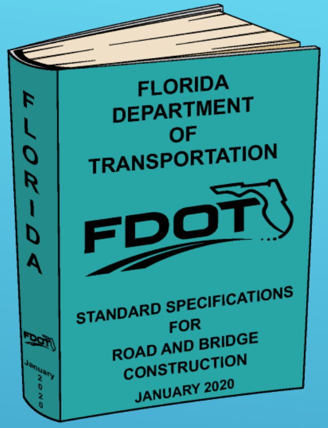
1. …
2. …
3. …
4. …
5. …
6. …

Materials Manual

- Section 12.1 “Fiber Reinforced Polymer Composites”
- Guidelines for Adding a Producer to the Production Facility Listing

FDOT Specifications

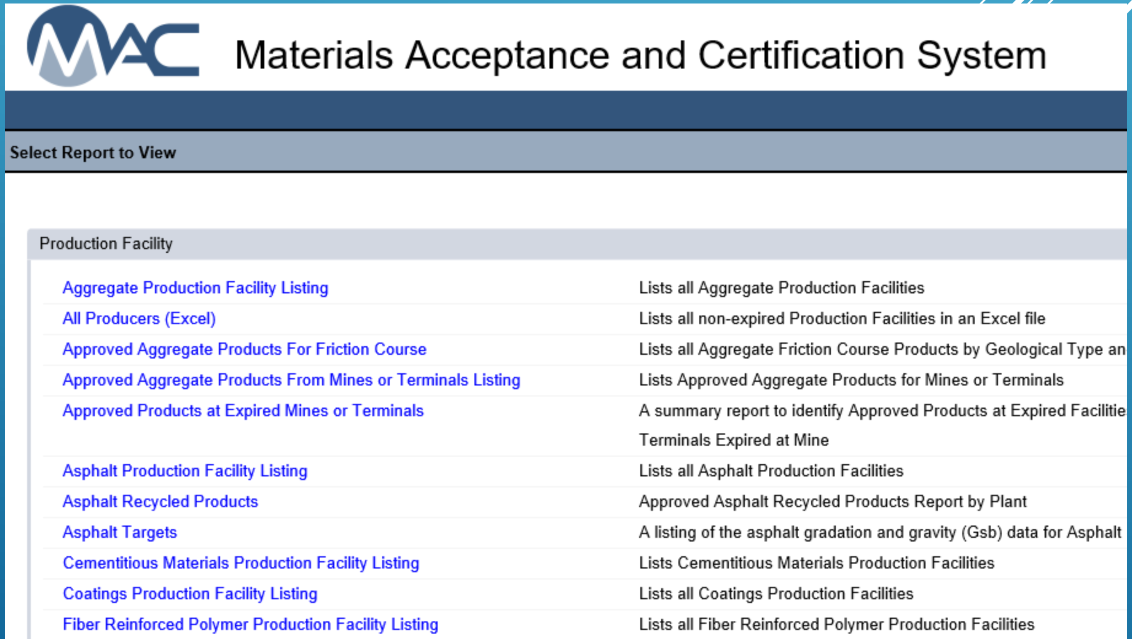
- *Not well developed yet for Standard Specs:* ***973 “FRP Composite Structural Shapes”***
- HCB used a ***Technical Special Provision (TSP)***



MANUFACTURER APPROVAL & SPECIFICATIONS

https://mac.fdot.gov/smoreports

https://www.fdot.gov/programmanagement/specs.shtm



Materials Acceptance and Certification System

Select Report to View

Production Facility

Aggregate Production Facility Listing	Lists all Aggregate Production Facilities
All Producers (Excel)	Lists all non-expired Production Facilities in an Excel file
Approved Aggregate Products For Friction Course	Lists all Aggregate Friction Course Products by Geological Type an
Approved Aggregate Products From Mines or Terminals Listing	Lists Approved Aggregate Products for Mines or Terminals
Approved Products at Expired Mines or Terminals	A summary report to identify Approved Products at Expired Facilitie Terminals Expired at Mine
Asphalt Production Facility Listing	Lists all Asphalt Production Facilities
Asphalt Recycled Products	Approved Asphalt Recycled Products Report by Plant
Asphalt Targets	A listing of the asphalt gradation and gravity (Gsb) data for Asphalt
Cementitious Materials Production Facility Listing	Lists Cementitious Materials Production Facilities
Coatings Production Facility Listing	Lists all Coatings Production Facilities
Fiber Reinforced Polymer Production Facility Listing	Lists all Fiber Reinforced Polymer Production Facilities

ACCEPTANCE CRITERIA

AASHTO
ASCE

Design

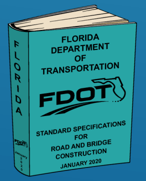
- Live Load Deflection:
  - L/1000 = Vehicular + Pedestrian
  - L/800 = Vehicular only
  - L/xxx = Pedestrian/Trail
- HL-93 Vehicular Bridge + FL120
- H-5 (≤ 8 ft.) / 90 psf Pedestrian or H-10 (> 8 ft. wide) /90 psf Pedestrian
- Fatigue (wind from vehicular under-pass)
- Storm Surge & Wave Loading

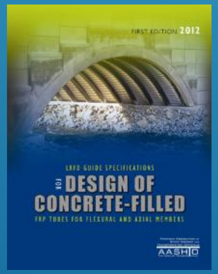
Bridge Size and Traffic Volume

- *Span lengths*
- Continuity
- Non-interstate

Benefits and Limitations to Standardization

- *Developmental Standard Plans*
- *Developmental (Construction) Specifications vs. TSP*





Procurement Model

- Bid-Build
- Design-Build
- Include addition time in contractors schedules for design and review and (resolution of disputes)

Asset Management

- Load Rating: FDOT vs Contractor's Engineer responsibility
- Inspection & Repair Criteria
- Future widening potential?

MANUFACTURER PREFERENCE DISCUSSION

ROADMAPPING

Next Steps

- Identifying gaps
- Identifying Pilot project
  - Structure type & function
- Pilot Procurement Model
  - Include addition time in contractors schedules for design and review and (resolution of disputes)
- Schedule
  - Design Criteria Development
  - Pilot Project Letting
  - Programmatic Implementation

Assignment of Tasks

- FDOT
  - Design
  - Materials
  - Construction
  - Maintenance
- Industry
- Academia

FDOT FRP-Composite Bridge Beam Meeting Notes

10/3/2019

- Introductions
  - Jeff Brown – summary of composite beam research under BDV22 977-01
    - Project examined:
      - Generic beam
      - Concrete filled tube beams
      - Strongwell double-I beam
      - Molded Fiberglass
      - Bridge in Poland: *Mostostal (Com-bridge beam)*
    - 2nd phase on hold due to large number of commercial options becoming available instead of creating a FDOT beam
- Robert Robertson – goal of this, and future, meetings
    - Move beyond pilot projects
    - Large amount of coastal areas in Florida, this will be a focus area for an FRP composite beam
    - Determine parameters to design for
    - Determine criteria to go to the Design-Build process
    - Once basic goals are setup contractors will join the conversation
    - Will need to move towards LCC and LCA for owners (FDOT) to determine most cost-effective structure.
- FDOT Practices
  - Volume 4 of ***FDOT Structures Manual*** has broad criteria, not specifics, in addition to what is required from the State Materials Office (***Materials Manual***) for production/QC
  - Bidding process needs to be revisited to assist Composite Bridge Beam manufacturers.
    - Who will be responsible for Load Rating of superstructure?
  - Currently FDOT does not allow precast units (without transverse post-tensioning) without a deck. Old Sonovoid units were problematic, similar to the double-T's. FSBs are a precast option with a partial depth deck cast. They are easy to erect. Historically FDOT has not used hollow box beams.
- What works for other DOTs?
  - Value Engineering is not working as planned. It is hard to convince the contractors to save the owner money in the long-run without significant profit for the contractor to offset construction risk (time and money).
  - Maine DOT
    - Detail-Build
    - Superstructure is detailed
    - Contractor selects bid design they prefer
    - Details are awarded generically

- Pennsylvania
  - Pre-approved systems
  - Extensive upfront design effort
  - Full example plans with calcs and specs
  - Designer picks pre-approved system
  - Designer to recommended option or Value Engineer to something else
  - Prescriptive to where each option can be used
- General Comments
  - Sometimes called out specifically, sometimes vague with requirements
  - Working towards meeting traditional option cost estimate
  - Work with contractors to avoid unfamiliarity with expected costs
  - Manufacturer should always have a representative on-site during erection (initially?)
  - Send out installation manual ahead of time
  - VE usually only successful when there is a lower project acquisition cost, contractor still needs current cost to be in their advantage.
    - In FDOT's case, FDOT will put alternatives against each other, not against traditional materials (RC and steel)
    - FDOT will make decision upfront for conventional projects
  - Consider "Best Value" Analysis, includes LCC, constructability and time.
  - Need guidelines for reviewers
  - Federal Proprietary Product restrictions going away is good idea
  - Need to create a model for economy of scale, there is a high material cost
  - Create a system that potentially avoids having to repeat the same design multiple times
  - Detail-Build assists with controlling design costs for manufacturers and approval path for Contractor's preference.
  - Give the contractors freedom to choose a pre-qualified manufacturer they are more comfortable with.
  - The IBRD program allowed owners to try innovative systems and limit cost risk.
  - In-Service Inspection recommendations for FRP decks under NCHRP 564 (2016)

- Accountability
  - Need to hold manufacturers accountable for quality:
    - 3rd party industry for inspections and QC is the preference
    - FDOT contracts for qualified inspectors throughout the country for steel fabrication
  - Simplify nationally to not 50 models of acceptance (one per State DOT)

        - What to measure against?
    - Need national standard for QC personnel
    - ASCE LRFD Pre-standard for pultruded shapes is almost ready for public review as a full Standard.
        - Public review in Fall/Winter 2019
        - Anticipated approval late Spring 2020?

FDOT FRP-Composite Bridge Beam Meeting Notes

10/3/2019

List of Attachments:

Appendix A - Submitted Notes from Producers.

Appendix B – State DOT Specifications for Comparison.

Appendix C – Sample Plans General Notes Sheet.

FDOT FRP-Composite Bridge Beam Meeting Notes

10/3/2019

<u>Appendix A - Submitted Notes from Producers:</u>

Manufacturer's Insight – Composite Advantage (*Scott Reeve & Gregg Blaszak*-Coastline Composites)

Composite Advantage's products in the bridge market are vehicle decks, pedestrian decks and deck/beam superstructure bridges for both vehicle and pedestrian.

All of our projects have been sold through direct selling to the key decision maker, either the owner or the design engineer.

The process has been special provisions with performance requirements and manufacturer's qualifications. Sometimes the plans are fairly detailed on the product features; while sometimes it is a generic callout saying "FRP".

Requirements in special provisions are similar across projects as engineers use language from previous projects and other states.

Other procurement options have only been successful when FRP offers a lower project acquisition cost. CA has only accomplished this with fender protection systems; not with bridges. There has to be a NOW value for FRP to be selected. That can be lightweight or prefabrication and coupled with long lasting corrosion resistance.

Very few owners select FRP purely for long life; there are some; but only a few. If owners have a tough justifying higher upfront cost purely on long life, how can you expect contractors to choose this.

CA has never sold a bridge product through value engineering. There is no economic incentive for the contractor to do it. We have converted fender systems to FRP through value engineering (BECAUSE THIS RESULTS IN LOWER INITIAL COST)

You can say 'Alternate Accepted' but still doubtful that FRP with higher acquisition cost is selected.

Design-Build-Maintain projects when the contractor has monetary responsibility for decades after construction have a possibility of encouraging use of higher cost technology like FRP. When I sell into these projects, I get the most and the hardest questions of any sale.

Elimination of the proprietary product restriction will make it easier on the designer/specifier. They won't have to work so hard to create specs and plans to push the contractor to the preferred product.

Having a contract model would be very helpful for all parties.

