Marine Composites

Webb Institute

Senior Elective

Composite Component Design Case Studies

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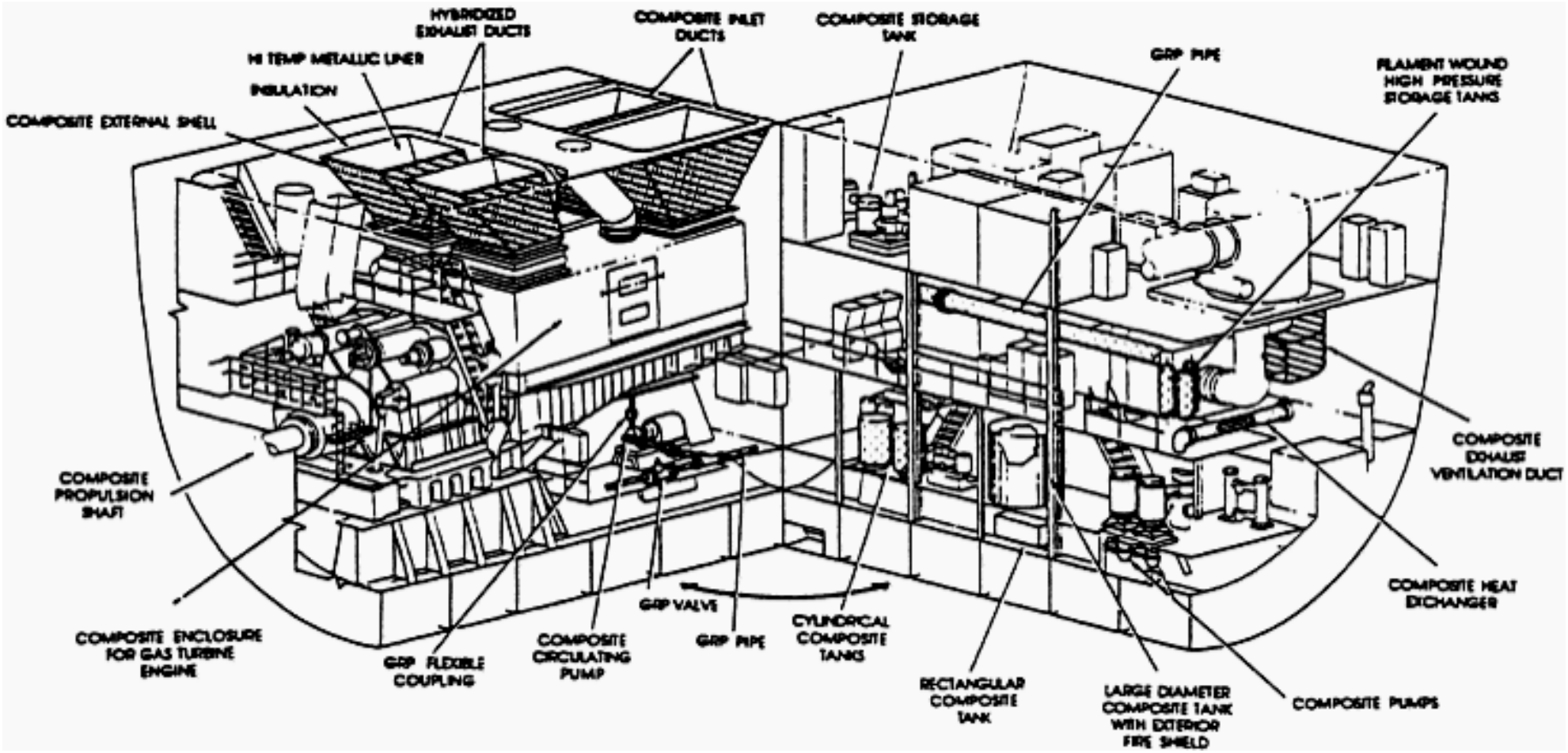
Proposed Shipboard Applications for Composites

Structural
Topside Superstructure
Masts
Stacks
Foundations
Doors
Hatches
Liferails
Stanchions
Fairings
Bulkheads
Propellers
Control Surfaces
Tanks
Ladders
Gratings

Machinery
Piping
Pumps
Valves
Heat Exchangers
Strainers
Ventilation Ducts
Fans, Blowers
Weather Intakes
Propulsion Shafts
Tanks
Gear Cases
Diesel Engines
Electrical Enclosures
Motor Housings
Condenser Shells

Functional
Shafting Overwraps
Life Rails/Lines
Handrails
Bunks/Lockers
Tables/Worktops
Insulation
Partitions
Seachest Strainers
Deck Grating
Stair Treads
Grid Guards
Showers/Urinals
Wash Basins
Water Closets
Mast Stays/Lines

Engine Room Applications



A.P Mouritza, , , E Gellertb, P Burchillb, K Challisb," Review of advanced composite structures for naval ships and submarines," Composite Structures, Volume 53, Issue 1, July 2001.

