2015 Design Training Expo

FRP Composites and FDOT Direction

Charles Boyd, P.E.

What is FRP?

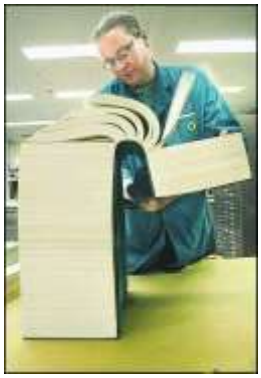
Fiber (Carbon, glass, Aramid)

+ Resin (polyester, vinylester, epoxy)

Fiber Reinforced Polymer

What's available from FDOT?

- Design criteria – ***Structures Design Guidelines*** and ***Fiber Reinforced Polymer Guidelines (FRPG)***
- Detailing criteria – ***Structures Detailing Manual***
- ***Developmental Design Standards***
- ***Specifications and Developmental Specifications***
- Fabricator requirements – ***Materials Manual***



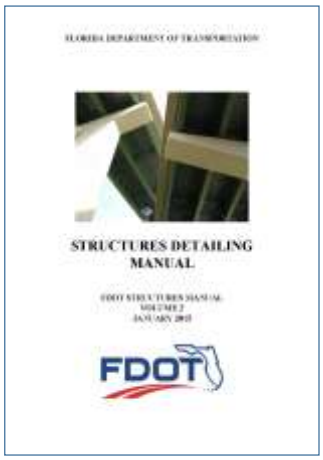
Design and Detailing Criteria

Structures Design Guidelines (SDG)

- Overall design criteria
- Revised and/or supplemented by ***Fiber Reinforced Polymer Guidelines (FRPG)*** for given applications of FRP

Structures Detailing Manual (SDM)

- Overall detailing criteria
- Revised and/or supplemented by ***Fiber Reinforced Polymer Guidelines (FRPG)*** for given applications of FRP



Fiber Reinforced Polymer Guidelines (FRPG)

- Overall commentary on FRP
- Design criteria, plan content and Specification requirements
- Design review requirements
- Approval of use process
- Permitted uses for each type of FRP

Fiber Reinforced Polymer Guidelines (FRPG)

- Glass and Carbon Fiber Reinforced Polymer (GFRP and CFRP) Reinforcing Bars
- Carbon Fiber Reinforced Polymer (CFRP) Strands
- Carbon Fiber Reinforced Polymer (CFRP) Structural Strengthening
- Thermoset Pultruded Structural Shapes
- Vacuum Infusion Process (VIP) Structural Shapes
- Thermoplastic Structural Shapes

GFRP and CFRP Reinforcing Bars

Use is approved for:

- Approach Slabs
- Bridge Decks and Bridge Deck overlays
- Cast-in-Place Flat Slab Superstructures
- Pile Bent Caps, Pier Columns and Caps not in direct contact with water
- Pedestrian/Bicycle Railings
- Drainage Structures

Hughes Bros.

Innovative Solutions for tomorrow's transportation needs

GFRP and CFRP Reinforcing Bars

Use is approved for:

- Retaining Walls, Noise Walls, Perimeter Walls
- MSE Wall Panels
- MSE Wall Copings with or without Pedestrian/Bicycle Railings
- Bulkheads and Bulkhead Copings with or without Pedestrian/Bicycle Railings
- Concrete Sheet Piles

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Innovative Solutions for tomorrow's transportation needs

CFRP Prestressing Strands

Use is approved for:

- 24 inch square concrete piles
- Concrete sheet piles
- Other prestressed concrete piles when approved by the State Structures Design Engineer



FRP Structural Strengthening

- External reinforcing for repair or maintenance
- Carbon fiber fabric wraps most common
- "Temporary" service life extension – research and testing shows 15+ years with good results so far

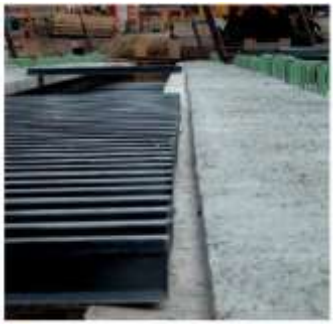

Thermoset Pultruded Structural Shapes

Use is approved for bridge fender systems

D. Troutman; Creative Pultrusions, Inc.

Thermoset Pultruded Structural Shapes

Use is approved for stay in place <u>non-composite</u> formwork for bridge decks



M. Oliva, et. al; SafPlank formwork

Thermoset Pultruded Structural Shapes

Use will be considered for:

- Pedestrian bridges
- Structural shapes for miscellaneous structures
- Sheet Piles
- Tubes used as arch beams for bridge culverts
- Single sign support posts*
- Light Poles*

* Crashworthy designs accepted by FHWA

Vacuum Infusion Process Structural Shapes

Use is approved for bridge fender systems

Use will be considered for:

- Decks for pedestrian bridges
- Stay in place non-composite formwork for bridge decks
- Sheet Piles
- Tubes used as arch beams for bridge culverts
- Single sign support posts*
- Light Poles*

* Crashworthy designs accepted by FHWA

Thermoplastic Structural Shapes

Use is approved for bridge fender systems

Figure 24.3-1 Schematic of Fender System Showing Treatment of Single or Dual Fixed Bridge with Non-Skewed Channel

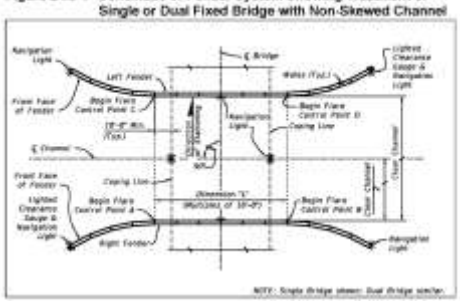
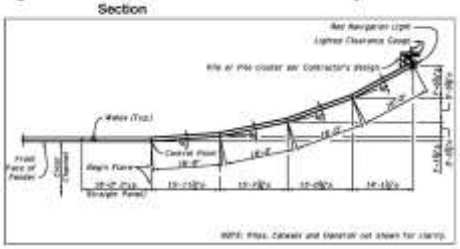
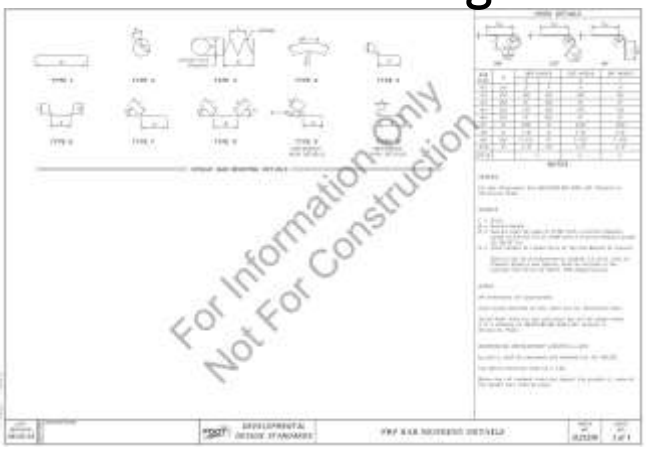


Figure 24.4-1 Partial Schematic Plan View of Fender System Flared Section



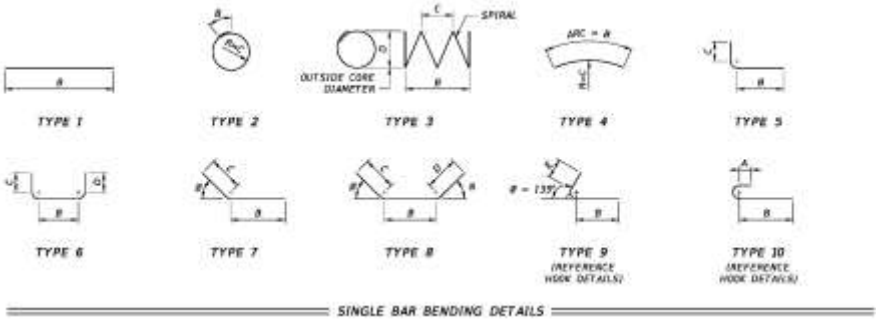
Developmental Design Standards

Developmental Design Standard D21310 FRP Bar Bending Details



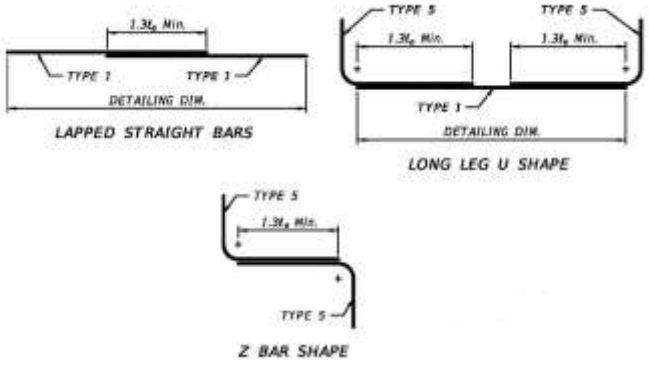
Developmental Design Standard D21310 FRP Bar Bending Details