Important elements:

FDOT FRP-Composite Bridge Beam Meeting Notes

10/3/2019

Manufacturer qualifications focusing on successful history with product. Has to be more than just FRP fabrication. Must demonstrate understanding of the structure; joints and connections are where issues occur.

Performance based specs; not prescriptive.

Rules/guidelines for the reviewers of submittals. Help them correctly do their part of the process.

FDOT FRP-Composite Bridge Beam Meeting Notes

10/3/2019

Appendix B – State DOT Specifications for Comparison:

1. Florida DOT: Technical Special Provision T450 – Furnishing & Installing Hybrid-Composite Beams (for Halls River Bridge FPID 430021-1-52-01, March 3, 2016), *[13 pages]*
2. Florida DOT: Standard Specification 973 – Fiber reinforced Polymer (FRP) Composite Structural Shapes (for Halls River Bridge FPID 430021-1-52-0, March 3, 2016), *[5 pages]*

3. Maine DOT: Special Provision 531 – Detail-Build Bridge Structure (July 20, 2018), *[5 pages]*

4. Pennsylvania DOT: Special Provision c80021 Item 8500-7022 – Composite Arch Bridge System, As Designed S-37104 (November 7, 2017)
[2 pages, 105-106]

5. Rhode Island: Code 800.9902 – Furnish and Deliver Composite Arch Bridge Components AND Installation of Composite Arch Bridge Components (June 14, 2018)
[9 pages]

FDOT - Halls River

TECHNICAL SPECIAL PROVISION

FOR

SECTION T450 - FURNISHING & INSTALLING HYBRID-COMPOSITE BEAMS

FINANCIAL PROJECT ID: 430021-1-52-01

The official record of this Technical Special Provision has been electronically signed and sealed using a Digital Signature as required by Rule 61G 15-23.004, F.A.C. Printed copies of this document are not considered signed and sealed and the signature must be verified on an electronic copies.

MAMUNUR RASHID SIDDIQUI LICENSE No 70094 STATE OF FLORIDA PROFESSIONAL ENGINEER

Digitally signed by Mamunur R Siddiqui
Date: 2016.03.03 17:53:02 -05'00'

Professional Engineer: Mamunur Rashid Siddiqui, P.E.
Date: March 3, 2016
Fla. License No.: 70094
Firm Name: FDOT
Firm Address: 11201 N McKinley Dr.
City: Tampa, State: FL, Zip code: 33612 Certificate of Authorization: N/A.
Pages: 1-13

SECTION T450-13. FURNISHING HYBRID-COMPOSITE BEAMS

T450-13.1. Description:

This work shall consist of furnishing (fabricating, storing and delivering) and installing Hybrid-Composite Beams (HCBs) to the dimensions and details shown on the plans and according to the requirements of the FDOT Standard Specifications and these Special Provisions. HCBs for incorporation into the project shall include the FRP shell, tension and compression reinforcement, shear connectors and 6H & 7H bars with couplers.

T450-13.2. Definitions:

The definitions specific to HCBs are described herein:

Hybrid-Composite Beam (HCB): A structural framing member comprised of three main sub-components that include a fiber-reinforced polymer (FRP) shell, compression reinforcement and tension reinforcement.

FRP shell: An external, fiber reinforced polymer shell consisting of a glass fabric infused with an epoxy vinyl ester resin matrix that encapsulates the internal components of the HCB.

Compression Reinforcement: A cementitious material such as Portland cement concrete, which is placed by suitable means into a profiled conduit fabricated within the FRP shell. The profile of the conduit is designed to resist the internal compression forces in the beam.

Tension Reinforcement: Prestressing Strand infused integrally into the FRP shell and designed to equilibrate the internal compression forces in the beam.

Shear Connector: A diagonal tension member with one end anchored in the compression reinforcement and the opposing end anchored in the deck slab. A plurality of shear connectors are utilized to provide a positive connection to the bridge deck as well as to facilitate composite bending behavior between the HCB and the concrete deck.

Preforms: Individual element components of materials to be incorporated into the manufactured FRP shell, e.g. glass fabric and tension reinforcement.

Tooling: The molds or forms that are used in the manufacturing of the HCB.

Supplier: HCB, Inc. of 10945 State Bridge Road, Suite 401-444, Alpharetta, GA 30022-5676, the only known licensed supplier of HCBs is to furnish hybrid-composite beams and will ultimately be responsible for the fabrication, storage, delivery, and technical support during the beam construction.

Manufacturer: A firm authorized by HCB, Inc. for the manufacturing of Hybrid-Composite Beams (HCBs).

Contractor: A company that accepts delivery of the beams from the supplier and is responsible for their erection and placement.

T450-13.3. Quality Control/Quality Assurance:

The Contractor shall submit to the Department, a Quality Control (QC) Plan for fabrication of the HCBs. Fabrication of HCBs shall not commence until the QC Plan has been reviewed and approved by the Department. The QC Plan shall identify the manufacturer(s) and include the quality control practices necessary to produce HCBs that meet all requirements of this specification.

The FDOT QA Inspector(s) will review the QC Plan for items including the following and inspect the fabrication process for compliance with the QC Plan and the requirements of this specification. The District Materials Office will provide support with QC Plan review, and verification inspection and testing activities for the polymer and FRP components of the HCBs.

- Material certifications for:
  - Glass fibers
  - Resin for FRP shell
  - Poly-iso foam
  - Methacrylate or epoxy adhesives
  - Gel coating for exterior application on FRP shell
  - Threaded rod inserts for diaphragms
  - Cable strand ½" diameter, low-relaxation cable strand
  - Re-bar
  - Zinc coating on bars and strands
  - Steel (in accordance with buy America provisions)

- FRP Shell fabrication:
  - QC acceptance/rejection procedures for raw material lots
  - QC procedures for fiber lay-up, resin batch mixing, infusion, curing, and de-bagging/de-molding
  - QC sampling and testing procedures
  - Calibration certifications for process equipment/instruments (thermometers, scales, etc.)

- Structural concrete (compression arch):
  - Approved mix design for self-consolidating concrete (SCC), 6000 psi
  - Approved batch plant with approved mix design from that plant
  - Description of concrete placement procedure
  - Concrete curing and protection methods approved
  - Physical location of concrete plant
  - QC qualifications for sampling and testing of concrete
  - Identify QC sampling for lot acceptance
  - Identify QC lab approved for concrete testing
  - QC concrete CTQP certifications in QC Plan (requirements of Section 105)

- Quality Control functions:
  - Commitment to quality statement
  - Identify plant location and layout
  - Identify storage area(s) of all components to be used in fabrication
  - Keep heat tags with bundles or coils until depleted, then keep with QC records
  - Example QC inspection forms
  - QC labels and labelling requirements/procedures
  - Notarized certification statement of compliance with specifications sent to job
  - Shipping tickets
  - Grant FDOT access to all QC records upon request
  - Maintain QC records on site and minimum 3 years after acceptance of project
  - Surrender material samples to FDOT upon request
  - Identify all independent testing labs and inspection firms
  - Submit all repair methods to District Materials Office for approval prior to repair

T450-13.4. Materials:

Materials shall be according to the following. Any substitutions to the materials specified must be submitted to the Engineer to get approval from the District Materials Office, 2730 SR 60 West, Bartow, FL-33830.

T450-13.4.1. FRP Shell: The FRP shell shall be comprised of a glass fiber reinforced polymer laminate bonded to a low-density foam core. The materials used in the laminate shall be as follows:

Glass Reinforcement: The glass reinforcement of the FRP laminate shall be as per the contract plans. Modulus of elasticity of E-glass Fiber is 10500 ksi and Poisson ratio 0.22. Additional non-structural layers of resin distribution media may be placed between the glass layers and the low-density foam. Submit detailed shop drawings for approval.

Resin: The matrix used in the manufacturing of the FRP Shell shall be a polyester resin or a bisphenol-A epoxy-vinyl ester resin with a dynamic viscosity between 100 and 400 centipoise at 77 degrees F. The resin shall be promoted with 12% cobalt solution comprising of between 0.07 to 0.15% by weight of resin, along with between 0 to 0.07% by weight N, N-Dimethylanileine (DMA), or as recommended by the manufacturer. The resin shall also contain 0.30% by weight UV-9 as a UV Stabilizer. 2, 4 Pentane Dione may be used as an inhibitor to increase the gel time if necessary. Modulus of elasticity of Vinyl Ester resin is 520 ksi and Poisson ratio 0.30.

Foam Core: Where shown on the contract plans, the interior volume of the shell shall be occupied by a polyisocyanurate (polyiso) foam core. The polyiso foam shall have an average density of no less than 2.0 lbs/cubic foot as determined by ASTM D1622 and a compressive strength of no less than 20 lbs/square inch as measured by ASTM D1621. Polyiso foam shall be cut using a saw capable of cutting the profiled shape of the compression reinforcement in the polyiso foam core to within ±1/8" per eight foot.

Structural Adhesives: The adhesive used in joining pieces of laminate together shall be high-viscosity, methacrylate adhesive compatible with the substrate materials being bonded, meeting the following requirements: Tensile Strength > 2,500psi, Tensile Modulus >/=

60,000psi, Maximum Tensile Elongation 100% to 150%, Service Temperature 0 to 120 deg F, using appropriate ASTM Standards, and Lap Shear Strength > 2,000psi as measured by ASTM D5868.

T450-13.4.2. Compression Reinforcement: The Compression Reinforcement shall consist of Self-Consolidating Concrete (SCC) with arch strands. Prior to placement of the compression reinforcement, the Contractor's Concrete Supplier shall demonstrate the ability to batch and deliver the self-consolidating concrete meeting the requirements of this specification and Dev346SCC. The SCC shall conform to the requirements of developmental specification Dev346SCC and the following:

1. Minimum compressive strength at 28 days shall be as shown on the contract plans.
2. Target air content shall be 2% to 8%.
3. Coarse aggregate shall be #89.
4. The mix shall contain a viscosity-modifying admixture at a dosage to be determined by the Contractor's Concrete Supplier.
5. The mix shall contain a hydration stabilizer dosed at a rate to ensure no hydration beginning for a minimum of three hours from batching or as needed by the ambient conditions at the time of concrete placement. The temperature shall be identified on the mix for the dosage rate of hydration stabilizer selected.
6. The measured spread of a slump flow test shall be within the range of 26 inches minimum and 32 inches max. Arch strands shall be 2- ½" diameter low-relaxation strands, 270ksi in accordance with ASTM A416 seven wire, galvanized strands.

T450-13.4.3. Tension Reinforcement: The Tension Reinforcement shall consist of one or more of the following:

a) Seven-wire, Prestressed Concrete Strand (PC) conforming to the requirements of ASTM A416, Grade 270. Where indicated, the strand shall be zinc coated in accordance with ASTM A475 and stress-relieved after galvanizing and stranding. The Tension Reinforcement shall be cut and bent after galvanizing. Seven-wire, Galvanized Barrier Strand, Grade 270 is also an acceptable substitution for ASTM A416 Strand.

b) Concrete Reinforcing Bars meeting the requirements of ASTM A615 or A706 Grade 60. Where indicated, the reinforcing bars shall be zinc coated (galvanized) in accordance with ASTM A123 or ASTM A767.

c) Other mild steels as indicated in the Contract Plans or in accordance with the final design meeting appropriate industry standards (ASTM, AISC, AASHTO, etc.) with the use of such materials, their source and fabrication subject to the approval of the engineer.

d) Glass Reinforcement as per section T450-13.4.1 of this specification.

T450-13.4.4. Shear Connectors and 6H & 7H bars with couplers in beams: The Shear Connectors and **6H and 7H** bars shall be ASTM A615 or A706 Grade 60 reinforcement bars. Where indicated, the Shear Connectors and **6H and 7H** bars and couplers shall be zinc-coated (galvanized) in accordance with ASTM A123 after they have been cut and bent to the sizes and shapes indicated on the Contract Plans. Bending tolerances and material certifications shall be in accordance with the appropriate sections of the Standard Specifications.