Replace Steel to Eliminate Corrosion

Examples of Corroded Metal Components on Navy Ships [Jeff Goldring, NAVSEA 05P24 and Eric Greene]

Ladders, Gratings and Screens

Ladders

Intake Screens

Gratings

Deck Grating

LSD Wing Wall

CVN Catwalk

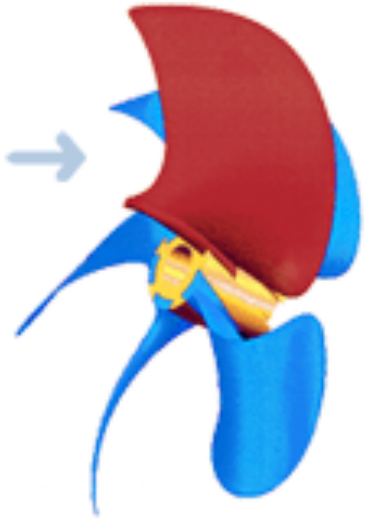
- 45% weight by reduction on CVN class catwalk (14 ton reduction)
- ~40,000 sq. ft. installed on CVN & LSD class

D. Michael Bergen, "Current Engineering for Reduced Maintenance Fleet Composite Applications," NSRP Conference, San Diego, CA, 2009.

Propellers

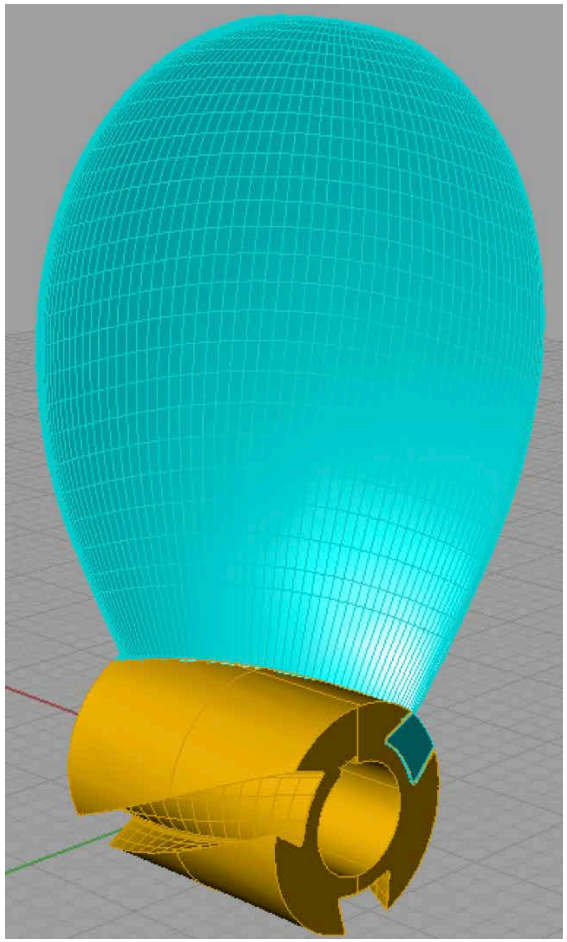
QinetiQ's prototype 2.9-meter marine propeller was fitted to the prototype military trimaran, *RV TRITON*. The blades are solid laminates with centermost plies of carbon fiber and glass on the inner and outer surfaces.

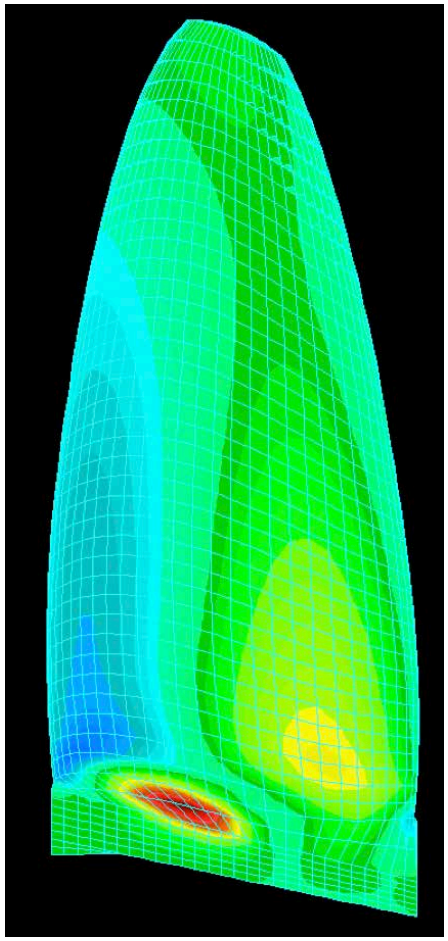
AIR Fertigung-Technologie GmbH has manufactured Contur propellers for over 1000 vessels since 1995.



