

CICI - Industrial Recruitment Meeting

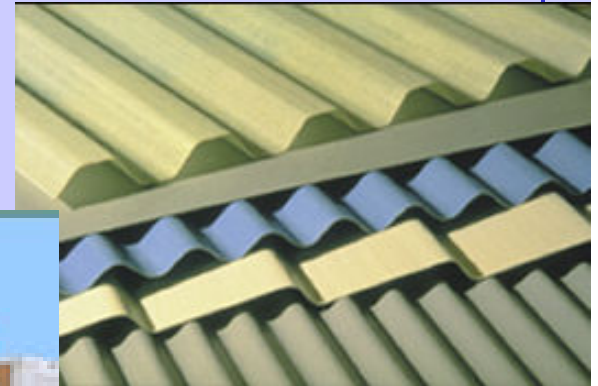
**Manufacture, Design and Implementation of
Panels and Structural Shapes**

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FRP Composite Panels

For extremely wide range of applications:
wall, floor, roof, housing,
bridge deck, pavement, board walk,
bulkhead, marina.....



Prospective Market: Bridge Decks

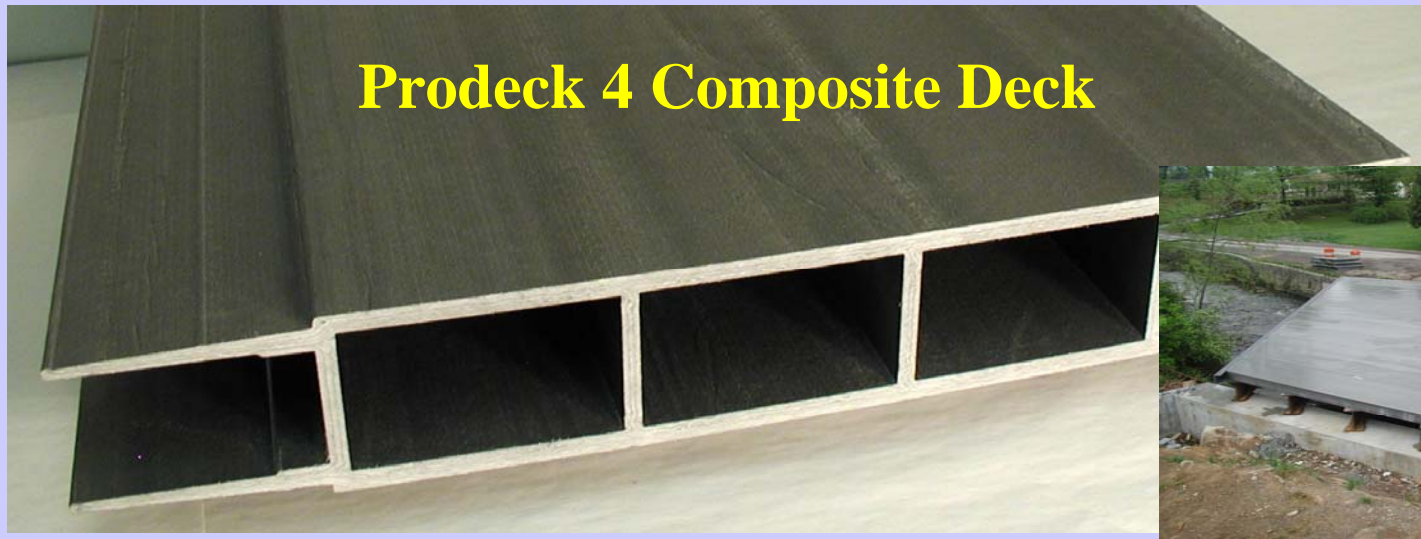
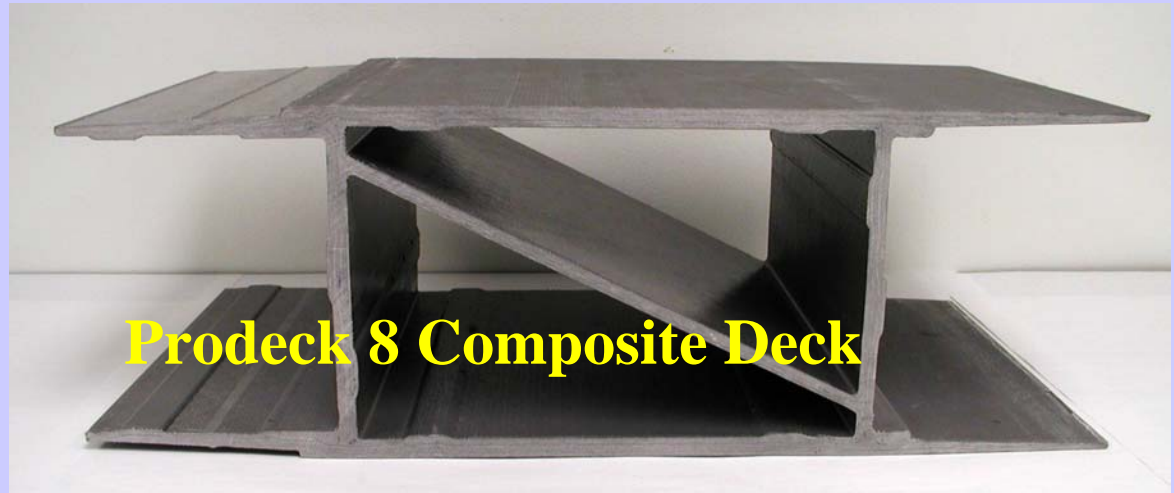
- **\$50 B** was spent on highways and bridges in 1999
- **\$8.1 B** Federal funded bridge projects in 2002
- **\$2-3 B** estimated bridge decks annual market