T450-13.5. Equipment:

Equipment shall be according to the following:

Vacuum System: A vacuum capable of sustaining a pressure equal to 25 inches of mercury shall be required for the vacuum infusion of the FRP Shell.

Concrete Pump: For placement of the SCC, a boom type concrete pump truck may be allowed. The pump truck shall be capable of reaching all HCBs to be filled with one truckload of concrete, without moving the truck. Aluminum pipe or conduit will not be permitted in pumping or placing concrete. The SCC concrete placement shall be done in the plant prior to erection of the beams.

T450-13.6. Working Drawings:

Prior to beginning fabrication, the Contractor shall submit complete Working Drawings to the Engineer for review and approval in accordance with section 5 of the Specifications. As part of the Working Drawings, the contractor may propose alternative glass fabric layups for the laminate that may deviate slightly from the fabrics indicated in the Construction Documents. The Contractor shall provide test data and supporting design calculation for the final laminate proposed to demonstrate that the properties meet the design intent of the Construction Documents. The Contractor shall submit shop drawings for the design of the deck overhang form brackets and forming system to ensure that damage does not occur to the HCB shell and foam during the placement of the deck concrete. Working drawings/shop drawings and supporting calculations have to be signed and sealed by Specialty Engineer or Contractor's Engineer.

T450-13.7. Fabrication:

Hybrid-Composite Beams shall be fabricated and stored according to the following requirements.

T450-13.7.1. Preform Storage and Preparation: Glass fabrics, tension reinforcing and polyiso foam shall be stored above the ground in a clean, dry environment upon platforms, skids, or other supports. It shall be kept free from water, dirt, grease, or other foreign matter, and shall be protected from corrosive and or deleterious materials.

Glass fabrics shall cut to the dimensions indicated for the layup on the approved Working Drawings. The fabrics shall be cut on a clean cutting surface, free of any deleterious material that could adhere to the fabrics prior to placing in the tooling. Any cutting of rovings within a piece of glass fabric that exceeds 5 percent of the dimension parallel to the line of the cut may be rejected.

Lap splices in the glass fabric will be permitted along the longitudinal direction of the beam. Lap splices shall be no less than 4-inches in length and placement shall be limited as follows:

- No lap splice will be permitted within 6-feet of either end of the beam
- If multiple, longitudinal splices are required, the splices shall be spaced no less than 10-feet apart within a single layer of the FRP laminate

- If splices are required in adjacent layers of the laminate, the splices shall be staggered to provide no less than 2-feet between splices in adjacent layers of glass within the FRP laminate

Tension Reinforcement shall be cut on a surface, free of any deleterious material that could adhere to the steel prior to placing in the tooling. Cutting of the Tension Reinforcement shall be performed utilizing a method that will not significantly alter the physical properties of the material. Cutting of the Tension Reinforcement with acetylene or plasma torches will not be permitted. Bends to the longitudinal strands necessary to produce the preformed Tension Reinforcement shall be made with a device suitable to provide a tight uniform bend with a radius of *no more than 3-inches*. The tolerance on the out-to-out dimensions after bending of adjacent strands of Tension Reinforcement shall be +0, -1/2 inch. Tension reinforcement length may be adjusted as required to account for tolerance in the form.

Polyiso foam shall be prefabricated in blocks to minimize the number of joints within the beam core. With the exception of some minor modifications to the blocks to accommodate manufacturing, the polyiso blocks shall be machine cut with a saw of sufficient throat to cut the entire depth of the section. All longitudinal cutting of the polyiso blocks to facilitate the shape of the compression reinforcement must be cut with a saw with sufficient depth to cut the entire depth of the section within the required tolerance. Once the longitudinal cuts for the compression reinforcement have been made, the separate pieces shall be match marked. Match marked pieces of polyiso foam shall be shipped and placed in the tooling to maintain the proper dimensions of the conduit for the compression reinforcement. Gaps in the joints between adjacent pieces of foam shall not exceed ¼-inch prior to pulling vacuum on the tooling. Additional processing for recesses and cutouts in the polyiso foam shall be performed with handheld and/or table mounted routers saws or other tools suitable for the intended purpose.

Resins and other chemicals necessary for catalyzing the infusion matrix shall be stored in a temperature-controlled environment, in accordance with the manufacturer's recommendations for each component.

T450-13.7.2. Tooling: Tooling shall be capable of fabricating units to the dimensions required by the contract plans within all allowable tolerances. The tooling surfaces shall be manufactured of steel or FRP laminate skins of sufficient thickness so that they will remain true to shape under the vacuum infusion pressures. Clamps, pins and other connecting devices shall be designed to hold the tooling rigidly in place during placement of the preforms and application of vacuum pressure for infusion as well as to allow removal of the FRP Shell without damage to the laminate. If metal forms are used, they shall be free from rust, grease, or other foreign matter. ¾-inch radius fillets shall be built into the tooling at all sharp corners or as indicated on the Plans. The tooling shall be designed with monolithic joints and/or seals to facilitate an airtight chamber capable of sustaining 1 atmosphere of pressure, without any leaks for the duration of the infusion process.

The HCB's shall be manufactured to the dimensions shown on the plans. Measurements of the product shall be recorded and compared to design plans and tolerances allowed. The dimensional tolerances for the tooling shall be as follows:

Maximum Allowable Dimensional Tolerances for HCB Components

HCB Component	**Inches (except as noted)**
Depth, overall (Bottom Shell)	± ¼ in.
Width, overall	± ¼ in.
Length (string line measurement along bottom of beam)	± ¼ in per 25 feet max ± ½ in.
Variation from specified elevation and squareness or skew	± 1/8 in. per 12" depth max ± 3/8 in.
Sweep	± ½" maximum
Camber variation from design camber (Bottom Shell)	-1/8 in.; +1/8 in. per 10 ft, +1 in. Max
Tipping and flushness of beam seat bearing area	± 1/8 in. per 24 inches
Shear reinforcing; longitudinal location	± 1/4 in.
Shear reinforcing; projection from beam surface	+ 1/4 in., - 1/4 in.

Prior to placement of preforms, the tooling shall be cleaned and coated with a semi-permanent form release agent common to the practice of composite manufacturing, Prior to charging the tooling with glass preforms, the Manufacturer may apply a gel coat to provide for protection of the laminate from Ultraviolet (UV) radiation in the completed FRP Shell.

T450-13.7.3. Vacuum Assisted Resin Transfer: Prior to vacuum infusion of the vinyl-ester or polyester matrix, the Manufacturer must thoroughly seal the tooling and demonstrate that the sealed tooling can obtain a minimum vacuum pressure of 25 inches of Mercury and for that vacuum pressure to drop no more than 1" of mercury over a period of five minutes.

Chemical additives and catalysts to be combined with the vinyl-ester resin shall be measured by weight, or the corresponding volume, based on the amount of vinyl-ester resin. The HCB Fabricator shall maintain a log of each batch of resin and the weights or volumes of each constitutive material included in each batch. Once a batch of resin has been catalyzed, it must be thoroughly mixed and placed into the infusion reservoir within the gel time for the specific composition of the catalyzed matrix with a specified quantity of gel time inhibitor.

The infusion reservoir must be charged with a sufficient amount of resin at all times to prevent air bubbles from entering the infusion port(s) in the tooling. Once catalyzed resin is introduced into the tooling, the infusion process shall continue, uninterrupted until it has been demonstrated the evacuation ports have of resin flowing past the finished surface of the tooling and that no less than the 90% of predicted volume of resin has been introduced into the tool.

In the absence of tests to determine the cured state of the resin matrix, the tooling shall remain in place, and remain under vacuum until at least 6 hours have elapsed after the infusion process is considered to have been completed.

The FRP laminate comprising the shell shall be tested in accordance with the specified ASTM Standards in conformance with the minimum mechanical properties outlined in the table below. Certified copies of test results shall be submitted to the FDOT District Materials Office at Bartow for review and approval prior to use.

PROPERTY	VALUE	UNITS	ASTM TEST METHOD
Tensile Strength Longitudinal Transverse	 > 50 > 25	 ksi ksi	D3039-07
Tensile Modulus Longitudinal Transverse	 > 3100 > 2680	 ksi ksi	D3039-07
Compressive Strength Longitudinal Transverse	 > 20 > 20	 ksi ksi	D695 or D6641
Shear Strength	> 8.3	ksi	D7078
Shear Modulus	> 850	ksi	D7078
Water Absorption	< 0.7	% max.	D570
Density	0.060-0.068	lb./in^3	D792
Specific Gravity	1.6-1.0		D792
Coefficient of Thermal Expansion (Longitudinal Direction)	< 6.0×10^{-6}	in./in./°F	D696
Glass Fiber Content	> 60	% by weight	D2584
Major Poisson ratio	0.30		
Minor Poisson ratio	0.26		
Maximum usable FRP strain	0.013		

T450-13.7.4. Post-Processing: Once the laminate of the FRP Shell has been sufficiently cured, the HCB may be removed from the tooling. Ridges or fins (flash) of resin shall be removed by scraping or grinding as required. Any tooling or appurtenances internal to the FRP shell, necessary for forming of the compression reinforcement conduit shall be removed.

Subsequent to infusion of the bottom FRP Shell and the FRP top flange, the two match pieces shall be joined using structural adhesive. The two-part adhesive shall be mixed and applied in accordance with the manufacturer's recommendations, centered along the line of fasteners located along the top flange. Within the working time allowed for the adhesive, the FRP top flange shall be joined to the top of the beam shell using self-tapping stainless steel, screws to ensure a secure bond. Fasteners shall be spaced no more than 3'-0" on center for the entire length of the beam.

Holes in the FRP Shell to facilitate the installation of Shear Connectors, diaphragm connections or reinforcing steel, anchor bolt studs and attachments for appurtenances shall be done by the Fabrication Contractor. Once these holes have been drilled, thoroughly remove all debris, including residual chunks of foam from the internal conduit within the FRP Shell.

T450-13.8. Handling, Storing and Transporting:

The FRP Shell, without compression reinforcement, may be placed upright, upside down or on its side, as necessary for drilling and post-processing of the finished piece. Care shall be taken in the handling of the HCB not to damage the surface finish of the laminate and beam.

The Contractor shall be responsible for removal of any standing water within the FRP shell immediately and prior to placement of the compression reinforcement, and protect shell from water intrusion until SCC concrete is placed. The beams shall be supported at both ends during SCC placement and afterwards.

Prior to moving any HCB FRP shell to storage, it shall be clearly marked with the mark number and date of fabrication of the FRP Shell in the location shown on the Working Drawings. All units shall be stored in an upright position on suitable dunnage, not in contact with the ground, at the support points shown on the approved working drawings. The FRP Shells may be stacked. When stacking, the HCBs shall be maintained in the upright position at all times and each beam shall be supported with cribbing supporting the upper beam in the same locations as the HCB's below. HCBs shall be protected against any significant accumulation of water in the compression reinforcement void while stored at the Manufacturer's facility.

HCBs shall not be approved for shipment until all dimension tolerances have been checked and the void for the compression reinforcement has been checked to ensure it is the proper size and free of any obstruction.

All filled HCBs shall be shipped upright at the transportation points shown on the approved working drawings. FRP shells or filled HCBs may be stacked for shipping and shall be protected against any accumulation of water in the compression reinforcement void during transit.

If the HCBs are to be stored on site, the same provisions outlined above for storage at the manufacturer's facility shall apply. In addition, the beams should not be allowed to come into contact with seawater, mud, grease or other deleterious materials that may be present on a jobsite.

If the HCBs are damaged during handling and storage prior to their incorporation into the structure, the damaged HCBs shall be repaired or replaced at the Engineer's discretion and at the Contractor's expense.

SECTION T450-14. INSTALLING HYBRID-COMPOSITE BEAMS

T450-14.1. Erection:

The Hybrid-Composite Beams shall be erected to the lines and grades as indicated in the plans and in accordance with the requirements of these Special Provisions. At least thirty days prior to erection, the Contractor shall submit an Erection Plan indicating lifting methods, erection sequence, construction inserts, and other pertinent information including a letter of concurrence from the supplier confirming his review and approval of all lifting methods, erection sequence, construction inserts, pertinent calculations, etc. Penetrations in the HCB Shells for construction purposes shall be shown on the erection plan and will not be permitted unless approved by the Engineer of Record.