The Contur(F) propellers have blades that can be replaced if damaged. The pitch of the blade can be engineered to change according to applied load.

YP Propeller Blade

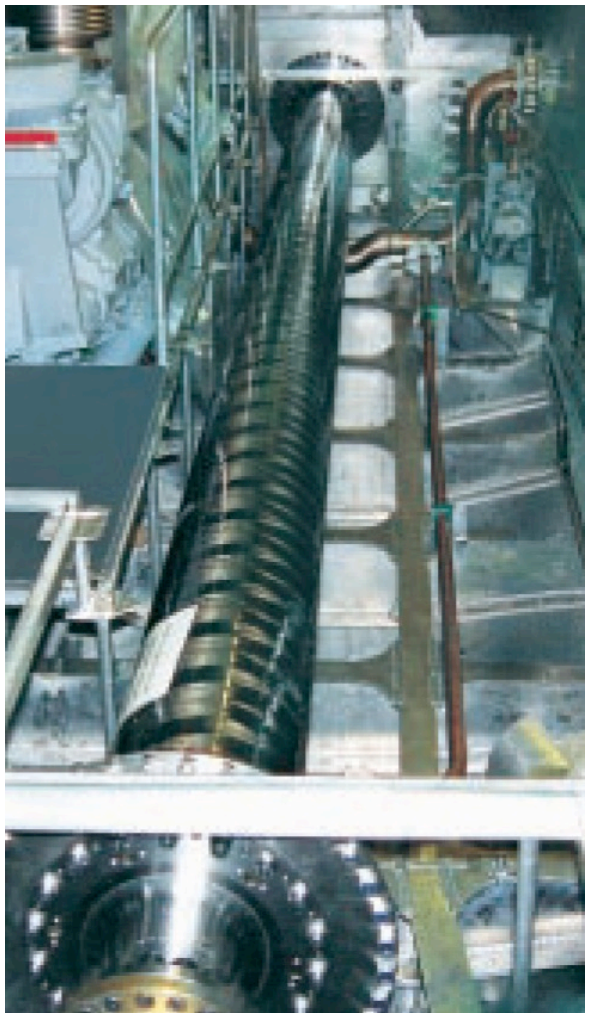




Christopher D. Wozniak and Paul Miller, “Analysis, Fabrication and Testing of a Composite Bladed Propeller for a U.S. Naval Academy Yard Patrol (YP) Craft,” Oct., 2010

Propulsion Shafting

The US Navy conducted full-scale land-based tests of a 10 m long 37 MW/2,500 kNm shaft section including related couplings



Carbon Fiber Propulsion Shaft [Centa]

Fans

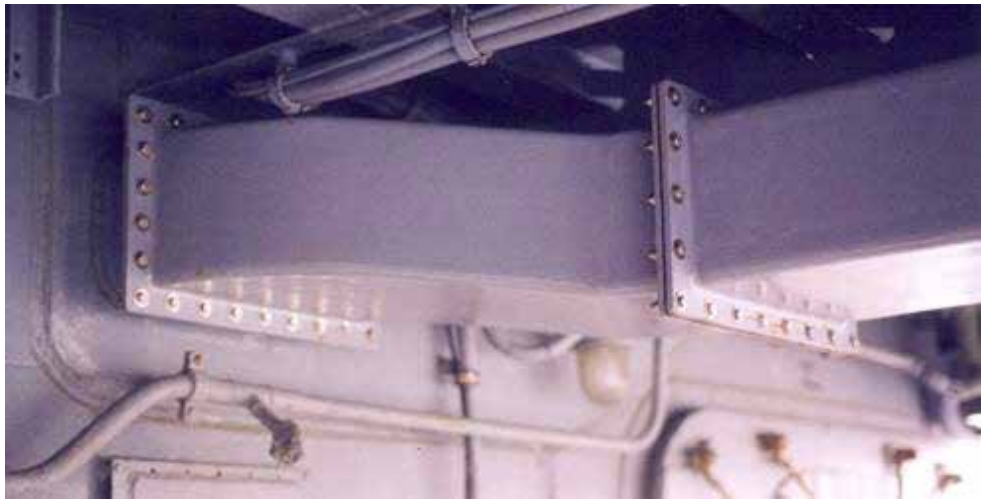
Direct Drive Axial Flow Marine Fans

Axial fans are built with fire retardant vinyl ester and phenolic resin [Composite Fan Technology]

Fiberglass In-Line Centrifugal Fan

Hartzell Air Movement, Piqua, OH

Ventilation Ducts



Ducts match-drilled with wood bit (top right) and installed on weather deck (top left and bottom right)

Ventilation Louvers and Vent Screens

Ebert-designed Navy louvers are in current production under an agreement with Peerless Mfg. Co.

