

Introduction: Overview of Marine Composite Construction

Brief History of Composite Boat Building

- Recreational Marine Industry

- Evolution of Recreational Boat Construction Techniques

- Single Skin Construction

- Sandwich Construction

- Resin Development

- Unidirectional and Stitched Fabric Reinforcement

- Advanced Fabrication Techniques

Overview of Boat Composite Construction

Reinforcement/Resin Interaction

- Composite Material Concepts

- Reinforcement and Matrix Behavior

- Directional Properties

- Design and Performance Comparison with

- Metallic Structures

Loads on Boats

- Hull as a Longitudinal Girder

- Still Water Bending Moment

- Wave Bending Moment

- Slamming

Typical Composite Boat Structures

- Composite Boat Structures

- Sandwich Construction

Composites in Marine Environment

- US Coast Guard 40 foot Patrol Boats

- Gel Coat Cracking

- Core Separation in Sandwich Construction

- Blisters

Materials

Reinforcement Materials

- Fiberglass

- Polymer Fibers

- Carbon Fibers

Reinforcement Construction

- Roving

- Wovens

- Knits

- Omnidirectional

Unidirectional
Resins

Polyester
Vinyl Ester
Phenolic
Epoxy
Gel Coat
Thermoplastics

Core Materials

Balsa
Thermoset Foams
Syntactic Foams
Cross-Linked PVC Foams
SAN and Linear PVC Foams
PMI Foams

Processes

One-Off Construction

Cored Construction over Male Plugs

Mold Manufacturing

Introduction
Process
Mold Maintenance

Open Mold Hand Lay-Up

Mold Preparation
Gel Coat Application
 Knowledge of Gel Coats
 Prepare Equipment for Gel Coating
 Troubleshooting Gel Coat Problems

Barrier Layer
Structural Lamination (Single Skin)

 Basic Overview

 Secondary Lamination

Chopper Gun Open Molding

Facilities Requirements
Materials
Equipment
Process

 Set-Up Equipment
 Apply Skin Coat

- Impregnator
- Sandwich Construction
 - Sandwich Materials
 - Core Materials
 - Sandwich Construction Equipment
 - Sandwich Installation Process
 - Balsa Core Installation Procedure
 - Foam Core Installation Procedure
 - Using Vacuum Bagging for Core Installation
- Vacuum Bagging
 - Vacuum Bagging Process Materials
 - Vacuum Bagging Process Equipment
 - Vacuum Bagging Process
- Infusion Methods
 - Introduction
 - Surface Infusion
 - Interlaminar Infusion
 - Recirculation Molding
 - Review of Process Differences
 - Additional Information on Infusion
- Prepreg Construction
- Resin Transfer Molding (RTM)
 - Vacuum Assisted Resin Transfer Molding (VARTM)
- Manufacturing Processes Conclusions

Structural Details and Hardware

- Stringers
 - Custom Fitted Stringers
- Bulkheads
- Hull-to-Deck Joint
- Chines
- Engine Beds
- Transoms
- Thru-Hull Hardware
- Deck Hardware
- Small Parts
- Flotation Foam
 - Flotation Requirements
 - How Foam is Formed
 - Application

Handling and Emergency Procedures
Health Considerations and Specific Safety Issues

Demold and Trim

Proper Demolding Techniques
Trimming and Grinding
Adding Thru-Hulls
Tools
Right Tool for the Job
Sharp Tools

Quality Assurance

Incoming Material Inspection
Material Storage, Handling, and Delivery
Material Placement
Catalyzation/Initiation
Proper Wet-Out
Degree of Cure
Final Inspection

Personal and Environmental Safety

Material Hazards
Scaffolding, Lifting, and Shop Layout
Ladders
Scaffolds
Proper Lifting Techniques
Work Area
Electrical Safety
Power Tools
Protective Clothing
Respiratory Protection
Fire Safety
Emergency Procedures
Emissions and Waste Reduction
Hazardous Air Pollutant (HAP) Reduction
Dust Control
Waste Material Reduction and Disposal