The Lions Gate Bridge (Vancouver, British Columbia, Canada) truss and deck sections were replaced during 10-hour night closures.



Bridge Decks



FIELD DEMONSTRATION

Market Street Bridge, Wheeling, WV – Jointless Bridge

GENERAL INFORMATION

Location: Ohio County, Wheeling, WV

State District Number: 6

Owner: West Virginia Division of Highways

Contractor: JD & E Associates; Wheeling, WV

Date of Construction Completion: July 2001

Superstructure: Steel plate girders

Deck Type: FRP- Creative Pultrusion: Superdeck™



GEOMETRY

Number of Spans: 1

Out-to-Out Length: ~180'

Center-to-Center Bearing Length: 177'

Skew: 0°

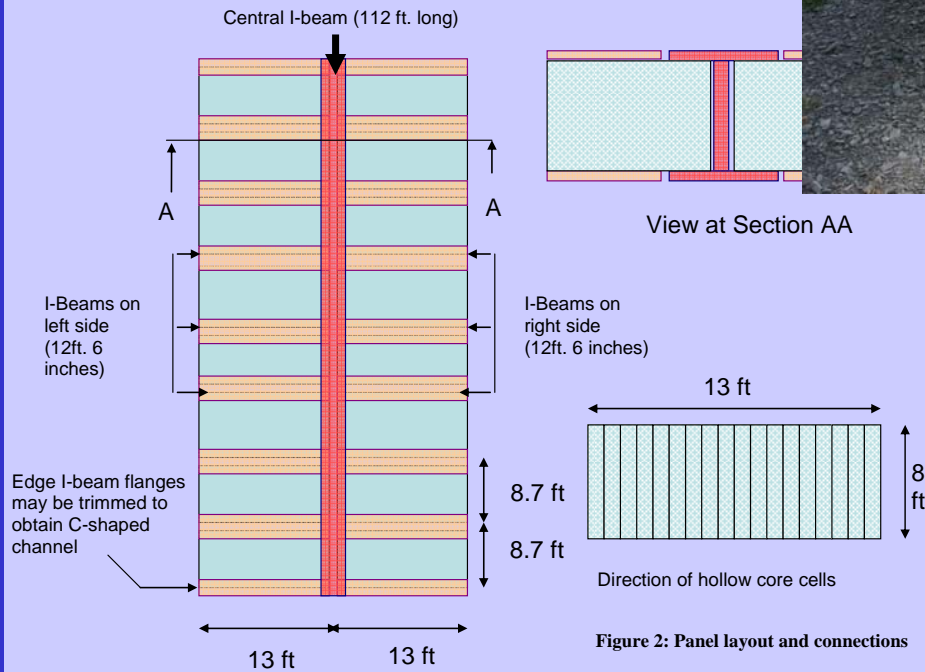
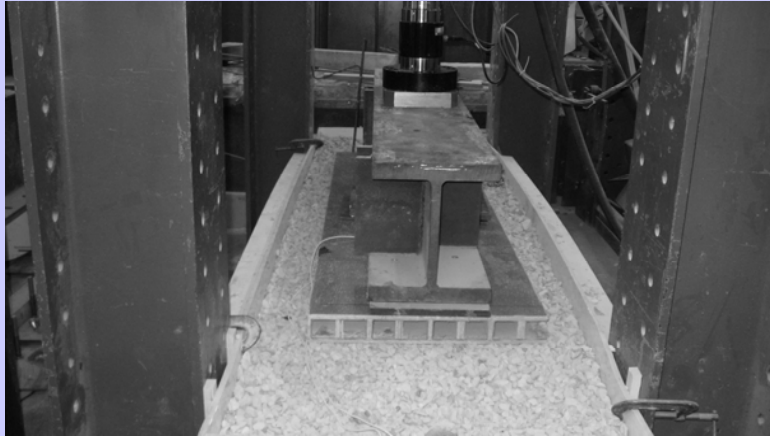
Number of Lanes: 2