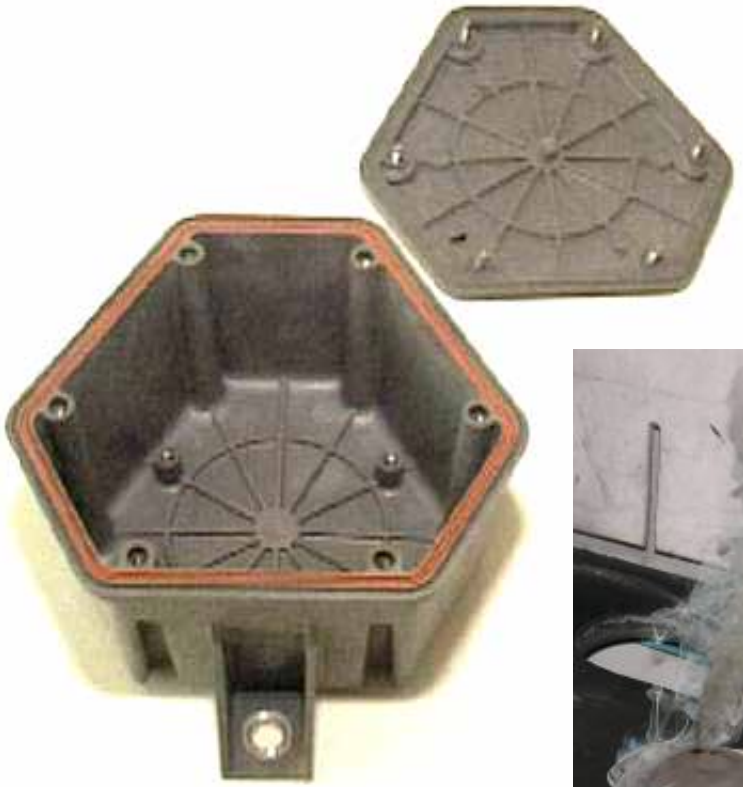
Ebert Composites Corporation, Chula Vista, CA

Composite vent screen installed on US Navy ship

D. Michael Bergen, "Current Engineering for Reduced Maintenance Fleet Composite Applications," NSRP Conference, San Diego, CA, 2009.