- Single bar bending diagrams



Developmental Design Standard D21310 FRP Bar Bending Details

- Combinations of single bars



Developmental Design Standard D21310 FRP Bar Bending Details

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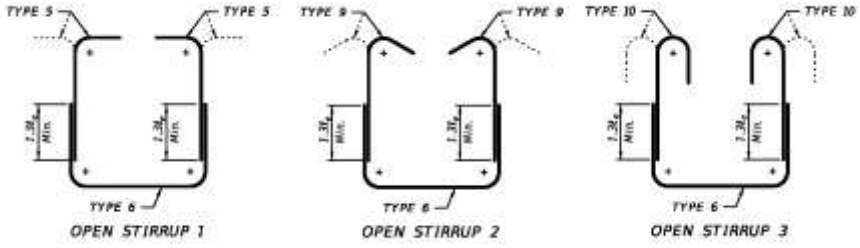

Developmental Design Standard D21310 FRP Bar Bending Details

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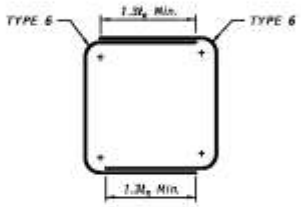
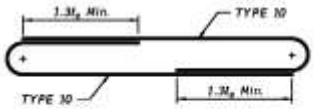


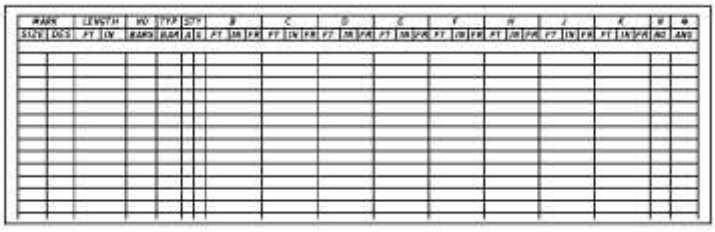
CLOSED STIRRUP 1



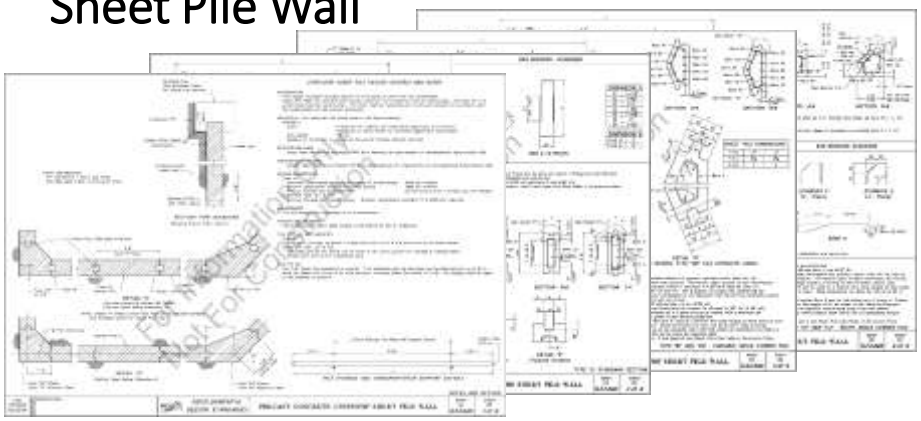
CLOSED STIRRUP 2

Developmental Design Standard D21310 FRP Bar Bending Details

- Complete the rebar table and include it in the Plans
- Label the table "FRP REINFORCING BAR LIST"
- Add a cross reference to Developmental Design Standards Index 21310