Deck Width: 56'

No. of Steel Girders and Spacing: 7 at 8'-6"



FRP Pavement Panel



Rapid Housing



**FRP composite home being erected at BRP Inc.
manufacturing facility**

Waterfront Structures

- **\$3.4 billion U.S. marina decking industry**
- **Est. 5.1 billion board feet market by 2005**

(Marina Today, July 2002)



Gel-Coated Composite Panels for Trailer Siding



Summary of Potential Market Impact

Applications	Annual market	Projected FRP market share	Projected FRP annual market
Highway signposts	\$100-200 million	10%	\$15 million
Guardrail posts	\$50 million	5%	\$2.5 million
Guardrail railing	\$180 million	5%	\$9 million
Bridge decks	\$2-3 billion	2%	\$50 million
Utility poles	\$4 billion	5%	\$200 million
Natural gas pipes	\$8 billion	2%	\$160 million
Marina decks	\$3.4 billion	5%	\$170 million
Army bridging	\$40 million	10%	\$4 million
Air Force towers	\$40 million	10%	\$4 million
Total	\$18.36 billion	Overall 3.35%	\$615 million

A Case Study: The Pultrusion Program

ONR Grant No. N00014-04/05-1-0050/96

Objective

To demonstrate feasibility of an automated pultrusion process for producing composite sandwich panels (4' x 3.5" x unlimited length) which results in a product with improved mechanical performance and reduced production cost in relation to VARTM process

Target panel: 1/4" FRP face sheets with 3" balsa core

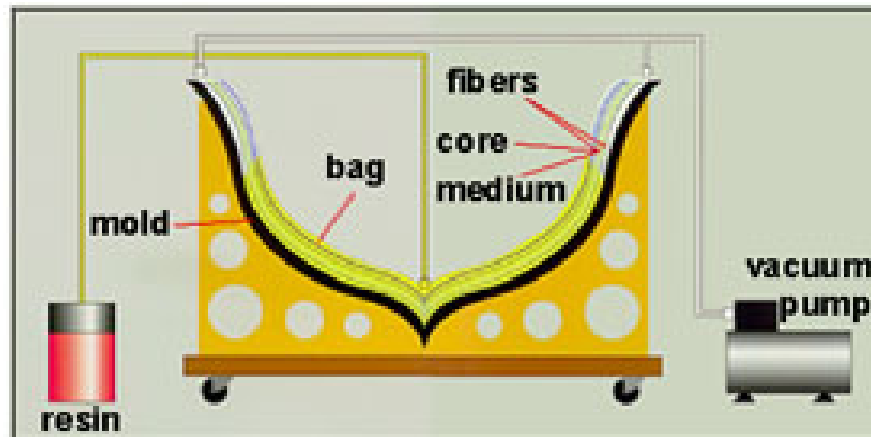
**Milestones: 2004 Pultruded GFRP vs. NSWC VARTM
2005 Pultruded GFRP vs. NGSS VARTM
2006 Pultruded CFRP
2007 High Temp Infused GFRP**