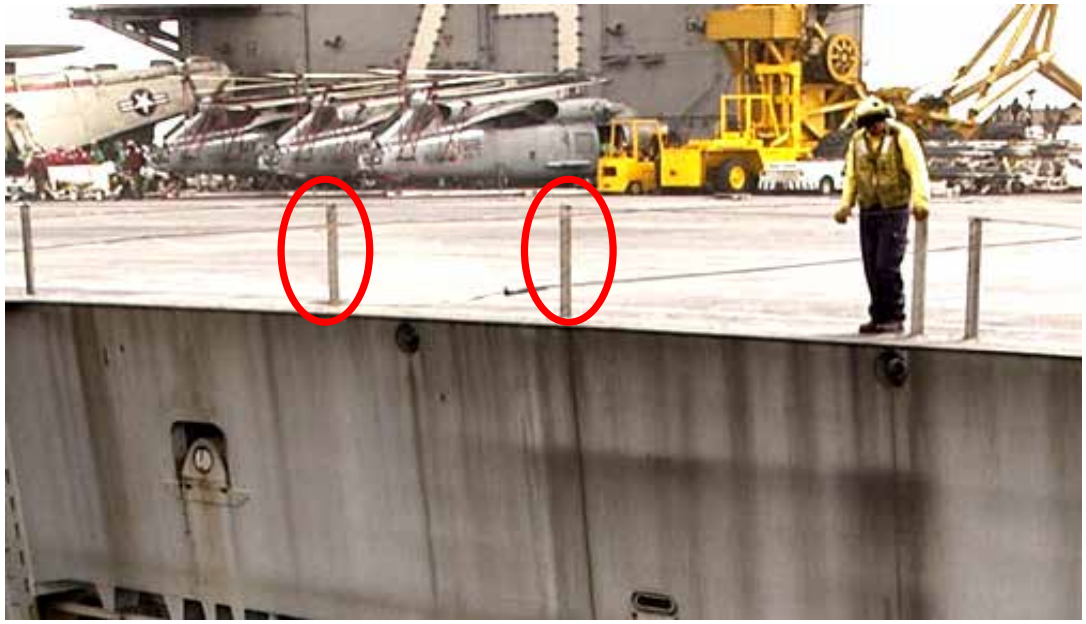
Circuit Boxes

Glenair Modar Electrical Box on DDG-52, 2003

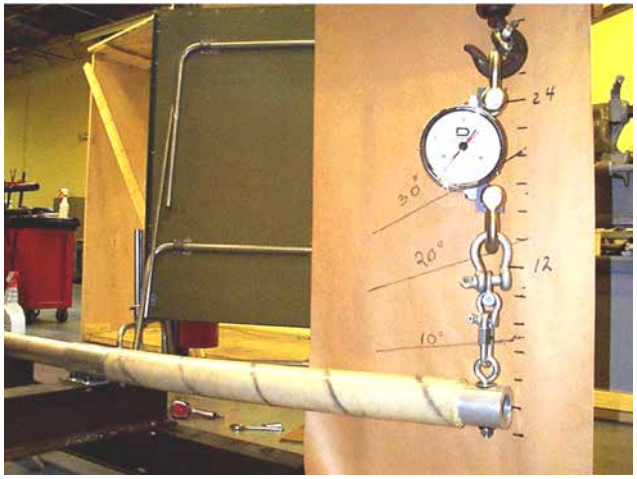


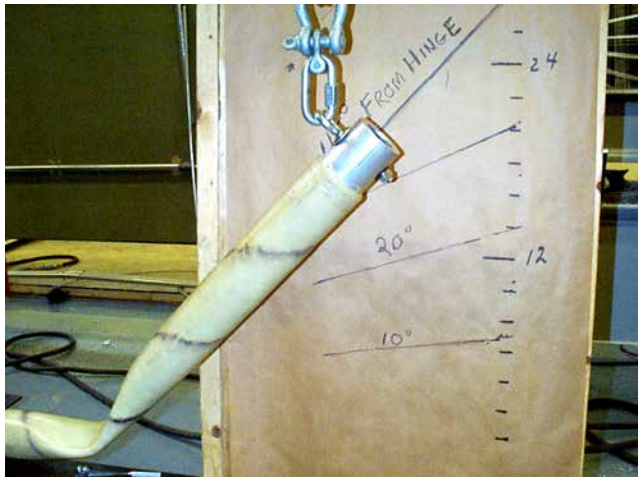
Fire Test of Glenair Modar Electrical Box

Stanchions



Glass rod, felt and polyurethane fabricated by pultrusion

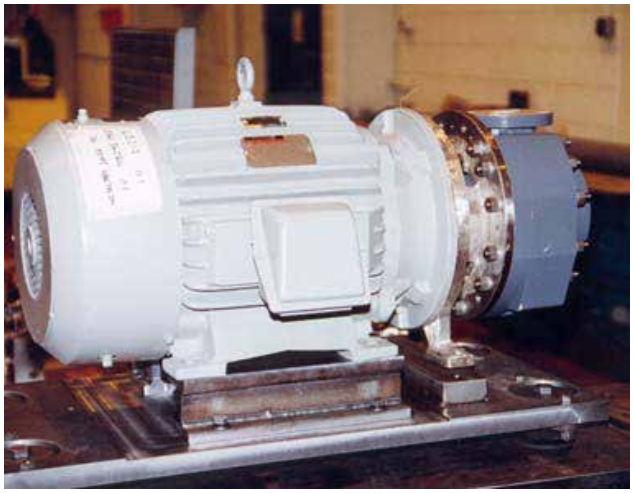




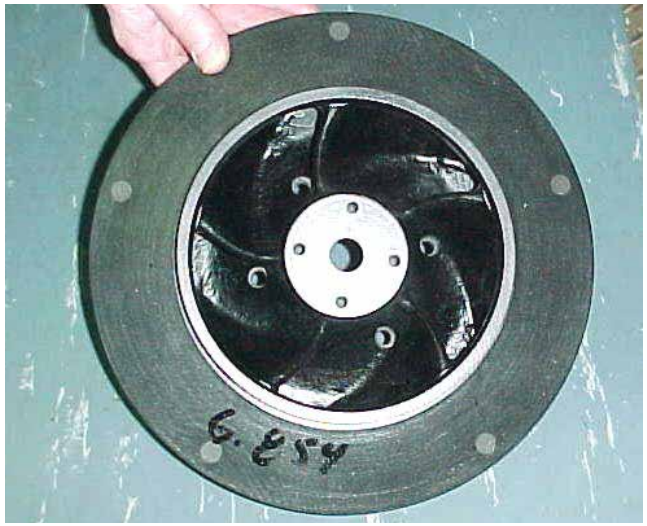
Jeff Goldring, "Small Composites Save BIG Money," ASNE Fleet Maintenance Symposium, San Diego, CA, 2005

