SECTION 471
FIBER REINFORCED POLYMER~~IC~~ FENDER SYSTEMS

471-1 Description.

Construct *fiber reinforced polymer (FRP)* fender systems using components in accordance with this Section~~,~~ *and* the Plans~~, Design Standards and, if applicable, the Qualified Products List (QPL) drawings~~.

~~If piling configurations listed on the QPL are allowed by the Plans, at the Contractor's option, either use a QPL listed piling configuration or develop a custom design. Develop a custom design if required by the Plans. For all Contractor d~~*D*evelop~~e d custom designs, follow~~ *and provide a design for the FRP fender system in accordance with*~~the design criteria and guidelines in the Structures Design Guidelines, Chapter 3 and applicable Structures Design Bulletins~~ *471-4.2*.

471-2 Materials.

Meet the following requirements:

~~Fiberglass f~~*F*iber reinforced *polymer* composite*s* ~~lumber (Dimensional Lumber~~*Piles, Wales, Spacer-blocks, Decking & Splice Plates*)	Section 973
~~Fiberglass structurally reinforced composite lumber (Wales)*~~ ~~……..Section 973~~	
Concrete used to fill hollow piles	Section 347

~~*or alternate wales as described below~~

Use only SAE Type 316 stainless steel metallic fastening and connection hardware.

471-3 Product Acceptance.

Obtain fender system components from a producer that is currently on the list of Producers with Accepted Quality Control (QC) Program for Fiber Reinforced Polymer Composites. Producers seeking inclusion on the list shall meet the requirements of 105-3.

Provide the Engineer with a manufacturer's certification in accordance with Section 6 that the fender system components meet the material requirements of Section 973.

471-4 Shop Drawings and Design Calculations.

471-4.1 Shop Drawings: *Submit shop drawings in accordance with Section 5. Include the following, as a minimum, in the shop drawings:*

(a) General notes.

(b) Energy absorption capacity (EAC) of the fender system (in units of kip-ft).

(c) Fender system deflection (in units of feet).

(d) Minimum pile tip elevation.

(e) The name and address of the manufacturer for each component, including the physical address where the fabrication is performed.

(f) Pile configuration and layout based on, and compatible with, the geometry shown in the Plans.

(g) Pile and wale material properties including fill material used for hollow piles and required admixtures. If the material properties are defined in the Standard Specifications, a reference to the applicable ~~specifications~~Sections.

(h) Pile and wale section properties used in the design (e.g., ultimate moment capacity, stiffness, etc.).

(i) Pile-to-wale and pile-to-pile connection details.

(j) Sections, views, details and dimensions required to successfully complete the construction of the fender system.

(k) Any supplier required limitations regarding pile installation techniques or other typical construction practices permitted by Section 455 (e.g., full length pile driving versus jetting/driving combination).

471-4.2 Design Calculations: *Design fender piling, wales and connections in accordance with the latest edition of the FDOT Structures Design Guidelines (SDG) and the FDOT Structures Detailing Manual based on the desired energy capacity rating. Design calculations may be either by hand or by a computer program with hand calculations verifying the program output.*

Provide the following design information:

(a) Written certification that the fender system meets the requirements of this Section.

(b) A report from an independent lab verifying the flexural properties of the piling as derived from ASTM D6109 using characteristic values in accordance with ASTM D7290 with the following modifications:

1. Supports shall be located to provide a minimum span to depth ratio of 16:1 and a maximum span to depth ration of 20:1.

2. Three-point bending tests are acceptable.

3. Test a minimum of 10 samples.

(c) Detailed material specifications showing material type, quality, certifications, acceptance and rejection criteria and placement procedures.

(d) Other information pertinent to the design and performance of the fender system as necessary.

471-~~3~~ *5* ~~Performance~~ *Design* Criteria.

**471-~~3~~*5*.1 ~~General:~~ ~~Provide a report from an independent lab as verification that the product meets the following minimum performance criteria.~~

~~**471-3.2 Alternate**~~ **Wales:** ~~For Contractor developed designs only, the w~~*W*ales must meet the following minimum ~~performance~~ *design* criteria:

*(*a) Be structurally continuous across a minimum of two spans.

*(*b) ~~Designed to accommodate r~~*R*ecess ~~ing of any~~*all* attachment hardware ~~to avoid potential for vessel snagging and sparking during impact~~.

*(*c) Provide sufficient creep resistance to prevent loosening of attachments over time.

*(*d) Provide adequate stiffness to distribute vessel impact loading so as to achieve the maximum efficiency of the system ~~where the critical design section remains within the piles~~.

*(*e) For *hollow* wale sections, ~~remaining hollow under service conditions,~~*provide* a minimum bolt pull-through *and crushing* resistance ~~of 10 kips when equipped with manufacturer's detailed connection hardware at a maximum distance of 2 feet from the end of a wale with a minimum length of 4 feet is required~~*greater than or equal to the maximum connection reaction force*. *Pull-through and crushing resistance is defined at the point of first yield and/or the load at which an audible crack occurs.*

*(*f) *Hollow* ~~W~~*w*ale sections ~~remaining hollow under service conditions~~ must be capable of resisting crushing loads perpendicular to the axis of the member as required for the impact force applied to fender in the analysis used to determine the associated energy absorption capacity of the system. This impact force may be equally distributed between two lines of wales and over a longitudinal distance of ~~5~~ *five* feet.

*(*g) *Provide black* ~~W~~*w*ales ~~shall be black~~ unless otherwise shown in the Plans.