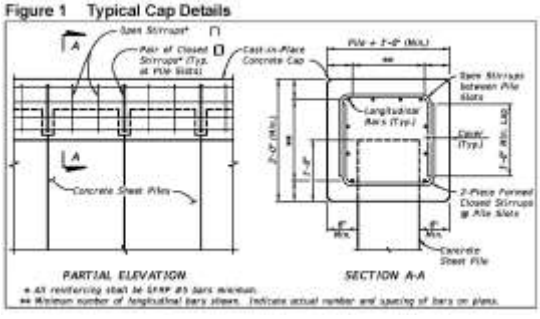


Developmental Design Standard D22440 Precast Concrete CFRP/GFRP Sheet Pile Wall

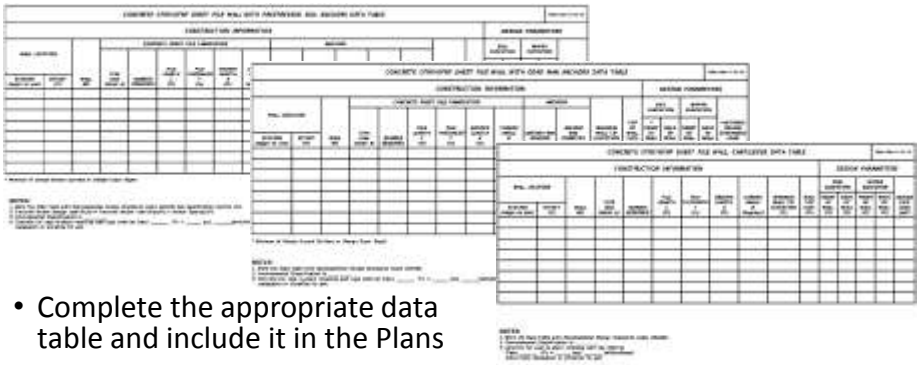


Developmental Design Standard D22440 Precast Concrete CFRP/GFRP Sheet Pile Wall

- Develop Wall Control drawings and cap details
- Complete the rebar table
- Include these in the Plans



Developmental Design Standard D22440 Precast Concrete CFRP/GFRP Sheet Pile Wall



- Complete the appropriate data table and include it in the Plans

Developmental Design Standard D22600 Series Square CFRP Prestressed Concrete Piles

- D22600 Notes and Details For Square CFRP Prestressed Concrete Piles
- D22601 Square CFRP Prestressed Concrete Pile Splices
- D22614 14" Square CFRP Prestressed Concrete Pile
- D22624 24" Square CFRP Prestressed Concrete Pile
- Associated ***Instructions for Design Standards*** and the Pile Data Table CADD cell

Developmental Design Standard D22600 Series Square CFRP Prestressed Concrete Piles

- Complete the Pile Data Table and include it in the Plans

Specifications

Construction Specifications:

- Dev400FRP Concrete Structures – Fiber Reinforced Polymer Reinforcing
- Dev410FRP Precast Concrete Box Culvert
- Dev415FRP Reinforcing for Concrete
- Dev450FRP Precast Prestressed Concrete Construction – Fiber Reinforced Polymer (FRP)
- 471 Polymeric Fender Systems

Material Specifications:

- 105 Contractor Quality Control General Requirements
- Dev932FRP Nonmetallic Accessory Materials for Concrete Pavement and Concrete Structures
- Dev933FRP Prestressing Strand
- 973 Fiber Reinforced Polymer (FRP) Composite Structural Shapes:
  - Thermoset Pultruded Structural Shapes
  - Vacuum Infusion Process (VIP) Structural Shapes
  - Thermoplastic Structural Shapes

105 Contractor Quality Control General Requirements

105-3.2 Compliance with the Materials Manual.

Producers of Fiber Reinforced Polymer Composites shall meet the requirements of Section 12-1, Volume II of the Department's Materials Manual, which may be viewed at the following URL:

http://www.dot.state.fl.us/specificationsoffice/Implemented/URLinSpecs/files/section121.pdf

Materials Manual

Section 12.1 Volume II Fiber Reinforced Polymer Composites

- Plant Qualification Process
- Functions and Responsibilities of Composite Producer
- Quality Control of Certified Materials
- Quality Control of Composite Manufacturing
- Quality Control Testing and Inspection of Composites
- Appearance and Inspection of Final Finished Composites
- Handling and Storage
- Quality Control Labels
- Shipment
- Documentation
- Training

GFRP & CFRP Rebar Dev Specs:

- No field or shop bending of FRP bars
- Fabricate bent FRP bars to the required shape
- FRP bars must be shielded from prolonged exposure to UV light

Hughes Bros.

GFRP & CFRP Rebar Dev Specs:

- No thermal or shear cutting of FRP bars
- Tie using plastic, polymer or nylon coated wire
- No mechanical couplers
- Paid for by the linear foot based on bar size

Hughes Bros.

CFRP Strand Dev Specs:

- Use self-consolidating concrete only
- No flame or shear cutting of CFRP strand
- Tie using plastic, polymer or nylon coated wire
- Spirals for CFRP reinforced piling must also be CFRP
- Headers must be wood, or steel with rubber grommets

Contacts:

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Questions?

… that I can answer.