Pumps

Size 5 – 3 X 2 X 6 (inlet, outlet, impeller) composite pump for US Navy requires 1 man 1.5 hours for total rebuild





Jeff Goldring, "Composite Materials for Ships to Reduce Maintenance and Capital Investment for Labor," November, 2003

Pipe

Examples of Ameron's Bondstrand® composite pipe installed on ships



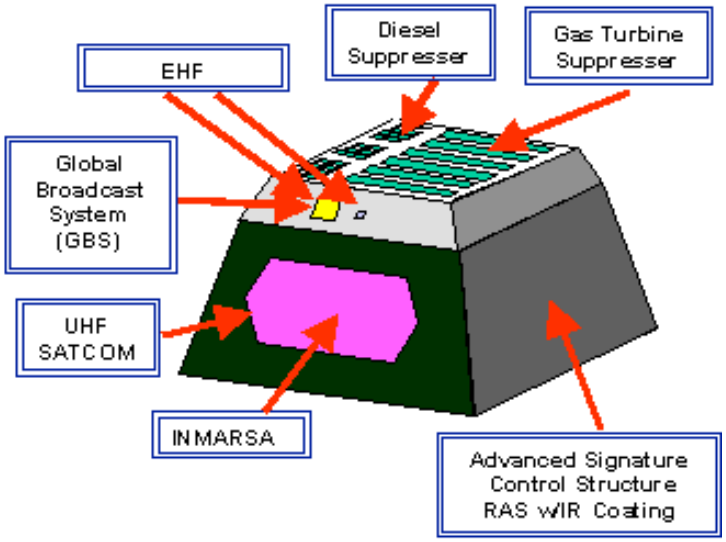
Bondstrand® pipe systems are extremely resistant to corrosion from salt water and to a wide range of chemicals. Bondstrand® pipe can be designed to operate at temperatures up to 121°C. Since 1957, Bondstrand® piping systems have been installed on thousands of ships and offshore units all over the world.

In 1993, the International Maritime Organization (IMO) developed guidelines (Res. A.753 [18]) to provide acceptance criteria for plastic materials in piping systems. [Ameron 2009 – FP 1006 04/09]

Stacks

Exhaust stack fairings of *Disney Magic* built at Fincantieri in 1997 [Trimarine, Isle of Wight, UK]

Low Observable Multifunction Stack installed aboard research vessel LAUREN



John P. Hackett, "Composites Road to the Fleet—A Collaborative Success Story," Northrop Grumman, 2011

Office of Naval Research

Radar Masts

Carbon fiber radar mast

PYI, Inc., Lynnwood, WA

Radar arch for superyacht Cassiopeia

GMT Composites, Bristol, RI

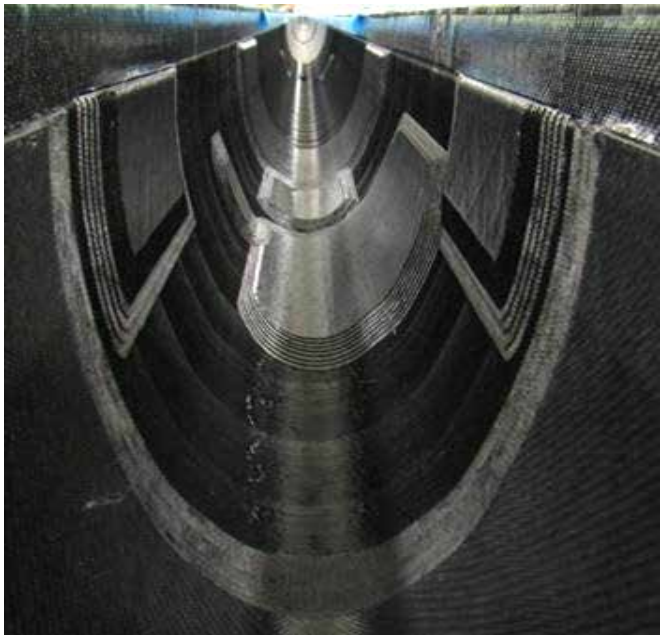
Radar arch for production Formula powerboat

Typical motoryacht radar support [Norco GRP, UK]