A. Beams shall be placed on clean bridge seats and tops of bearing devices. Any shifting of beams shall be done while they are held free of the supports.

B. HCBs shall be handled with a suitable hoisting device or crane of sufficient capacity to handle the members. Nylon slings or other approved methods shall be used to prevent damage to the surface of the HCBs. The Contractor shall cast the compression reinforcement in the plant prior to erection or hauling of the HCBs, the lifting anchors, in accordance with the approved working drawings shall be cast into the ends of the beams during placement of the compression reinforcement.

C. The Contractor shall provide sufficient bracing of the beams to prevent rotation or instability during casting of the deck and end diaphragms. Bracing shall also provide for a tie-down force to prevent displacement of the beams resulting from climatic events such as high winds or wave impact or other environmental or jobsite hazards, as required.

D. The shear connectors must be in place and positively secured prior to placing the compression reinforcement.

T450-14.2. Compression Reinforcement:

The Contractor shall precast the compression reinforcement, he shall not receive any additional payment for any additional reinforcement or couplers that may be required to make connections between units or to cast-in-place reinforcing in the field. The HCBs shall be supported at the bearing areas as shown on the Plans (or other locations as shown on the approved Working Drawings) and shall meet the requirements of the Specification. The HCBs shall be suitably braced during the placement of the compression reinforcement. HCBs shall not be moved after placement until the compression reinforcement has reached the required strength indicated on the approved working drawings.

T450-14.3. Placing Compression Reinforcement:

The Contractor shall place the compression reinforcement in HCB at the Fabrication/Precast plant prior to hauling or erection of the HCB beams. The Contractor's Quality Control Technician (QCT) shall be present for all compression reinforcement concrete placements. The Contractor shall be responsible for ensuring that all requisite reinforcing bars, dowel bars and other inserts have been properly installed in the HCB shell prior to placing of the compression reinforcement. Concrete shall not be placed until the HCBs and shear connectors have been checked and approved by the Engineer. The beams shall be clean of all debris and the HCB shell purged of any standing water.

The only acceptable method(s) shall be that approved in the placement plan. The SCC for the compression reinforcement shall be placed into the HCB at the locations shown on the approved working drawings. If a concrete pump is used, the concrete pressure at the discharge end of the pump shall be no more than 10 psi. The filling shall continue until there is sufficient evidence at vent ports at the ends of the beams that the conduit for the compression reinforcement is completely filled. Once filling has been initiated for any given HCB, the beam must be completely filled without delay. Cold joints in compression reinforcement will not be allowed without the written approval of the Engineer. Adjustments to the placement plan based on ambient conditions and field experience will be allowed with the concurrence of the Engineer.

Although SCC is a flow able concrete that is designed for placement with no vibration, the Contractor may find it necessary or may be directed to use vibrators to ensure that the HCB shell is completely filled with the compression reinforcement and free of any air voids. For this purpose, 2-inch diameter holes may be drilled into the top flange of the HCB shell at two-foot minimum intervals along the center line of the top flange to accommodate a conventional concrete vibrator. The location of any additional holes necessary during placement of the concrete must have the concurrence of the Engineer.

In addition, hand placement of concrete may be used to completely fill the final few inches of the beam. It is the Contractors responsibility to ensure each beam is completely filled. Due to the nature of SCC Concrete, the contractor may have to remove some foam or excessive bleed water by placing additional concrete by hand in the injection or vibration openings after pumping is complete until such time as concrete appears to the tops of these openings.

Care shall be taken to prevent mortar from spattering on the HCB shell and, reinforcing steel and forms. Concrete or mortar that becomes dried on the HCB, reinforcing steel or forms shall be thoroughly cleaned off before the erection. Upon completion of the bridge structure, the HCBs shall be cleaned of all concrete, mortar or other materials present on the HCB shells in a manner that does not damage the HCBs and as approved by the Engineer.

No less than 24 hours after the placement of the compression reinforcement, but prior to placing the deck reinforcement, the Contractor, shall inspect the beam(s) containing cast compression reinforcement for voids. The inspection shall consist of a minimum of the following:

- Visual Inspection of all openings including around the shear connectors and embedded items for voids
- Sounding along the top flange for voids using a hammer
- Drilling through the FRP top flange where voids are suspected by either of the two methods above to ensure complete filling of the beams

If the inspection indicates the presence of voids, they shall be filled using either the same SCC concrete mix, an approved FDOT prepackaged grout with the same 28 day compressive strength as the SCC mix or the deck concrete placement when the void is completely exposed to the deck and the opening is not less than 1" across in any direction. Voids not filled with the deck concrete placement shall be re-inspected to ensure the void has been filled.

T450-14.4. Delivery:

Delivery and discharge of the concrete from the mixer shall be completed within a maximum of 2½ hours from the time that the cement is added or working time based on the amount of hydration stabilizer added. Placement of concrete in any given HCB shall not be initiated until the Contractor has demonstrated that there is sufficient concrete located at the plant as verified by the Engineer for placement in the final structure. The Contractor may request permission from the Engineer to add water or admixtures to the mixture before or after discharge has been initiated from the mixer as long as the amount of additional water does not exceed the maximum water/cement ratio for the approved mix design. Concrete that is allowed to stand in the pump line for a period of more than ten minutes shall be purged from the line and shall not be utilized for compression reinforcement and a slump flow range test shall be required before continuing pumping operations. Recirculation of concrete shall not be considered "standing" for this specification.

T450-14.5. Temperature Restrictions:

Concrete temperature when pumped into the HCBs shall not exceed 75°F. Placement shall not be initiated unless the ambient temperature is at least 40°F and below 90°F . Additionally, placement shall not be initiated if the temperature of the HCB shell is in excess of 90 °F. Concrete, which has been rejected for any reason, shall be removed immediately from the plant and disposed of properly at the Contractor's expense.

T450-14.6. Method of Measurement:

FURNISHING & INSTALLING HYBRID-COMPOSITE BEAMS – per linear foot will be measured as each for payment.

T450-14.7. Basis of Payment:

Payment for FURNISHING & INSTALLING HYBRID-COMPOSITE BEAMS – shall be made at the Contract Unit Price per linear feet and shall be considered full payment for fabrication, delivery and installation of the HCBs, including the FRP Shells complete with tension strands, longitudinal strands in compression arch, shear connectors, 6H and 7H galvanized bars with couplers for diaphragms, supply and placement of compression reinforcement (SCC), temporary bracing as required and all submittals required for approval prior to execution of this work.

T450-14.8. Payment Items:

Payment will be made under:

Item No. 915-450-21 Hybrid Composite Beam (HCB-21) – per LF.

SECTION 973
FIBER REINFORCED POLYMER (FRP) COMPOSITE STRUCTURAL SHAPES

973-1 Description.

This Section covers material and fabrication requirements for fiber reinforced polymer (FRP) composite structural shapes.

973-2 Product Acceptance.

Obtain FRP composites from a producer that is currently on the Department's Production Facility Listing. Producers seeking inclusion on the list shall meet the requirements of Section 105.

973-3 Thermoset Pultruded Structural Shapes.

Thermoset pultruded structural shapes must meet the requirements in the materials section of the ASCE, Pre-Standard for Load & Resistance Factor Design (LRFD) of Pultruded Fiber Reinforced Polymer (FRP) Structures.

Manufactured components shall be inspected according to ASTM D3917 for dimensional tolerances and ASTM D4385 for visual defects.

Pultruded profiles located on bridge and overhead sign structures shall meet a flame spread index of Class B in accordance with ASTM E84 and meet the requirements of UL94 with a rating of V-1.

973-4 Vacuum Infusion Processed (VIP) Structural Shapes:

973-4.1 Materials:

973-4.1.1 Fibers: Use commercial grade glass fibers that conform to ASTM D578. Glass fibers may be in any form such as rovings, woven fabrics, braided fabrics, stitched fabrics, continuous fiber mats, continuous strand mats, continuous filament mats (CFM), and chopped strand mats (CSM) of any size or weight.

Each structural element shall contain a minimum of 40% (by weight) of glass fibers oriented in a minimum of two directions in accordance with the manufacturer's requirements.

Tensile strength of glass fiber strands, yarns and rovings shall not be less than 290 ksi in accordance with ASTM D7290, determined by a tension test in accordance with ASTM D2343.

973-4.1.2 Resin: Use a commercial grade thermoset resin for fabricating shapes.

973-4.1.3 Additives: Additives such as fillers, promoters, accelerators, inhibitors, UV agents, and pigments, used in the processing or curing shall be compatible with the fiber and resin.

973-4.2 Physical and Mechanical Properties: The physical properties of VIP FRP products shall conform to the requirements of Table 4-1. The characteristic mechanical properties of VIP FRP composite structural members, determined in accordance with ASTM D7290, shall equal or exceed the minimum requirements in Table 4-2 for shapes and Table 4-3 for plates.

Table 4-1 Required Physical Properties - VIP FRP

Table 4-1 Required Physical Properties - VIP FRP		
Physical Property	Requirement	Test Method
Barcol Hardness	> 40	ASTM D2583
Glass Transition Temperature	> 180 F	ASTM D4065
Coefficient of Thermal Expansion	< 7.5 x 10^{-6} in/in/ F (longitudinal)	ASTM D696
Moisture Equilibrium Content	< 2%	ASTM D570, Section 7.4

Table 4-2 Required Mechanical Properties - VIP FRP Shapes		
Property	Minimum Requirement	Test Method
Longitudinal Tensile Strength	30,000 psi	ASTM D3039
Transverse Tensile Strength	7,000 psi	
Longitudinal Tensile Modulus	3 x 10^6 psi	
Transverse Tensile Modulus	0.8 x 10^6 psi	
Longitudinal Compressive Strength	30,000 psi	ASTM D6641
Longitudinal Compressive Modulus	3 x 10^6 psi	
Transverse Compressive Modulus	1 x 10^6 psi	
In-Plane Shear Strength	8,000 psi	ASTM D5379
In-Plane Shear Modulus	0.4 x 10^6 psi	ASTM D5379
Interlaminar Shear Strength	3,500 psi	ASTM D2344

Table 4-3 Required Mechanical Properties -VIP FRP Plates		
Property	Minimum Requirement	Test Method
Longitudinal Tensile Strength	20,000 psi	ASTM D3039
Transverse Tensile Strength	7,000 psi	
Longitudinal Tensile Modulus	1.8 x 10^6 psi	
Transverse Tensile Modulus	0.7 x 10^6 psi	
Longitudinal Compressive Strength	24,000 psi	ASTM D6641
Transverse Compressive Strength	15,500 psi	
Longitudinal Compressive Modulus	1.8 x 10^6 psi	
Transverse Compressive Modulus	1 x 10^6 psi	
Longitudinal Flexural Strength	30,000 psi	ASTM D790
Transverse Flexural Strength	13,000 psi	
Longitudinal Flexural Modulus	1.6 x 10^6 psi	
Transverse Flexural Modulus	0.9 x 10^6 psi	
In-Plane Shear Strength	6,000 psi	ASTM D5379
In-Plane Shear Modulus	0.4 x 10^6 psi	
Interlaminar Shear Strength	3,500 psi	ASTM D2344

973-4.3 Fire, Smoke and Toxicity: VIP profiles located on bridge and overhead sign structures shall meet a flame spread index of Class B in accordance with ASTM E84 and meet the requirements of UL94 with a rating of V-1.

973-4.4 Impact Tolerance: Where impact resistance is stipulated, impact resistance shall be determined in accordance with ASTM D7136.

973-5 Thermoplastic Structural Shapes.