Each ship would use ~ 200,000 sq ft of flat composite panel

Vacuum-Assisted Resin Transfer Molding (VARTM)

SCRIMP SYSTEM SCHEMATICS



source illustration from Hardcore DuPont Composites

Boat Hull Manufacture

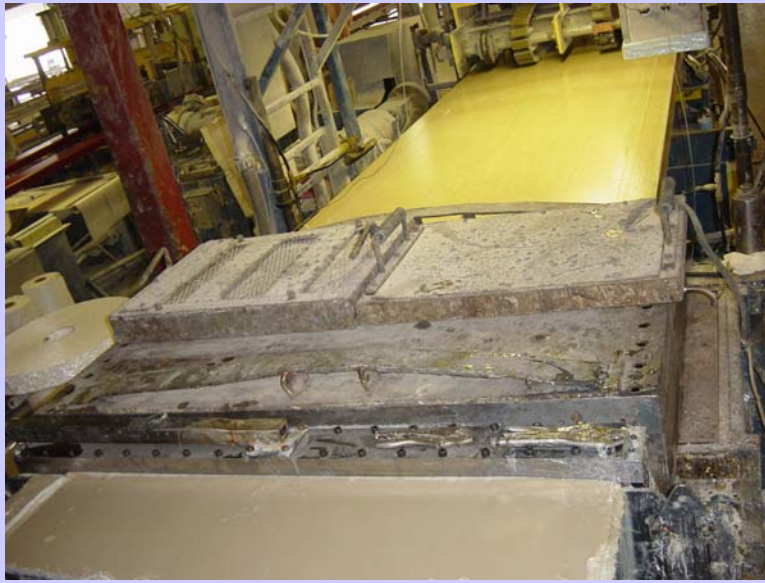


- Process developed and patented by Seamann's Composites
- Single-sided tooling
- Injection achieved through high-permeability surface layer to cause through-the-thickness flow

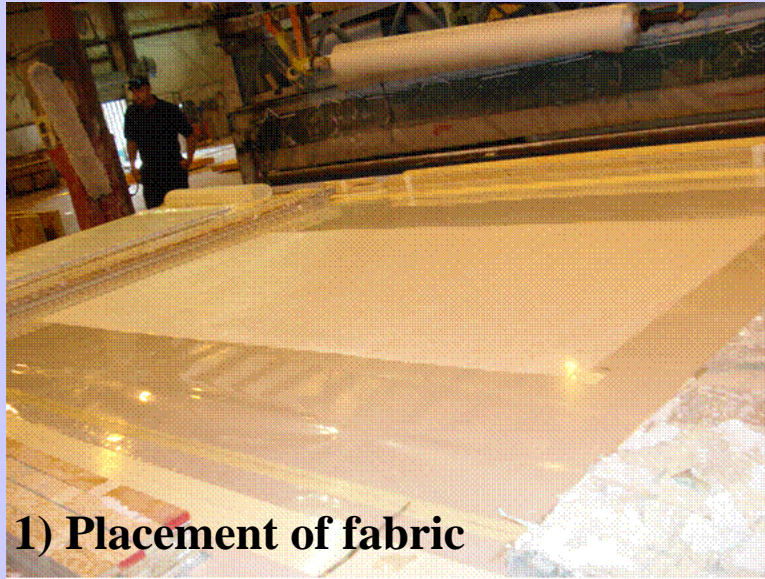
Seeman's Composite Resin Injection Molding Process (SCRIMP)