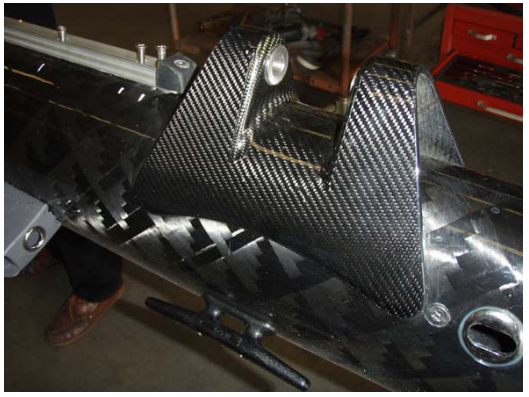
Sailboat Masts

The *Maltese Falcon* has three 190-foot carbon fiber masts, which are free-standing and able to rotate

Prepreg mast production at Southern Spars, NZ



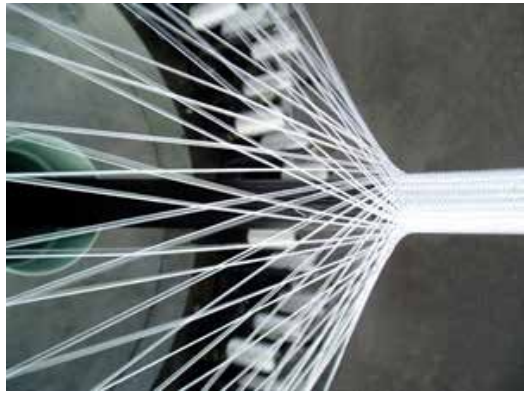
Forte Composites



CST Composites

Sailboat Rigging

Element C6 cables are constructed from a bundle of small diameter pultruded carbon fibre rods. The carbon rods are made from Toray's T800 intermediate modulus fiber [Southern Spars]



5,000lb breaking strength Dyneema 12-strand line serves as emergency shroud kit [Colligo Marine]

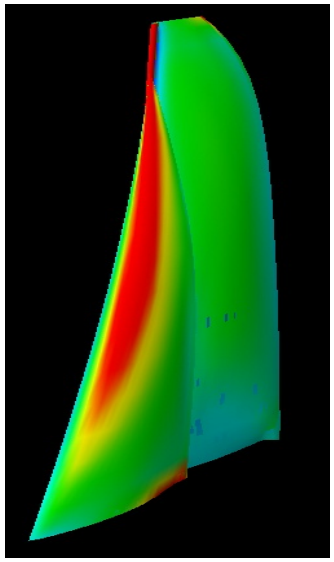
Composite rigging termination fitting

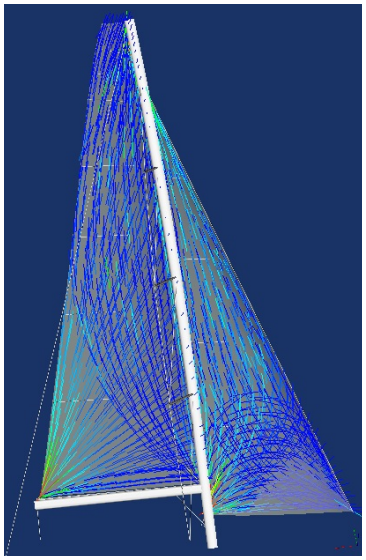
Sailboat Winches

Sailboat Steering Wheels

Edson's carbon yacht wheels are available from 36" (2.8 lbs.) to 59" (9.2 lbs.) and are fabricated in carbon fiber using one piece monocoque construction. The high gloss clear coat finish over carbon fabric weave yields a hi-tech look. [Edson, New Bedford, MA]