973-5.1 General: For the purpose of this specification, use the following definitions:

a. Thermoplastic Structural Shapes (TSS) includes a thermoplastic matrix reinforced with chopped fiberglass filaments.

b. Reinforced Thermoplastic Structural Shapes (RTSS) includes a thermoplastic matrix reinforced with chopped fiberglass filaments and continuous FRP reinforcing bars meeting the requirements of this Section. Steel reinforcing bars are not permitted.

973-5.2 Materials: Use polyethylene made from recycled post consumer or post industrial thermoplastics. Mix the polyethylene with appropriate colorants, UV inhibitors, hindered amine light stabilizers, antioxidants, and chopped fiberglass reinforcement so that the resulting product meets the requirements specified in Table 5-1 for RTSS and Table 5-2 for TSS. Use a minimum of 15% (by weight) chopped fiberglass reinforcement for both TSS and RTSS. The thermoplastic matrix must not corrode, rot, warp, splinter or crack.

For RTSS members, the use of separate materials for skin and core is at the discretion of each manufacturer; however, both materials must meet the requirements in Table 5-1. The material surrounding the rebar within 1 inch from the rebar surface shall not contain voids greater than 3/4 inch diameter and extend no further than 2 inches along the length of the member. The cross section of the product shall not contain voids exceeding 1-1/4 inches in diameter and the sum of all voids greater than 3/8 inches in diameter shall not exceed 5% of the cross sectional area.

Extrude final product as one continuous piece with no joints or splices to the dimensions and tolerances in accordance with Table 5-3.

Reject any sections containing cracks or splits.

Table 5-1
RTSS Matrix

Property	Test Method	Requirement
Density	ASTM D792	48–63 pcf
Water Absorption	ASTMD570	2 hrs: <1.0% weight increase 24 hrs: <3.0% weight increase
Brittleness	ASTM D746	Brittleness temperature < minus 40°C
Impact Resistance	ASTM D256, Method A (Izod)	>0.55 ft-lbs/in
Hardness	ASTM D2240	44-75 (Shore D)
Ultraviolet	ASTM D4329 UVA	500 hours <10% change in Shore D Durometer Hardness
Abrasion	ASTM D 4060	Weight Loss: <0.02 oz Cycles = 10,000

Table 5-1
RTSS Matrix

		Wheel = CS17 Load = 2.2 lb
Chemical Resistance	ASTM D543	Sea Water: <1.5% weight increase Gasoline: <9.5% weight increase No. 2 Diesel: <6.0% weight increase
Tensile Properties	ASTM D638	2,200 psi at break min.
Compressive Modulus	ASTM D695	40 ksi min.
Static Coefficient of Friction	ASTM D1894	0.25, wet max.
Screw Withdrawal	ASTM D6117	400 lb (screw) min.

Table 5-2
TSS Matrix

Property	Test Method	Requirement
Density	ASTM D792	50-65 pcf
Impact Resistance	ASTM D256 Method A (Izod)	> 2.0 ft-lbs/in
Hardness	ASTM D2240	44-75 (Shore D)
Ultraviolet	ASTM D4329 (UVA)	500 hours <10% change in Shore D Durometer Hardness
Chemical Resistance	ASTM D756 or ASTM D543	Sea Water: <1.5% weight increase Gasoline: <7.5% weight increase No. 2 Diesel: <6.0% weight increase
Tensile Properties	ASTM D638	3,000 psi at break min.
Static Coeffecient of Friction	ASTM D2394	0.25, wet or dry min.
Nail Withdrawal or Screw Withdrawal	ASTM D6117	250 lb (nail) min. 400 lb (screw) min.
Secant Modulus at 1% Strain	ASTM D6109	150,000 psi min.
Flexural Strength	ASTM D6109	2,500 psi min.
Compressive Strength	ASTM D6108	2,200 psi min.
Compressive Strength Perpendicular to grain	ASTM D6108	700 psi min.

Table 5-3
Tolerances

Dimension	Tolerance
Length	0/+6 inch
Width – RTSS	±1/2 inch

Table 5-3 Tolerances	
Width – TSS	±1/4 inch
Height – RTSS Width – TSS	±1/2 inch ±1/4 inch
Clear cover from outer surface to rebar elements (RTSS)	≥3/4 inch (wales) ±1/2 inch (other)
Straightness (while lying on a flat surface)	<1-1/2 inches per 10 feet

Maine DOT

York
WIN 21709.00
July 20, 2018

SPECIAL PROVISION
SECTION 531
DETAIL-BUILD BRIDGE STRUCTURE
(Lump Sum)

531.1 DESCRIPTION

This work shall consist of the design, detailing, fabrication, delivery, and construction of a single span, buried Bridge Structure (including associated retaining wall/wingwall systems and foundations) in accordance with these Specifications, and in conformity with the lines, grades, and dimensions shown on the Contract Plans. This work shall include, but is not limited to, the following*:

- Design, load rating, and detailing of the new Bridge Structure
- Design and detailing of the new bridge substructure which consists of spread footings on bedrock/fill concrete
- Design and detailing of new headwalls, retaining walls and wingwalls and their foundations
- Precast Structural Concrete Bridge Structure
- Cast-in-place Structural Concrete Bridge Structure
- Composite Arch Bridge System
- Reinforced Concrete Foundations for Bridge Structure and Retaining Wall/Wingwall Systems
- Structural Concrete including quality control program
- Reinforcing Steel
- Membrane waterproofing on concrete surfaces
- Structural Earth Excavation
- Structural Rock Excavation
- Concrete Fill
- Granular Borrow
- French Drains
- Protective Coating for Concrete Surfaces
- Plain Riprap
- Drainage culverts, catch basins and/or paved downspouts to divert roadway low point drainage away from northwest wingwall

*Notes:
1. Some of the items listed above may not be applicable, depending on the structure option chosen.
2. Any items specifically needed for the construction of the proposed bridge as shown on the contract drawings that are not specifically covered by a separate item shall be considered incidental to the work included under this item.

531.2 DETAIL-BUILD OPTIONS

All Bridge Structure options and associated retaining wall/wingwall systems shall be supported by detail-build foundations consistent with the Bridge Structure and retaining wall/wingwall systems selected by the Contractor. The detail-build Bridge Structure shall have a headwall on each end of the structure to retain the Route 1 embankments. Allowable detail-build Bridge Structure options are limited to the following:

1. Precast structural concrete arch or three-sided frame with concrete headwalls and wing-walls

2. Composite Arch Bridge System in accordance Special Provision 509 with concrete headwalls and wing-walls

3. Cast-in-place structural concrete arch or three-sided frame with concrete headwalls and wing-walls

The Bridge Structure shall be constructed over the Cape Neddick River in accordance with the Plans. Allowable retaining wall/wingwall/headwall systems are the following:

- Cast-In-Place Concrete Headwall, Retaining Wall, or Wingwall System
- Precast structural concrete Headwall, Retaining Wall, or Wingwall System

531.3 DESIGN REQUIREMENTS

The Bridge Structure, Bridge Structure foundation, retaining wall/wingwall systems, and retaining wall/wingwall system foundations shall be designed by a Professional Engineer (Engineer of Record) licensed in the State of Maine. The designs shall be completed in accordance with the latest editions of the AASHTO LRFD Bridge Design Specifications, the MaineDOT Bridge Design Guide (BDG), MaineDOT Standard Details, MaineDOT Standard Specifications, and project-specific Special Provisions. The geotechnical design of the Bridge Structure foundation and the retaining wall/wingwall systems shall follow the design requirements and recommendations specified in the project Geotechnical Design Report (GDR) For the Replacement of Cape Neddick Bridge. Where differences exist between the information contained in the GDR and the information shown on the Contract Plans and project-specific Special Provisions, the information shown on the Contract Plans and project-specific Special Provisions shall take precedence.

All structural components of the Bridge Structure and retaining wall/wingwall design, in their entirety, shall be checked through independent calculations by a Professional Engineer (different than the Engineer of Record) licensed in the State of Maine. Proof of the independent check shall be submitted to the Department as part of the final design submittal in accordance with 531.5 Submittals.

The Bridge Structure shall be load rated in accordance with the AASHTO Manual for Bridge Evaluation, latest edition using the LRFR method. The Bridge Structure shall be rated based on the HL-93 live load and the HL-93 modified live load (defined below). The live load rating computations shall include a completed MaineDOT Summary of Rating Form based on the rating factors for the HL-93 live load only. The MaineDOT Summary of Rating Form may be accessed at the following MaineDOT web address: http://www.state.me.us/mdot/publications/.

The Bridge Structure shall be designed for a modified HL-93 live load. The modification to the HL-93 loading shall be an increase in the truck live load by 25% for the Strength I load combination only; all other load combinations shall use the standard HL-93 live load. The proposed structure shall have a rating factor of at least 1.0 for HL-93 at inventory.

The Bridge Structure clear span shall be a minimum of 29'-0" at the streambed and have a minimum hydraulic opening of 233 square feet. The vertical alignment and finished grades of Route 1 shown in the Contract Plans shall not be modified. The Contractor shall verify that the 16" water main can be installed below the roadway subbase as shown on the Plans. The proposed structure centerline shall be aligned with the stream centerline. The proposed wingwalls shall be skewed at 45 degrees (±10 degrees) from the centerline of the buried structure.

Riprap shall be placed around the structure as shown on the Plans.

531.4 MATERIALS

All materials shall meet the minimum requirements of the MaineDOT Standard Specifications, project-specific Special Provisions, and the MaineDOT BDG and shall apply to all work included within this Special Provision with additional project-specific requirements listed below:

Buy America **IS** applicable to this project.

Structural Concrete

- Precast concrete shall be in accordance with Standard Specification 712.061
- All other concrete shall be Class A unless otherwise noted
- All steel hardware and fasteners shall be galvanized per ASTM A153

Backfill material shall meet the requirements of Standard Specification 703.19, Granular Borrow unless otherwise noted.

Riprap shall meet the requirements of Standard Specification 610 - Stone Fill, Stone Blanket, and Stone Ditch Protection.

Drainage items shall meet the requirements of Standard Specifications 603 Pipe Culverts and Storm Drains and 604 Manholes, Inlets and Catch Basins.

531.5 SUBMITTALS

The Contractor shall submit to the Department a formal design package submittal at the 50% design development stage containing plans that show the type of Bridge Structure, Bridge Structure foundation, and associated retaining wall/wingwall/headwall systems to be constructed and an overall layout of the bridge and its foundation including a plan, profile, and typical section drawing. The Department shall have up to ten business days to return comments on the 50% submittal. All comments by the Department shall be addressed by the Contractor with written verification of resolution from the Department prior to the final submittal.

The final submittal shall be submitted by the Contractor to the Department electronically and shall include the final Design Drawings, Design Computations, Load Rating Computations (including the MaineDOT Load Rating form), Independent Design Check Computations for the Bridge Structure, Bridge Structure foundation, and retaining wall/wingwall/headwall systems. The Department shall have up to ten business days to return comments on the final submittal. All comments made by the Department on the final submittal shall be addressed by the Contractor. The resolution of all comments shall be tracked, reconciled, and submitted to the Department for review and verification. Fabrication shall not proceed until written acceptance of the final design is received by the Contractor from the Department. The Design Computations and Load Rating Computations shall be signed and sealed by the Engineer of Record and the Engineer responsible for the design check. The Design Drawings shall be signed and sealed by the Engineer of Record.

Upon completion of construction, the Contractor shall submit an electronic submission of as-built drawings signed and sealed by the Engineer of Record with any field changes or alterations noted. If any field changes or alterations do occur and will affect the bridge structure load capacity, the load rating shall be updated and resubmitted.

531.6 CONSTRUCTION REQUIREMENTS

All included work shall meet the applicable sections of the Standard Specifications, project-specific Special Provisions, the project GDR, and Standard Details as well as the following:

Precast concrete options shall have standard membrane waterproofing over the entire structure. For a three-sided frame, the membrane shall be placed on the top and to 12 inches down on the vertical portion of the exterior sides. For an arch, the membrane shall be placed all the way down to the bottom of the extrados of the arch.

All work shall be completed within the right of way limits shown on the Plans.

