ORIGINATION FORM

THE INFORMATION BELOW IS TO BE PROVIDED BY THE ORIGINATOR

☐ Modify Specification ____________________.
Section/File number

☐ New Section _______973_________.
Section number

Subject: Structural Plastics

Origination date: Jan 18, 2006

Originator: Jerry Hocking
Office/Phone: State Structures Office/414-4268 SC 994-4268
Email address/ Userid: Jerry.hocking@dot.state.fl.us

Problem statement: This specification originated from a developmental specification that has previously been in use. Consideration of multiple vendor products and current ASTM standards have been incorporated in this specification.

Information source: N/A

Background data: N/A

Recommended Usage Note:

Expected fiscal impact, if implemented: The use of structural plastics and its construction initiated at the request of the Maintenance Department resulting in a developmental specification. This specification is a finalization of the developmental specification that has been in use for approximately 10 years. The life cycle of structural plastics will be approximately 4 to 5 times that of timber. Where as the initial cost of structural plastic is around 1.5 to 2 times that of timber.

Implementation of these changes, if and when approved, will begin with the January 2007 letting.

Florida Department of Transportation

JEB BUSH
GOVERNOR

605 Suwannee Street
Tallahassee, FL 32399-0450

DENVER J. STUTLER, JR.
SECRETARY

M E M O R A N D U M

DATE: June 27, 2006

TO: Specification Review Distribution List

FROM: Duane F. Brautigam, P.E., State Specifications Engineer

SUBJECT: Proposed Specifications Change: 9730000-Structural Plastics

In accordance with Specification Development Procedures, we are sending you a copy of a proposed specification change to Structural Plastics.

This change was proposed by Jerry Hocking of the State Structures Office to propose that this Developmental Specification for structural plastic, become a Standard Specification. Initiated by the Maintenance Office approximately ten years ago, it has now been determined that the life expectancy of structural plastic is approximately four to five times that of timber. Therefore, this is now being proposed for use as a standard specification.

Please share this proposal with others within your responsibility. Review comments are due within four weeks and should be sent to Mail Station 75 or to my attention via e-mail at SP965DB or duane.brautigam@dot.state.fl.us. Comments received after July 25, 2006 may not be considered. Your input is encouraged.

DFB/sh

Attachment

COMMENTS: ____

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Submitted by: ______________________ Phone #: ______________

STRUCTURAL PLASTICS.
(REV ~~4-13-06~~*6-15-06*)

PAGE 878. The following new Section is added after Section 972:

SECTION 973
STRUCTURAL PLASTICS

973-1 Description.

This work covers structural plastic (SP) components including fiberglass structurally reinforced composite piles (CP), fiberglass structurally reinforced composite lumber (SCL) and smaller dimensional fiberglass fiber reinforced composite lumber (NSCL).

973-2 Product Acceptance.

Use only products listed on the Department's Qualified Products List (QPL). Manufacturers seeking evaluation of products must submit an application in accordance with Section 6 and include independently certified test reports that the material meets the requirements of this Section.

Provide the Engineer certification conforming to the requirements of Section 6, from the manufacturer confirming that the material~~(s)~~ used meet~~s~~ the requirements of this Section and is the appropriate product for the intended use.

973-3 Materials.

Use polyethylene made from recycled post consumer or post industrial thermoplastics. Mix the plastic with appropriate colorants, UV inhibitors, hindered amine light stabilizers and antioxidants so that the resulting product meets the material property requirements specified in Tables 1 and 2. Structural Plastic must not corrode, rot, warp, splinter or crack. The outer skin must be smooth and black in color unless otherwise specified in the Contract Documents.

Manufacture Structural Plastic as one continuous piece with no joints or splices to the dimensions and tolerances in accordance with Table 3 and consisting of a dense outer skin surrounding a less dense core. Interior voids shall not exceed 3/4 inch in diameter. Structural Plastic shall be free of twist and curvature.

Reinforce 10"x10" fiberglass structurally reinforced composite lumber for use in heavy duty and medium duty fender systems with a minimum of four 1 1/2 inch reinforcing rods placed in the corners of the section. Reinforce 10"x10" fiberglass structurally reinforced composite lumber for use in light duty fender systems with a minimum of four 1 inch reinforcing rods placed in the corners of the section. Reinforce 16" O.D. Components including fiberglass structurally reinforced composite piles for use in heavy duty fender systems with a minimum of sixteen 1 1/2 inch fiberglass reinforcing rods. Reinforce 16" O.D. Components including fiberglass structurally reinforced composite piles for use in medium duty fender systems with a minimum of sixteen 1 inch fiberglass reinforcing rods.