- Hybrid of VARTM and vacuum bagging

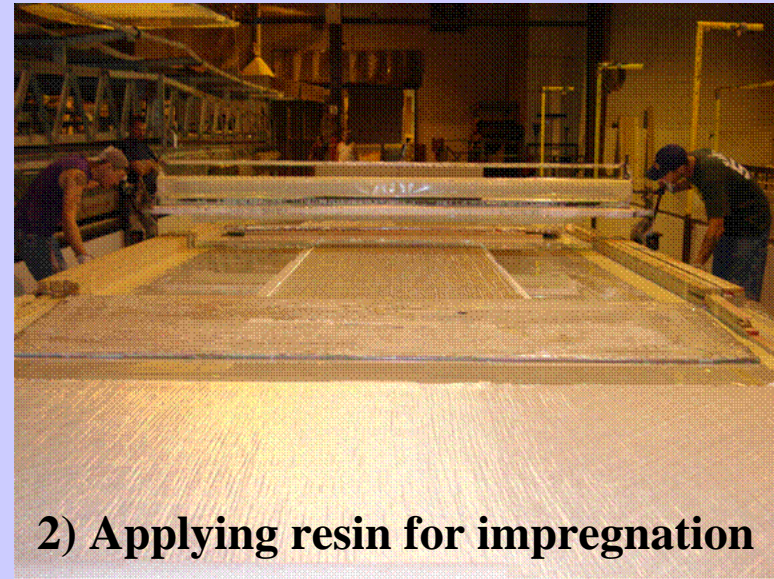
Pultrusion of GFRP Panel



High Temperature Resin Infusion Process



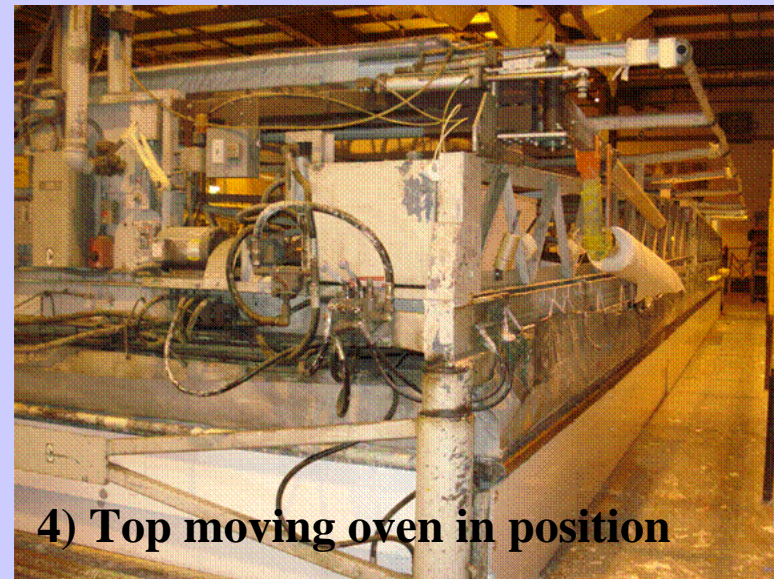
1) Placement of fabric