531.7 METHOD OF MEASUREMENT

The accepted Bridge Structure will be measured by lump sum for the design, detailing, fabrication, delivery, and construction of the new Bridge Structure.

531.8 BASIS OF PAYMENT

The accepted Bridge Structure will be paid for at the contract lump sum price for the pay item listed below. Such payment shall be full compensation for the design, detailing, fabrication, delivery, and construction of one of the options listed under 531.2 Detail-Build Options, and all of the applicable items listed under 531.1 Description required for that option. The individual items shall be governed by their respective Specifications and Special Provisions.

The Lump Sum will be payable in installments as follows:

Upon acceptance of the design plans, computations, and load rating	20%
Completion of the foundation and erection of the Bridge Structure	40%
Completion of retaining wall/wingwall systems, foundations, and headwalls	20%
Upon acceptance of Bridge Structure	10%
Upon acceptance of As-Built plans	10%

Payment will be made under:

Pay Item		Pay Unit
531.51	Bridge Structure Detail-Build	Lump Sum

In accordance with Section 855 except as follows:

Section 855.1 DESCRIPTION - Revise to read:

This work is the furnishing, installing, replacing, maintaining and disposing of a Pumped Water Filter Bag with compost filter sock ring as indicated.

Section 855.2 MATERIAL - Revise by adding the following:

(e) Compost Filter Sock. Section 867

(f) Sandbags. Of sufficient weight to satisfactorily direct water away from the Pumped Water Filter Bag

Section 855.3 CONSTRUCTION - Revise by adding the following:

Place Compost Filter Sock in a ring around the filter bag as indicated on the Erosion and Sedimentation Plan, in accordance with Section 867 and the DEP Erosion and Sediment Pollution Control Program Manual.

When located on asphalt or concrete pavement, surround the Filter Bag on three sides with sand bags to direct flow toward a vegetated (stabilized) area.

Section 855.4 MEASUREMENT AND PAYMENT - Revise by adding the following:

Includes replacement and disposal of filter bags and contained sediment as required.

Project Specific Details:

Special Provision: 00 - c80021 Item 8200-7022 - Composite Arch Bridge System, As Designed, S-37104

Addendum:

Action:

Item(s) Associated:

8200-7022 - COMPOSITE ARCH BRIDGE SYSTEM, AS DESIGNED, S-37104

Header:

Provision Body:

DESCRIPTION - This work is the design, manufacture, storage, delivery, installation, and construction of the Composite Arch Bridge System as indicated and specified on the approved PADOT Drawing No. 2013-236 PE (Dated 07/07/2014). In addition, this work is the designing, furnishing, and erecting of approved mechanically stabilized systems used as retaining walls above and around the arch. These systems, some of which are proprietary, employ either strip or grid type metallic reinforcements in the soil mass and a discrete modular precast facing.

a. Design

i. Composite Arch Bridge - Design is in accordance with PADOT Drawing No. 2013-236 PE (Dated 07/07/2014) using AASHTO 1st Edition, "LRFD Guide Specifications for Design of Concrete-filled FRP Tubes for Flexural and Axial Members".

ii. Mechanically Stabilized Earth Retaining Wall - In accordance with the Standard Provision entitled, Mechanically Stabilized Retaining Wall Systems.

MATERIAL - As indicated and as specified in the applicable sections of the Specifications, Publication 408, Supplements thereto, and/or the Special Provisions for each respective item included in the construction of the structure.

a. Composite Arch Bridge - PADOT Drawing No. 2013-236 PE (Dated 07/07/2014), including design and fabrication requirements is available upon request from District Bridge Engineer office. Obtain Composite Arch Bridge System units from a fabricator listed in Bulletin 15, certify in accordance with Section 106.03(b)3.

b. Mechanically Stabilized Earth Retaining Wall - In accordance with the Standard Provision entitled, Mechanically Stabilized Retaining Wall Systems.

CONSTRUCTION -

a. Shop Drawings - Provide all shop drawings meeting the general requirements of Section 105.02(d).

i. Composite Arch Bridge - Provide approved shop drawings before fabricating the Composite Arch Bridge components.

ii. Mechanically Stabilized Earth Retaining Wall - In accordance with the Standard Provision entitled, Mechanically Stabilized Retaining Wall Systems.

b. Installation -

i. Composite Arch Bridge - Install in accordance with PADOT Drawing No. 2013-236 PE (Dated 07/07/2014).

ii. Mechanically Stabilized Earth Retaining Walls - In accordance with the Standard Provision entitled, Mechanically Stabilized Retaining Wall Systems.

MEASUREMENT AND PAYMENT - Lump Sum

This item will be measured and paid for in a proportionate manner, designated by the Department. Submit the "Component Item Schedule", included with the Proposal, as specified in Section 103.01 (a). Make the "Total" at the end of the "Component Item Schedule" equal the amount of the lump sum shown for the structure.

Project Specific Details:

Special Provision: I90012A - c90012 Item 9000-0012 - Sawcut Of Existing Pavement

Addendum:

Action:

Item(s) Associated:

9000-0012 - SAWCUTTING OF EXISTING PAVEMENT

Header:

Provision Body:

DESCRIPTION - This work is full depth sawcutting of the existing pavement as directed.

CONSTRUCTION - As directed.

MEASUREMENT AND PAYMENT - Linear Foot

Project Specific Details:

Rhode Island

CODE 800.9902
FURNISH AND DELIVER COMPOSITE ARCH BRIDGE COMPONENTS AND INSTALLATION OF COMPOSITE ARCH BRIDGE COMPONENTS

1.0 DESCRIPTION

This work shall consist of furnishing and delivering the Composite Arch Bridge Components in accordance with these specifications and in conformity with the lines, grades, and dimensions shown on the Contract Drawings. Although installation is paid for separately, requirements are included herein.

The Composite Arch Bridge System is supplied by:
Advanced Infrastructure Technologies (AIT), LLC
20 Godfrey Drive, Orono, Maine 04473
Phone: 207.866.6526 Fax: 207.866.6501
www.aitbridges.com

The Bridge System shall be designed by AIT in accordance with AASHTO LRFD Bridge Design Specifications, AASHTO LRFD Guide Specifications for Design of Concrete-Filled FRP Tubes for Flexural and Axial Members, and other applicable specifications. The composite arch bridge shall be designed by a licensed professional engineer registered in the State of Rhode Island. Calculation packages and drawings shall be provided to the customer by AIT for the bridge system supplied.

As supplier, AIT will deliver to the jobsite the following elements:

Quantity	Units	Description
6	Each	Composite Arches, hollow[1]
32	Each	FRP Decking panels, 18'-6"x 20" x 3.5" cut to length
1	Lump sum	Decking Screws (used to fasten decking to top of arch)
1	Lump sum	Pliogrip 7770 polyurethane adhesive (used in decking lap joint)
12	Each	CFCC Rebar cages installed in arch (with locator plates)
12	Each	Arch Setting Hardware (threaded rods, washers, nuts, and eye hooks)
1	Each	Deck Closure Strip, 18'-6"x 8" x 0.375"
SUPPLIED BY CONTRACTOR		
9[2]	CY	SCC Arch Fill Concrete

[1] Arches will arrive on 2 flatbed trucks and will be able to be unloaded all at once with a spreader bar or individually
[2] Quantities given are estimates only

All elements not listed above shall be provided by the Contractor

Each component is custom designed, detailed, and fabricated for the specific bridge project.

The Composite Arch Bridge System is a buried bridge structure consisting of two components:

1. ARCHES - The advanced FRP composite tubes shall be custom designed, manufactured, and delivered by AIT
2. DECKING PANELS - The decking panels shall be custom designed, manufactured and delivered by AIT

Terms found within this specification shall be defined as follows:

Composite Arches: A hollow advanced FRP tube structural member comprised of an advanced fiber reinforced polymer shell which functions as external reinforcement and stay-in-place form for expansive self- consolidating concrete.

Manufacturer: A firm licensed by AIT for manufacturing the composite tubes.

1.1 COMPOSITE ARCHES

This work shall consist of fabricating and delivering the composite arch tubes to the dimensions, details, and quantities shown on the plans and according to the requirements of these specifications

1.12 DESIGN

Design loads are in accordance with AASHTO LRFD Bridge Design Specifications, HL-93 live loading. Arch design is in accordance with the AASHTO LRFD Guide Specifications for Design of Concrete-Filled FRP Tubes for Flexural and Axial Members, supplemented by laboratory testing as necessary.

1.13 MATERIALS

Materials shall conform to the following specifications:

Glass Fibers shall be type E-glass manufactured in accordance with ASTM D578 Section 4.2.2 and tested in accordance with ASTM D2343.

Resin shall be epoxy vinyl ester resin with viscosity suitable for infusion. Clear casting tensile strength and tensile modulus shall be tested in accordance with ASTM D638. Clear casting flexural strength and modulus shall be tested in accordance with ASTM D790. Heat distortion temperature shall be documented in accordance with ASTM D648.

The arches are coated with Macropoxy 646-100 as a primer and Hi-Solids Polyurethane 100 Semi-Gloss finish coat.

1.14 QUALITY CONTROL

Arches shall be manufactured according to the requirements of AIT's QC plan and standard operating procedures. The portions of the suppliers QC plan and procedures which do not contain trade secret material shall be submitted to the customer for review prior to beginning fabrication.

The FRP laminate comprising the shell shall be tested for tensile strength. Test result documentation of the mechanical properties and the required design values shall be provided to the engineer. A minimum of five (5) test specimens shall be obtained from each arch. A minimum of two (2) specimens per arch shall be tested. If the mean of the two (2) tests from any one arch fails to meet or exceed the required design value at least three (3) more specimens from the corresponding arch shall be tested. If the mean of the three (3) additional specimens does not meet or exceed the design value the arch shall be rejected and replaced. All tests shall be submitted to the engineer prior to arch installation.

1.15 FABRICATION

The composite arches shall be manufactured according to the requirements of this section using a closed mold vacuum assisted resin transfer method (VARTM) of composite manufacturing.

Reinforcement Storage and Preparation: Fabrics shall be stored in a clean, dry environment in the original packaging. They shall be protected from water, dirt, grease, grinding dust, and other foreign matter. The fabrics shall be cut on a clean cutting surface, free of any deleterious material that could adhere to the fabrics prior to layup. No splices shall be permitted in the longitudinal fabric. Splices may be permitted in the hoop reinforcement.

Chemicals: Vinyl ester resins and other chemicals necessary for catalyzing the infusion matrix shall be stored in accordance with the manufacturer's recommendations.

Vacuum Assisted Resin Transfer: Prior to vacuum infusion of the vinyl ester matrix, the manufacturer must thoroughly seal the tooling and demonstrate that the sealed tooling can obtain a minimum workable vacuum pressure and a drop test. Chemical additives and catalysts to be combined with the vinyl ester resin shall be measured by weight, or the corresponding volume, based on the batch weight of the vinyl ester resin. The manufacturer shall maintain documentation of the promotion rates and the actual amount of catalyst used for each infusion. The infusion tank must be charged with a sufficient amount of resin at all times to prevent air bubbles from entering the infusion ports in the tooling. Once resin is introduced into the tooling, the infusion process shall continue uninterrupted until it has been demonstrated that all evacuation ports have a surplus of resin flowing past the finished surface of the tooling and that no less than the predicted volume of resin has been introduced into the tool.

Post Processing: Once the laminate of the composite tube has been allowed to harden, the arches shall be removed from the form with care so as not to induce stresses into the curing laminate. The laminate shall reach a minimum Barcol hardness value of 35 prior to de-molding.

Tolerances: The finished arches shall conform to the dimensions set forth in the approved shop drawings. The diameter shall not vary in any one section by more than 1 percent of the dimension given on the shop drawings. The arches shall be checked for shape variations. No arch shall vary from the shop drawing shape, except for diameter, by more than 1.5 inches or 0.5 percent of the dimension, whichever is smaller. All arches shall be clearly marked by the manufacturer according to the shop drawings.