Reinforcing rods must be continuous and offer a minimum flexural strength of 70.0 ksi when tested in accordance with ASTM D 4476 and a minimum compressive strength of 40.0 ksi when tested in accordance with ASTM D 695. Steel reinforcing rods are not permitted.

Reject any sections of structural plastic containing cracks or splits. Also, inspect the ends of the reinforcing rods and reject any sections containing reinforcing rods with voids or cracks.

Add a minimum of 15% (by weight) chopped fiberglass reinforcement to the polyethylene used for fiberglass structurally reinforced composite lumber, a minimum of 5% (by weight) chopped fiberglass reinforcement for components including fiberglass structurally reinforced composite piles and a minimum of 15% (by weight) chopped fiberglass reinforcement for smaller dimensional fiberglass fiber reinforced composite lumber. The fiberglass reinforcement may be reduced when other means of controlling cracking are specified with test results which show long term cracking is nonexistent.

Fiberglass structurally reinforced composite lumber must meet the minimum structural properties listed in Tables 4A and 4B.

Smaller dimensional fiberglass fiber reinforced composite lumber must meet the minimum physical properties listed in Table 5.

Components including fiberglass structurally reinforced composite piles must meet the structural properties listed in Tables 6A and 6B.

Table 1 Plastic Material Properties- CP and SCL			
Density	ASTM D792	Skin	55-63 pcf
Density	ASTM E12		
Water Absorption Absorption	ASTM D570	Skin	0
		Core	2 hrs:<1.0% weight increase 24 hrs:<3.0% weight increase
Brittleness	ASTM D746	Skin	No break at -40°F at 5 ft-lbs/in
Impact Resistance	ASTM D746 Modified	Skin	Greater than 4 ft-lbs/in
Hardness	ASTM D2240	Skin	44-75 (Shore D)
Ultraviolet	ASTM D4329 (B Lamp)	Skin Core	500 hours<10% change in Shore D Durometer Hardness 500 hours<10% change in Shore D Durometer Hardness
Abrasion	ASTM D4060	Skin	Weight Loss: <0.02 oz Wear Index: 2.5 to 3.0 Cycles=10,000 Wheel=CS17 Load-2.2 lb
Chemical Resistance	ASTM D543	Skin/Core Sea Water Gasoline No. 2 Diesel	 <1.5% weight increase <7.5% weight increase <6.0% weight increase
Tensile Properties	ASTM D638	Skin/Core	Minimum 500 psi at break
Compressive Modulus	ASTM D695	Skin/Core	Minimum 40 ksi
Static Coefficient of Friction	ASTM F 489-03		Maximum 0.25, wet
Nail Pull-Out	ASTM D1761	Skin/Core	Minimum 60 lb

Table 2 Plastic Material Properties - NSCL		
Density	ASTM D6111	50-65 pcf
Brittleness	ASTM D746	No break at -40°F at 5 ft-lbs/n

Table 2 Plastic Material Properties - NSCL		
Impact Resistance	ASTM D746 Modified	Greater than 4 ft-lbs/in
Hardness	ASTM D2240	44-75 (Shore D)
Ultraviolet	ASTM D4329 (B Lamp)	500 hours <10% change in Shore D Durometer Hardness
Abrasion	ASTM D4060	Weight Loss: <0.02 oz Wear Index: 2.5 to 3.0 Cycles = 10,000 Wheel = CS17 Load -2.2 lb
Chemical Resistance	ASTM D543 Sea Water Gasoline No. 2 Diesel	 <1.5% weight increase <7.5% weight increase <6.0% weight increase
Tensile Properties	ASTM D638	Minimum 3000 psi at break
Static Coeffecient of Friction	ASTM C1028 (Neolite-wet)	Minimum 0.50, wet or dry
Nail Pull-Out	ASTM D 1761	Minimum 250 lb
Screw Withdrawal	ASTM D6117	Minimum 450 lb

Table 3 Dimensions and Tolerances		
Structural Plastic	Dimension	Tolerance
Length	Per order (80 ft Maximum)	0/+6 inch
Width	See Contract Plans	±1/4 inch
Height	See Contract Plans	±1/4 inch
Corner Radius – SCL Corner Radius – NSCL	1 3/4 inch 1/4 inch	±1/4 inch ±1/16 inch
Outer Skin Thickness	3/16 inch	±1/8
Distance from outer surface to center rebar elements (SCL)	2 inches	±1/4 inch
Distance from outer surface to center rebar elements (CP)	1 3/8 inches	±1/4 inch
Straightness (gap, bend or inside while lying on a flat surface)		<1 1/2 inches per 10 feet