2) Applying resin for impregnation

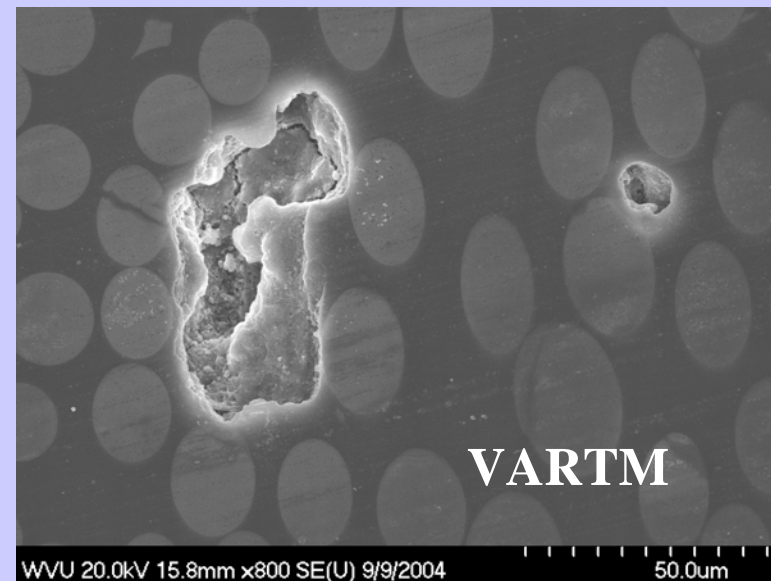
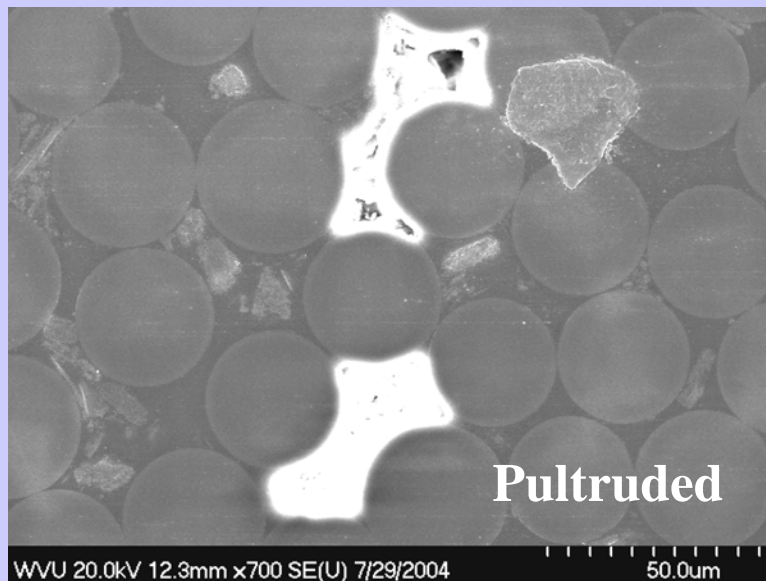
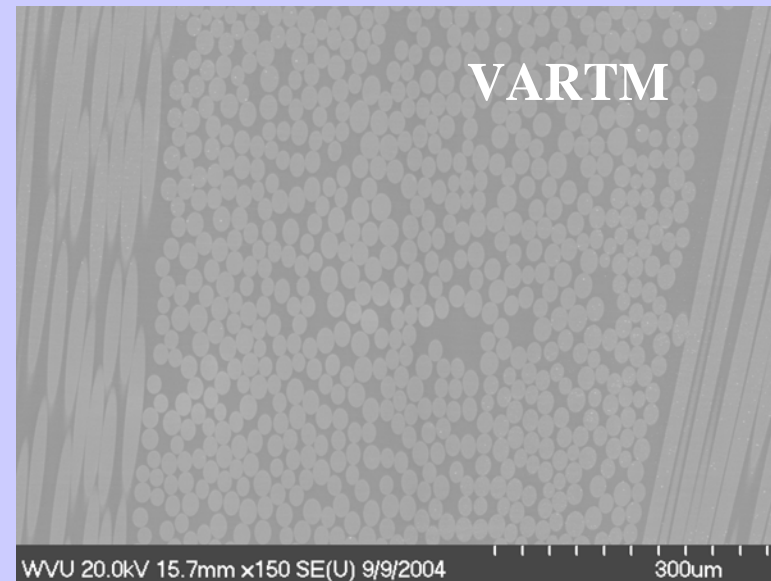
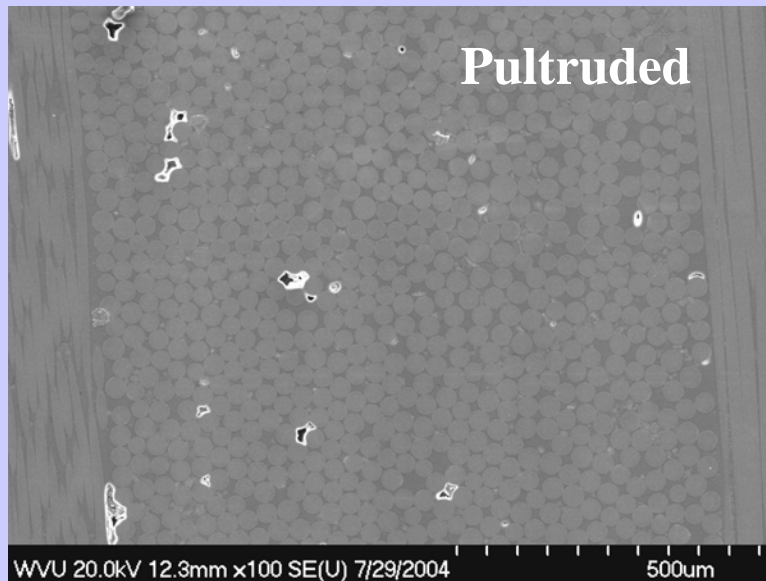