1.16 COMPOSITE ARCH ERECTION

This work shall consist of installing the composite arches of the Composite Arch Bridge System in accordance with these specifications and in conformity with the lines, grades, and dimensions shown on the Contract Drawings. The contractor is responsible for the complete installation of the composite arches including but not limited to unloading the arches, storing on the jobsite, and erecting and supporting the arches into the foundation, as detailed on the plans.

Care shall be taken when handling the hollow composite arches such that no damage is caused to the unfilled tubes. When moved or placed by hand, arches shall be stabilized to prevent tipping over. When moved by hoist, straps shall provide at least 2 inches of padded contact area.

Installation: The arches shall be installed in a vertical position and decking installed prior to filling with concrete. The maximum allowable variation of installed arches shall be +/- ½ inch in plane and out of plane. The custom FRP decking as specified in section 2 shall be installed over the arches after the arches are erected and aligned. The arches shall be embedded into the foundations as shown on the Contract Drawings and the foundation placed and achieving the minimum strength as noted on the Contract Drawings prior to filling the arches with self-consolidating concrete as specified in section 3. Care shall be taken when placing the foundation and vibrating around the base of the arches as to not damage or displace the arches.

The Contractor will be responsible for means and methods of bracing arches until installation of FRP Decking is complete.

2.0 FRP DECK PANELS

This work shall consist of furnishing and installing the FRP deck panels, fasteners, and adhesive for the Composite Arch Bridge System in accordance with the Contract drawings and these specifications. The custom panels are designed and supplied by AIT in accordance with the AASHTO LRFD Bridge Design Specifications and the ASCE Pre-Standard for LRFD of Pultruded FRP Structures to carry the required loading.

2.1 MATERIALS

The FRP Deck Panels shall conform to the following:

1. The resin type shall be noted on the shop drawings as premium grade, chemically resistant, UV stabilized: polyurethane (TYPE A PANEL), vinyl ester (TYPE B PANEL), or polyester (TYPE C PANEL)
2. The glass reinforcement shall be E Glass that is straight and continuous, with fibers oriented in three directions (0, 45, 90 degrees with respect to the length of the panel). The glass content shall be a minimum of 70% by weight
3. The panels shall have a class B flame spread rating (75 or less when tested in accordance with ASTM E84)
4. The panels shall be 0.25 inches thick, 3.75 inches high to top of corrugation and 20 7/8 inches wide
5. The fasteners for attaching the deck panels to the arches shall be ¼" - 14 x 2" Hex Drive Washer Head Epoxy Finished #3 point 410 Stainless Steel Self-Drilling Screw.
6. The adhesive for sealing the longitudinal joint shall be urethane, Pliogrip or equal, as recommended by the designer and approved by the Engineer.

2.2 DELIVERY and INSTALLATION

AIT will supply the custom FRP Deck Panels and the required stainless steel fasteners to the job site on the date requested by the contractor. A notice of 60 days is required prior to the desired delivery date. The Contractor is responsible for receiving, unloading, and storing the deck panels. All FRP deck panels shall be handled with care and protected from cuts, scratches, and abrasions. Panels shall be stored on blocking off the ground and kept clean and dry. Damaged panels shall be replaced at the contractor's expense.

Deck shall be installed as shown on the shop drawings using fasteners provided. Adhesive provided shall be used per the manufacturer's recommendations to seal the longitudinal joint between the panels. Panels shall be installed starting at the bottom at both sides of the arch and proceeding to the apex. The contractor shall assure that the starter panels are placed as shown on the shop drawings to a level line. A closure plate is provided at the apex to be trimmed to fit in the field and attached after the arches are filled with SCC.

3.0 SELF-CONSOLIDATING CONCRETE

The hollow composite arch tubes shall be filled with Self-Consolidating Concrete (SCC). The arch fill SCC shall conform to this section.

3.1 MATERIALS

Total Cementitious Materials (CM) shall include cement, fly ash, and an expansive cement component.
Cement shall be Type I/II Portland Cement, AASHTO M 85 (ASTM C150)
Fly Ash (ASTM C618 Class F) or Ground Granulated Blast Furnace Slag (GGBFS, ASTM C989 Grades 100 or 120) may be added at the rates allowed in this specification.
Expansive Cement (ASTM C845 Type K) shall be added at the rate as specified in this section. An acceptable product is CTS Komponent manufactured by CTS Cement Manufacturing, 11065 Knott Ave, Suite A, Cypress CA 90630.

3.2 MIX DESIGN

Design the SCC mix in accordance with the Standard Specifications and the following requirements:

1. 28 Day Compressive Strength = 6000psi
2. Maximum size of Coarse Aggregate = 3/8 inch rounded crushed quarry rock.
3. Minimum Cementitious Material (CM) = 850 lb. /CY
4. Use of a High Range Water Reducer at a dosage recommended by the supplier is mandatory for producing SCC.
5. A Viscosity Modifying Admixture may be added at a dosage recommended by the supplier to improve mix stability.
6. The use of a hydration stabilizer (retarder) may be required to ensure sufficient placement time.
7. Fine Aggregate shall not be less than 50% of the total aggregate by volume.

8. The mix shall contain expansive cement Type K at a rate of between 12-15% by weight of total cementitious material.
9. The mix may include fly ash at a rate less than 25% by weight of cementitious material or grade 100 or 120 Ground Granulated Blast Furnace Slag (GGBFS) at a rate less than 50% by weight of cementitious material.
10. The water/cementitious material ratio (W/CM) shall be between 0.40 and .5
11. Air content shall be 0% to 5.0%

The concrete shall meet the following requirements in accordance with ASTM C1611 or AASHTO TP 73 and AASHTO TP 80 for slump flow and visual stability index:

Slump Flow = 24-30 inches
Visual Stability Index = 0-1.0

3.3 TESTING

Testing shall be performed by the Contractor. Trial batches shall be prepared prior to use to verify Compressive Strength, Slump Flow, Air Content, and Visual Stability Index. Results shall be made available to the Engineer for review. Each batch of SCC delivered to the jobsite shall be tested for Slump Flow, Visual Stability Index, and Air Content. If the concrete fails to meet the requirements re-dosing with additives is permitted.

3.4 CONCRETE PLACEMENT

All arches shall be filled with SCC under the supervision of the Engineer. They shall be filled in one continuous operation. Vibration may be necessary for shallow arches and its use shall be determined by the Contractor. The arches shall be filled through the fill holes that are field drilled by the contractor to the sizes and locations shown on the shop drawings. The concrete placement shall be accomplished using a method capable of directing the concrete into the 3.0 inch fill hole and regulating placement speed to prevent voids. The acceptable methods include the use of a boom type pump truck, a trailer pump, or a standard concrete bucket. The contractor shall have a backup method available in the event of an equipment malfunction. All tubes shall undergo auditory tap testing after SCC placement to ensure complete filling of tubes. Tap testing shall be done by the Contractor under the supervision of an AIT representative. In the event that voids are discovered, they shall be injected with grout such as SikaGrout 328 or approved equal for large voids or Sikadur 35 or approved equal for small voids. The determination of a large void versus a small void will be by an AIT representative. The maximum permitted hole size for grout injection is ¾ inch. AIT shall be given 48 hours notice, and offered the opportunity to be present for the filling of the arches and tap testing.

4.0 BACKFILLING and COMPACTION

Arch Tube concrete must reach a minimum compressive strength of 2000 psi prior to any backfilling or compaction activities on the structure. Contractor shall perform compressive strength tests (1 cylinder per arch) and provide results to Ridot for review and approval prior to backfilling.

4.1 MATERIALS

Backfill material shall be Pervious Fill in conformance with the Standard Specifications. Aggregate size over the crown of the arch shall be limited as shown on the plans.

4.2 PLACEMENT

Backfill shall extend to the lines and grades shown on the contract drawings, and shall be performed according to the standard specifications, and the additional requirements of this specification.

Backfill soil shall be placed in maximum 8 inch loose lifts. Compaction within four (4) feet of the structure shall be accomplished with hand compactors only. Vibratory rollers may be used outside of this zone and above the structure provided there is at least 12 inches of compacted cover above the structure.

All backfill shall be carefully placed to avoid damage to the structure.

Lightweight equipment (less than 12 tons) may be operated over the structure provided there is at least 12 inches of cover. Construction equipment greater than 12 tons may be used after 24 inches of compacted backfill has been placed over the structure. In no case shall the loading exceed the AASHTO design loading of HL-93 or RI-BP loads without written permission from the Designer and the Engineer.

Backfill shall be placed in lifts such that at no time will the elevation difference exceed 24 inches between opposite sides of the structure.

Backfill shall be placed around lateral tie rods which hold spandrel walls together. Special care shall be taken not to damage these rods while ensuring sufficient compaction.

5.0 METHOD OF MEASUREMENT

Furnish and Deliver Composite Arch Bridge System will be not be measured for payment.

6.0 BASIS OF PAYMENT

Item 800.9902 "Furnish and Deliver Composite Arch Bridge Components" will be paid for at the "Only Acceptable Bide Price" per Lump Sum as listed in the Proposal.

The price listed in the Proposal includes 10% markup from the **$113,100** due AIT.

Payment terms for AIT are 50% down upon execution of purchase order, 40% upon delivery of the Composite Arch Bridge System to jobsite, and 10% upon completion of installation. An interest charge of 1.5% per month may be added to all past due invoices.

Installation of Composite Arch Bridge System will be paid for under item 800.9901.