Table 4A Structural Properties for Heavy Duty and Medium Duty SCL	
Member Size	10 inches x 10 inches
Modulus of Elasticity as derived below	521 ksi
Stiffness, E.I.	4.05E+08 lb-inch^2
Yield Stress in Bending	5.8 ksi
Weight	30-37 lb/ft

Table 4B Structural Properties for Light Duty SCL	
Member Size	10 inches x 10 inches
Modulus of Elasticity as derived below	307 ksi
Stiffness, E.I.	4.05E+08 lb-inch^2
Yield Stress in Bending	5.8 ksi
Weight	30-37 lb/ft

Determine the Modulus of Elasticity of a full size specimen by conducting a three point bend test with a load applied in the center of a simply supported 14 foot span ~~[4.27 m]~~, at a deflection rate of 0.25 inch~~es~~ per minute. The Modulus is to be taken at a strain of 0.01 inch~~es~~ per inch, where strain equals (6) x (depth of cross section) x (deflection) / (span length squared) and where Modulus of Elasticity equals (load) x (span length cubed) / [(48) x (deflection) x (moment of inertia)].

Table 5 Properties for NSCL	
Modulus of Elasticity ASTM D 6109	306,000 psi
Flexural Strength ASTM D 6109	2,500 psi
Compressive Strength ASTM D 6108	1,960 psi
Compressive Strength Parallel to gain ASTM D 6112	3,500 psi
Compressive Strength Perpendicular to gain ASTM D 6112	700 psi

Table 6A Structural Properties for Heavy Duty CP	
Member Size	16 inch O.D.
Modulus of Elasticity as derived below	1,146 ksi
Stiffness, E.I.	3.69E+09 lb-inch^2
Yield Stress in Bending	9.1 ksi
Weight	68-83 lb/ft

Table 6B Structural Properties for Medium Duty CP	
Member Size	16 inch O.D.
Modulus of Elasticity as derived below	622 ksi
Stiffness, E.I.	2.0E+09 lb-inch^2
Yield Stress in Bending	4.9 ksi
Weight	61-74 lb/ft

Determine the modulus of elasticity for composite piles using the following test:

Place a 54 feet long plastic composite marine fender piling of manufacturer's standard commercial type horizontally in a clamping device so that 6 feet of the piling will be firmly fixed and unable to move and the other end simply supported. Gradually apply a vertical (downward) load to a point 12 feet from the simply-supported end. Measure the deflection along the length of the piling at the load point, and 3 equidistant locations. Use the load and deflection data to calculate the flexural modulus of elasticity, maximum outer fiber stress, stiffness (EI), and the bending stress. The flexural modulus of elasticity is calculated by dividing EI by the moment of inertia of the cross section of the product.

Calculate the properties in Tables 6A and 6B utilizing standard elastic beam flexure formulas (as found in references such as Machinery's Handbook; and Formulas for Stress and Strain, by Roark and Young). Report the Stiffness (EI) as the average of the stiffness at all measurement locations, between zero load and half the load corresponding to the specification yield stress. The specified minimum yield stress in bending shall be reached before failure of the product. Calculate the stress at the load point, on the tension side of the plastic composite marine piling.

As stated, conduct the tests on a full-scale product of the specified size. The results of these tests may be extended through engineering calculations, to a product of another size only if the other size has the same or smaller cross section than the tested product. Do not use smaller cross sections to predict the performance of larger cross sections.

~~Components including fiberglass structurally reinforced composite pilesCP shall exhibit recoverable deflection. CP and shall not exhibit more than a 5% reduction in bending stiffness (EI) when cyclically load tested. Upon request, the manufacturer of the CP shall provide cyclical, flexural load test results from an independent test laboratory. Cyclical load testing shall be conducted on the 16 inches O.D. CP. The test shall be for a minimum of 200 load cycles. The test shall be a four point load condition with a minimum 30.5 feet clear span and a minimum 15 feet shear span. The applied load shall produce a minimum of 40% of the CP's bending moment at yield. The bending moment at yield shall be determined by the formula M = f (I / c) where:~~

Components including fiberglass structurally reinforced composite piles shall exhibit recoverable deflection with not more than a 5% reduction in bending stiffness (EI) when cyclically load tested. Upon request, the manufacturer of the composite piles must provide cyclical, flexural load test results from an independent test laboratory ensuring the tests were conducted under four point load conditions with a minimum 30.5 feet clear span and a minimum 15 feet shear span. They must have also been conducted on the 16 inch O.D. composite pile, for a minimum of 200 load cycles with the applied load producing a minimum of 40% of the composite pile's bending moment at yield, as determined by the formula $M = f (I / c)$ where:

M = bending moment at yield (in-lbs)
f = yield stress in bending (lb/in^2)
I = moment of inertia of cross-section (in^4)
c = distance from neutral axis to point where stress is desired (inches)