*(*h) Wales must meet the minimum requirements in Section 973, Table *5*-1 ~~for Water Absorption, Brittleness, Impact Resistance, Ultraviolet, Abrasion, Chemical Resistance, and Static Coefficient of Friction (wet)~~.

471-~~3~~*5*.~~3~~ *2* ~~Polymeric~~ Piles: ~~All polymeric p~~*P*iles must meet the following minimum ~~performance~~ *design* criteria:

*(*a) ~~Pile surfaces that may be exposed to contact with the impacting vessel must accommodate r~~*R*ecess~~ing of any~~*all* attachment hardware ~~to avoid potential for vessel snagging and sparking~~.

*(*b) Provide sufficient creep resistance to prevent loosening of attachments over time.

*(*c) For *hollow* pile sections ~~remaining hollow under service conditions~~, *provide* a minimum bolt pull-through and crushing resistance ~~of 10 kips when equipped with manufacturer's detailed connection hardware at a maximum distance of 2 feet from the end of a pile with a minimum length of 4 feet is required~~*greater than or equal to the maximum connection reaction force*. *Pull-through and crushing resistance is defined at the point of first yield and/or the load at which first crack occurs.*

*(*d) *Provide black* ~~P~~*p*iles ~~shall be black~~ unless otherwise shown in the Plans.

~~**471-4 Product Acceptance.**~~

~~Manufacturers seeking evaluation of piling configurations for inclusion on the QPL must submit an application in accordance with Section 6.~~

~~Submit all Contractor developed custom designs to the Engineer for review and approval by the State Structures Design Office.~~

~~Design fender piling, wales and connections in accordance with the latest edition of the FDOT Structures Design Guidelines and applicable Structures Design Bulletins based on the desired energy capacity rating. Sign and seal all drawings in 11 inches x 17 inches PDF format and all design calculations by a Professional Engineer licensed in the State of Florida. Design calculations may be either by hand or by a computer program with hand calculations verifying the program output.~~

~~For evaluation of Contractor developed custom designed fender systems or piling configurations for listing on the QPL, provide the following additional information:~~

~~Written certification that the custom designed fender system or QPL piling configuration meets the requirements of this Section.~~

~~A report from an independent lab verifying the flexural properties of the piling as derived from ASTM D 6109 with the following modification. Supports shall be located to provide a minimum span to depth ratio of 16:1 and a maximum span to depth ration of 20:1.~~

~~For custom designed fender systems using wales not in accordance with Section 973, a report from an independent lab verifying the structural properties used in the design of the wales.~~

~~Detailed material specifications showing material type, quality, certifications, acceptance and rejection criteria and placement procedures.~~

~~Other information pertinent to the design and performance of the pile configuration or custom designed fender system as necessary.~~

471-~~5~~ *6* ~~Construction Details~~*Storage, Handling and Installation*.

Unless otherwise shown in the manufacturer's approved field construction manual, use the following construction details.

Protect materials at all times against exposure to extreme heat or impact. Transport products in a manner that will minimize scratching or damage to the outer surfaces, stack on dunnage above ground so that it may be easily inspected and store in a manner that will avoid damage. Handle and lift products with nylon slings. Do not use sharp instruments in handling the product. Products damaged in shipping or handling will be rejected.

Products containing cracks in the reinforcing rods*,* or cracks *or splits~~,~~ (*partial or full depth*)~~,~~* across the section ~~or splits~~ will be rejected.

Cut, bevel, drill, countersink and otherwise install products in accordance with the manufacturer's recommendations. Set all material accurately to required levels and lines, with members plumb and true and accurately cut and fitted. Securely attach all materials to substrate by anchoring and fastening as shown in the ~~Plans~~*shop drawings*. Perform all cutting and drilling in a manner that allows for the collection of all debris and dispose of properly.

Install piles in accordance with Section 455.

471-~~6~~ *7* Method of Measurement.

~~When using QPL listed piling configurations, the quantity of dimensional fiberglass fiber reinforced lumber and fiberglass structurally reinforced composite lumber to be paid for will be the plan quantity, computed based upon the dimensions shown in the Plans and the quantity of polymeric piles to be paid will be lump sum.~~

~~When using custom designed fender systems t~~*T*he quantity for the entire fender system to be paid will be lump sum.

471-~~7~~ *8* Basis of Payment.

471-~~7~~*8*.1 ~~QPL Listed Pile Configuration:~~ ~~Price and payment for plastic marine lumber will be full compensation for the work specified in this Section including all material, storage costs, disposal of unused material and waste, transportation costs, labor, equipment, fasteners and other necessary items required for completing the work. No separate payment will be made for plates, bolts, screws or other hardware necessary to complete the work.~~

~~Price and payment for polymeric piles will be full compensation for all labor, equipment and materials required to furnish and install the piles to the pile cut-off elevations shown in the Plans.~~

~~Payment will be made under:~~

~~Item No. 471-1 Fender System, Plastic Marine Lumber - MB.~~

~~Item No. 471-2 Fender System, Polymeric Piles – LS~~

~~471-7.2 Custom Fender System Designs:~~ Price and payment for ~~polymeric~~ fender system will be full compensation for the work specified in ~~the~~ *this* Section including all labor, equipment and materials required to furnish and install the piles to the pile cut-off elevations shown in the Plans, *and all* wales, dimensional lumber, material, storage costs, disposal of unused material and waste, transportation costs, fasteners and other necessary items required for completing the work.

Payment will be made under:

Item No. 471-3 Fender System, Polymeric – LS.