FDOT FRP-Composite Bridge Beam Meeting Notes

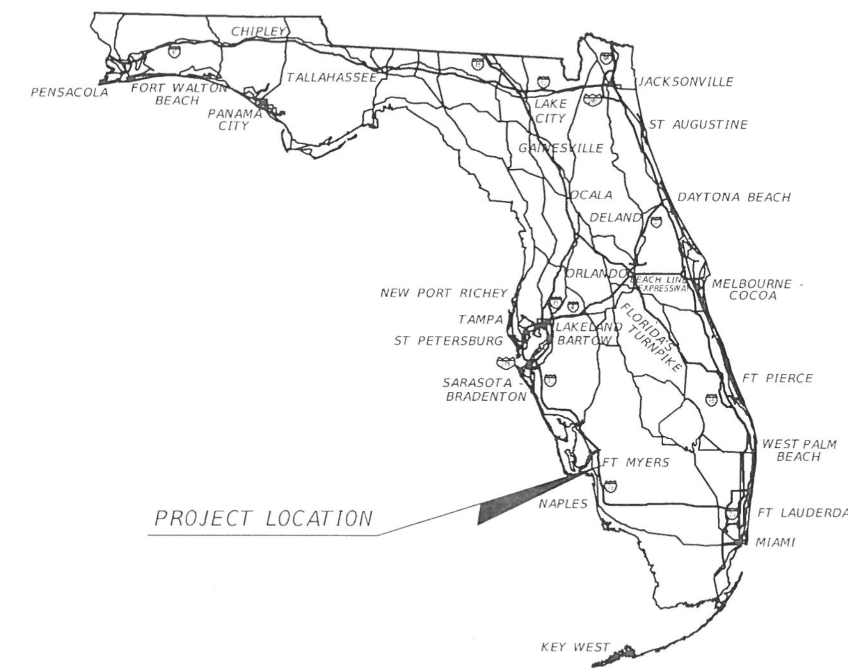
10/3/2019

Appendix C – Sample Plans General Notes Sheet

Lee County Port Authority (Florida) – Skyplex Boulevard

LEE COUNTY PORT AUTHORITY

CONTRACT PLANS



PROJECT LOCATION

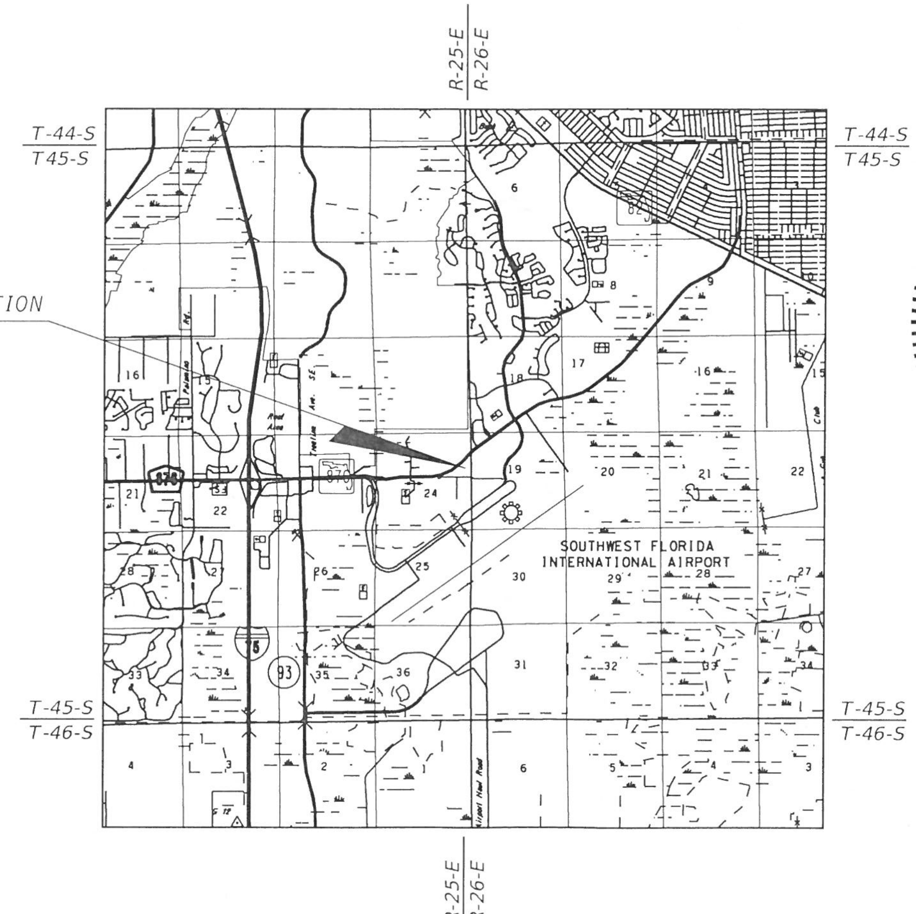
SKYPLEX BOULEVARD ARCH BRIDGE

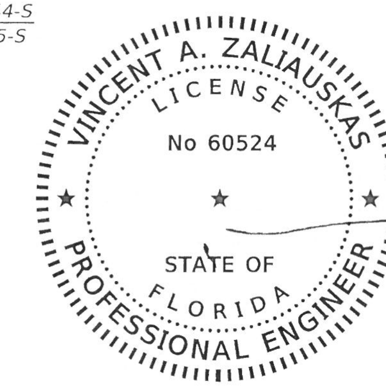
INDEX OF STRUCTURE PLANS

SHEET NO.	SHEET DESCRIPTION
B-01	KEY SHEET
B-02	GENERAL NOTES
B1-01	PLAN AND ELEVATION
B1-02	FOUNDATION LAYOUT
B1-03	SUPERSTRUCTURE PLAN & TYPICAL SECTION
B1-04	SUPERSTRUCTURE SECTION & DETAILS
B1-05	PEDESTRIAN/BICYCLE RAILING DETAILS
B1-06	REINFORCING BAR LIST
BW-01 THRU BW-02	MSE RETAINING WALLS - WALL CONTROL DRAWINGS
BW-03	MSE RETAINING WALLS - WALL DETAILS
BW-04	MSE RETAINING WALLS - GENERAL NOTES & DATA TABLES

STRUCTURE PLANS

BRIDGE LOCATION



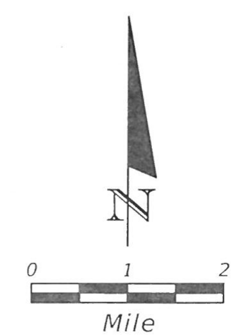


THIS ITEM HAS BEEN DIGITALLY SIGNED AND SEALED BY:

Vincent A Zaliauskas

Digitally signed by Vincent A Zaliauskas
Date: 2018.04.11 14:56:09 -04'00'

PRINTED COPIES OF THIS DOCUMENT ARE NOT CONSIDERED SIGNED AND SEALED. THE SIGNATURE MUST BE VERIFIED IN THE ELECTRONIC DOCUMENTS.



UTILITY PROVIDERS:

LEE COUNTY UTILITIES
(WATER AND SEWER)
1500 MONROE STREET
FORT MYERS, FL 33901
(239) 533-8181

LEE COUNTY PORT AUTHORITY ARFF
(FIRE RESCUE)
11901 REGIONAL LANE
FORT MYERS, FL 33913
(239) 590-4716

LEE COUNTY TRAFFIC
5642 ENTERPRISE PARKWAY
FORT MYERS, FL 33905
(239) 533-9300

FPL
15834 WINKLER ROAD
FORT MYERS, FL 33908
(239) 415-4319

CENTURY LINK
2820 CARGO STREET
FORT MYERS, FL 33916
(239) 336-2035

COMCAST
12641 CORPORATE LAKES DRIVE
FORT MYERS, FL 33913
(239) 432-1805

STRUCTURE PLANS ENGINEER OF RECORD:

VINCENT ZALIAUSKAS, P.E.
P.E. NO.: 60524
1500 JACKSON STREET, SUITE 201
FORT MYERS, FL 33901
(239) 433-3000
CERTIFICATE OF AUTHORIZATION NO.: 27559

LEE COUNTY PORT AUTHORITY PROJECT MANAGER:

HECTOR YANEZ, P.E.

CONSTRUCTION CONTRACT NO.	FISCAL YEAR	SHEET NO.
	15	B-01

THE OFFICIAL RECORD OF THIS SHEET IS THE ELECTRONIC FILE DIGITALLY SIGNED AND SEALED UNDER RULE 61G15-23.004, F.A.C.

GENERAL NOTES

A. Design Specifications
1. FDOT Structures Manual dated January 2017 and subsequent Structures Design Bulletins.
2. American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor (LRFD) Bridge Design Specifications, [7th] Edition and all subsequent interims.
3. Load rating is based on the 2016 Manual for Condition Evaluation and Load Resistance Factor Rating (LRFR) of Highway Bridges, and as amended by volume 8, of the January 2017 Structures Manual.
4. FDOT Plans Preparation Manual dated January, 2015 and subsequent Roadway Design Bulletins.

B. Governing Standards and Construction Specifications
Florida Department of Transportation, 2015 Design Standards and revised Index drawings as appended herein, and July 2015 Standard Specifications for Road and Bridge Construction, as amended by Contract Documents.

C. Vertical Datum
All elevations are referenced to datum indicated on the site plans.

D. Environment
Substructure: Moderately Aggressive

E. Design Methodology
Load and Resistance Factor Design (LRFD) method using strength, service [extreme event] and fatigue limit states. For bridges designed by grid or 3-D analyses provide name and version number of design software.

F. Design Loadings
1. Live Loads: HL-93
2. Dead Loads:
Reinforced Concrete 150 pcf
Backfill Soil Unit Weight 105 pcf
Backfill Soil Internal Friction Angle 28 degrees
Subsurface soils data per the signed and sealed geotechnical investigation report dated 5/17/13 with\ amendment dated 6/28/13 performed by Allied Engineering.

3. Utilities: No allowance for utility loads has been included in the design.

G. Materials
1. Reinforcing Steel: Reinforcing Steel (Unless otherwise Noted) shall be Grade 60, Fy=60 ksi, in accordance with ASTM A615.

2. Concrete:

Concrete Class	Min. 28-day Compressive Strength (psi)	Location of Concrete in Structure
II	3400	Curb & Coping
II (Bridge Deck)	4500	Bridge Deck
IV	5500	C.I.P. and Footings
V (Special)	6000	Prestressed Concrete Piles

3. Concrete Cover:

Cast-In-Place Superstructure (Top of Deck)	2"
Cast-In-Place Superstructure (Except Top of Deck)	2"
Cast-In-Place Substructure (Cast Against Earth)	3"
Cast-In-Place Substructure (Formed Surfaces)	3"

Unless otherwise noted, a minimum cover of 2" shall be provided for superstructure elements and 3" for substructure elements. All dimensions pertaining to the location of reinforcing steel are to centerline of bar except where clear dimension is noted to face of concrete. Unless otherwise noted, provide ¾" chamfers on all exposed edges.

H. Applied Finish Coating
The following proposed surfaces shall receive a "Class 1 Surface Finish" (2 rubs), in accordance with Section 400-15.2.2 of the Standard Specifications, all exposed surfaces: Barriers, Arch Coping, & Wall Coping. In addition, see MSE Wall notes for architectural finish and concrete stain.

I. Plan Dimensions
All dimensions in these plans are measured in feet either horizontally or vertically unless otherwise noted.

J. Utilities
Data concerning type and location of underground and other utilities are approximate. The Contractor is responsible for making determinations as to the type and location of utilities as may be necessary to avoid damage thereto. See Utility Adjustment Plans. The Contractor's attention is called to the presence of overhead powerlines on the project site.

K. Screeding Decks
Screed the riding surface of the Bridge Deck and Approach slabs to achieve the Finish Grade Elevations shown in the plans. Account for theoretical deflections due to self weight, deck casting sequence, deck forming systems, construction loads, overlays and temporary shoring, etc. as required.

L. Stay-In-Place Deck Forms
Stay in place deck forms will not be permitted on this project.

M. Joints In Concrete
Construction joints will be permitted only at the locations indicated in the plans. Additional construction joints or alterations to those shown shall require approval of the Engineer.

COMPOSITE ARCH NOTES

1. C.I.P. Arch details provided describe the work as intended.
2. Pre-approved alternate arch system: AIT Composite Arch Bridge System,
3. High-Rise Constant Radius 32-ft span with 30% S/R Ratio.
4. Arch Rib Diameter: 12-in (concrete filled FRP)
5. Arch Rib Spacing: 4'-2" O.C.
6. FRP Material Requirements:
   a. Glass Fibers shall be type E-glass manufactured in accordance with ASTM D578 Section 4.2.2 and tested in accordance with ASTM D2343.
   b. Carbon Fibers shall be standard modulus fibers. Tensile strength, tensile modulus, and strain of the fibers shall be documented in accordance with the manufacturer's test specifications and submitted to the Engineer for Approval.
   c. Resin shall be epoxy vinyl ester resin with viscosity suitable for infusion. Clear casting tensile strength and tensile modulus shall be tested in accordance with ASTM D638. Clear casting flexural strength and modulus shall be tested in accordance with ASTM D790. Heat distortion temperature shall be documented in accordance with ASTM D648.
7. Composite Arch design shall conform to AASHTO LRFD and the 2014 AASHTO LRFD Guide Specifications for Design of Concrete-Filled FRP Tubes for Flexural and Axial Members.

Arch Characteristics	
f^*_{ful}	66.5 ksi
f^*_{fuh}	21.8 ksi
f^*_{fcu}	33.3 ksi
ε^*_{ful}	0.0162 in/in
ε^*_{fuh}	0.00984 in/in
ε^*_{fcu}	0.0081 in/in

8. C.I.P. Arch details provided describe the work as intended.
9. A precast arch system may be submitted for review at the Contractor's expense provided the following is met:
   a. Reinforcing steel covers meet the project design criteria.
   b. The design criteria are equivalent to those indicated for this project.
   c. The foundation design shall be independently provided by the supplier and signed and sealed by a FL Registered Professional Engineer.
10. The Composite Arch System Supplier shall submit fully detailed shop drawings for review and approval.
11. A preliminary concept shall be submitted for approval prior to any official re-design is performed.
12. The contractor shall submit arch falsework details and concrete placement for review.

THANK YOU FOR PARTICIPATING

Lunch group meeting at Millers ale house at 11:35 am
https://millersalehouse.com/locations/tallahassee/

MILLER'S ALE·HOUSE

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