3) Placement of core panel

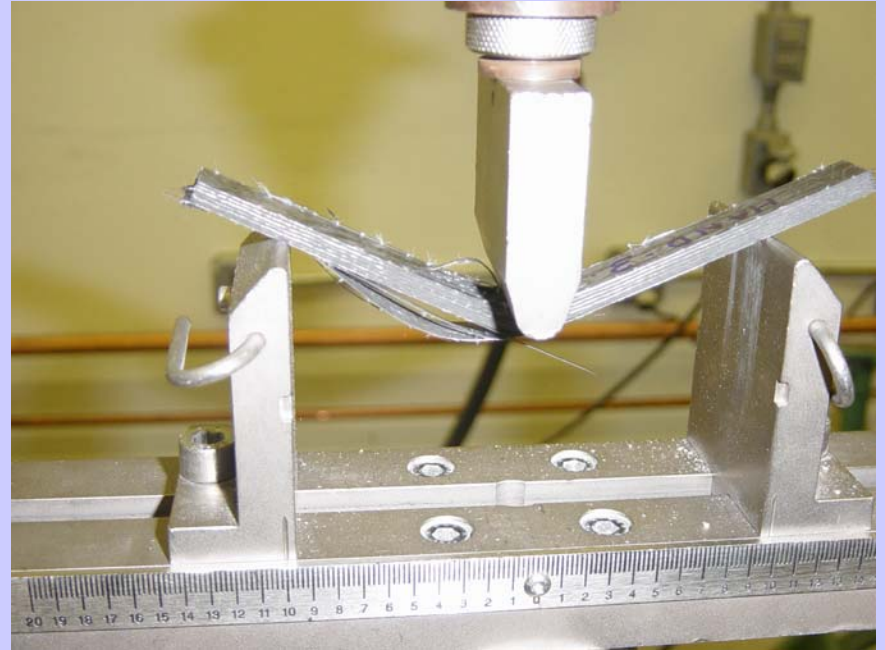


4) Top moving oven in position

SEM Micrographs of Fiber/Resin Interface



CFRP Failed Specimens Under Bending



Pultruded Carbon /VE vs. Compression molded Carbon/Epoxy

The high performance of carbon fiber has not translated into a proportionate property improvement of CFRP composites over GFRP, due to the carbon sizing incompatible with VE. Carbon/epoxy should be recommended.

Finite Element Modeling of FRP Composite Sandwich Panels and Joints



Deflection contours by 3D orthotropic solid model for 40"x100" CFRP panel

Conclusions

- FRP composites can be used for a wide range of structural and non-structural panels in addition to conventional structural shapes, including wall panels, floor panels, pavement panels, bridge decks, marina dock panels, mining panels, housing panels, sound barrier boards, retaining wall, etc, with each representing a huge market potential.
- Certain technological innovations and breakthroughs are needed to arrive at economical and durable FRP composite products and systems.
- The objective will be to develop, evaluate and implement FRP composite panel systems with emphasis on joints and multi functionality as well as design/ manufacturing innovation and cost effectiveness.
- **Yr 1 Deliverables: will provide design procedure for optimized FRP panel system with simplified connections as specified by Industry (e.g. pavement, housing, bridge deck, sound barrier...)**