

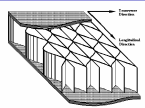
# Honeycomb Fiber-Reinforced Polymer Materials for Raceway Construction

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## In troduction

### Description of HFRP Panels used for Raceways

- Constituent materials are chopped e-glass fibers and polyester resin
- Face sheets: 3 plies of 3 oz. Chopped Strand Mat
- Core Sheets: 2 plies of 3 oz. ChSM
- Side panel thickness is 2 inches, bottom panel thickness is 4 inches.



Honeycomb FRP Sandwich Panel Configuration

### Structural Analysis of Components and Raceway

- Experimental investigation of panel samples in the linear and failure ranges
- Experimental investigation of panel to panel connection samples in the linear and failure ranges
- Finite element analysis of panel and connection samples verified by experimental testing
- Finite element analysis of complete raceway unit under various loading and support conditions

## Manu facturing



Honeycomb Core



Tank Assembly



Completed Raceway Units



### Manufacturing Process:

- The core is produced to accommodate the required depth of panels.
- Face sheets are bonded to the core components to produce panels.
- Completed panels are assembled into raceways according to design.
- Finish work includes corner fabrics, gel coating and color.
- Assembled raceways are shipped to the site for installation.

## Dogwood Lakes

Dogwood Lakes is an acid mine water treatment facility located eight miles southwest of Morgantown, WV. The terrain at Dogwood Lakes is very rugged, making it nearly impossible to use conventional cast-in-place concrete raceways. Moreover, the owners of the facility will not allow permanent structures to be built at this site. It was decided that a series of four staggered raceway units would be used, with the quiescent zone of the preceding unit resting on the top of the following raceway. Water is first collected in a distribution box, which is used to equally divert the flow into the two parallel channels of the first raceway. After water flows through the first raceway, it cascades from tank to tank in a step-wise manner. After flowing through the final raceway, the water is discharged back into the same stream from which it was diverted.



Transportation of Raceway Units



Unloading HFRP Raceway Units



Working System



Completed System

### Dogwood Lakes Raceway System Overview:

The installation procedure consisted of four major steps: (1) initial excavation; (2) leveling and placement of individual units; (3) connecting water supply; and (4) finishing work. The initial excavation consisted of clearing the hillside of trees and grub for the access road and initial raceway placement. This was done prior to receiving the raceway units. Secondly, the footprint for the four units was excavated, and the raceways were set into place and leveled. The contractor started with the last raceway at the bottom and worked up to the distribution box. Once this was completed, the water resources needed to be prepared. This consisted of the intake from the pond, the drains in each quiescent zone, and the diversion ditch for the outflow of water back into the ecosystem. After all the necessary piping was installed, the water was allowed to flow through the tanks and the tank inspected for defects. Finally, once all details were completed, finishing excavation and placing of rip-rap rock was done. Then, the fish were transferred into the system to begin the intended studies. The system was fully operational in October of 2002. Since then, minor modifications relating to the functionality of the system have been made.

## Reymann Memorial Farms

Reymann Memorial Farms is a West Virginia University owned research facility located in Wardsville, West Virginia. Unlike the Dogwood Lakes facility, the terrain here is gentle and mostly flat. An abundant spring water source is available, with a total flow rate of 400 gallons per minute. The terrain, water collection, and waste disposal were among the significant challenges in installing the raceway system at this location.



Placement of Raceway Units



Distribution Box



Collection Box



Settling Chambers



Completed System

### Wardsville Raceway System Overview:

- Water is diverted from a spring-fed stream into the distribution box at the head of the raceways using a 12-inch PVC pipe. The function of the distribution box is to supply an equal amount of water to each side of the dual-channelled raceway.
- There is a series of four raceway units, in which the water flow is similar to that of the Dogwood Lakes system, with the exception of a smaller (10-inch) drop between units. Water leaving the final raceway unit accumulates in a collection box from where it is directed to the finishing pond.
- Accumulated solid waste from each raceway unit is removed through a drain in the detachable quiescent zone and collected in two cone bottom tanks. The tanks are essentially used as settling chambers, allowing solids to fall to the bottom and cleaner water to flow from the top and be directed into the finishing pond. The pond is to provide a final "cleaning" of the water before leaving the system.

## Duquesne Light

An unconventional, but equally effective way to utilize HFRP sandwich materials for the aquaculture industry is to produce in-pond or floating raceway systems. For the first time, an HFRP system is being used by Duquesne Light Company, which owns and operates an acid mine water treatment facility in Greene County, Pennsylvania. Before the installation of this new floating raceway system, the company was solely using a series of net pens, suspended from a dock system floating in the polishing pond, which is used in the water treatment process. However, since the use of net pens will cause an accumulation of solids in the pond due to fish waste, a floating raceway system was proposed, which permits raising fish in a denser population and can effectively collect and remove solid waste from the system. Based on the favorable attributes of HFRP materials, this new floating raceway system was selected by the operators of the treatment facility.



Flat Panel Assembly Process

Quiescent Zone



Launch of Raceway using 1-ton Crane



Airlift System

Completed System

### Floating Raceway System Overview:

- A total of two raceways were produced, each 40-foot long and 6-foot wide with a designed water depth of 3½-foot. A total length of 32-feet can be used to rear fish.
- Based on water flow rate through the raceway, a unique quiescent zone design was implemented to maximize the solids removal potential.
- An airlift system is used, in which air is pumped into a series of air stones, which creates a vacuum drawing water into the raceway, thus creating the desired flow rate.
- Unlike conventional raceways used at Dogwood Lakes or Wardsville, the manufacturer of the HFRP material produced panels instead of manufacturing complete raceways. Panels were shipped to the site and assembled using a bolted panel-to-panel type connection. Assembly of both tanks took less than a week.
- Floatation for the raceways is provided by 6" thick Styrofoam sheets, bolted to the four corners of the raceway.