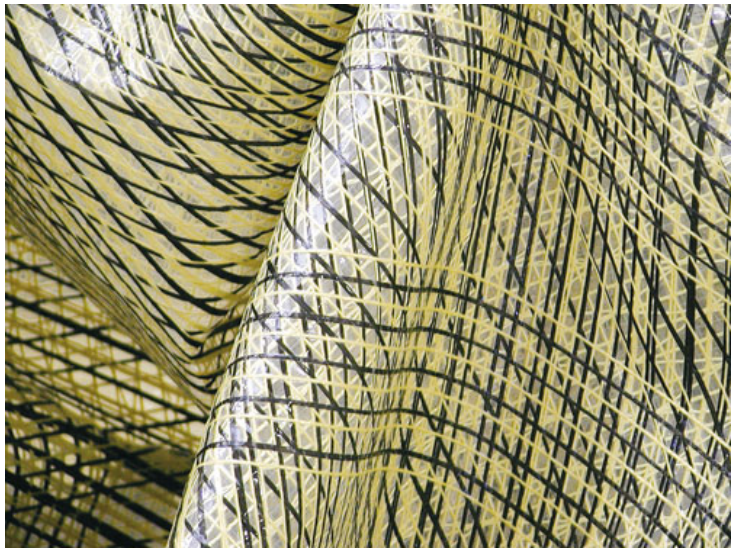
Sails





Quantum membrane sails are laminates with custom fiber maps sandwiched between sheets of very thin Mylar® film. Fibers are strung on the base film in a custom pattern according to the design specifications. After the top layer of film is in place, a vacuum bagging process is used to "shrink wrap" the film around the fibers. The layers are then fused using infrared heat and six to eight tons of pressure to thermoset the adhesives. [Quantum Sail Design Group, Annapolis, MD]

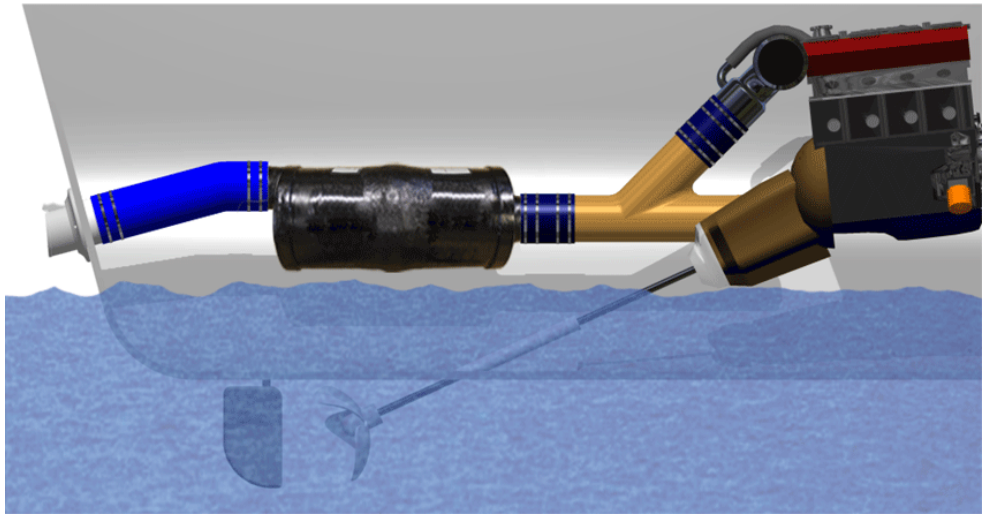
Carbon and aramid fibers "molded" in Mylar



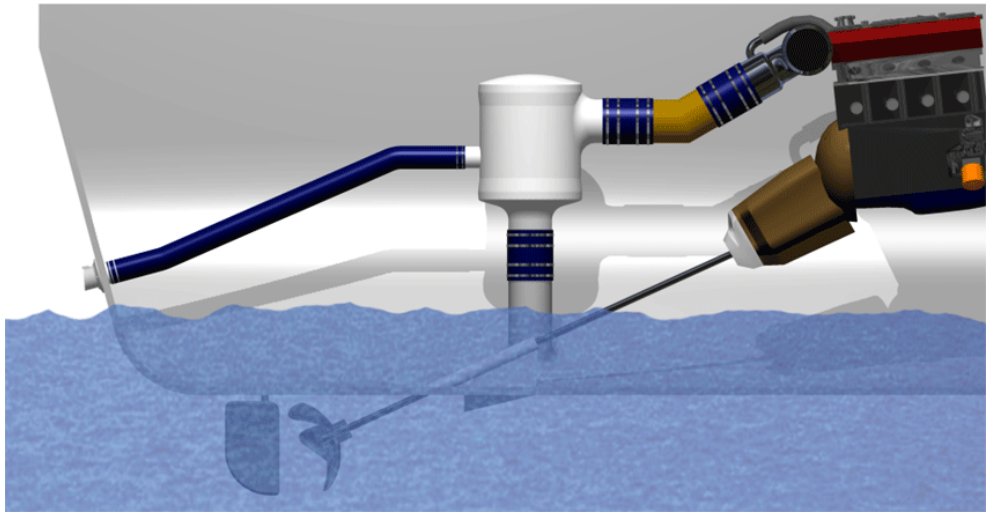
Proposed cargo ship with telescopically reefing hard composite sails [Kazuyuki Ouchi and Kiyoshi Uzawa of the University of Tokyo, Japan]

Wet Exhaust Systems

This style of marine exhaust has been used by boat builders and boaters world wide for over 40 years. [Centek Industries]

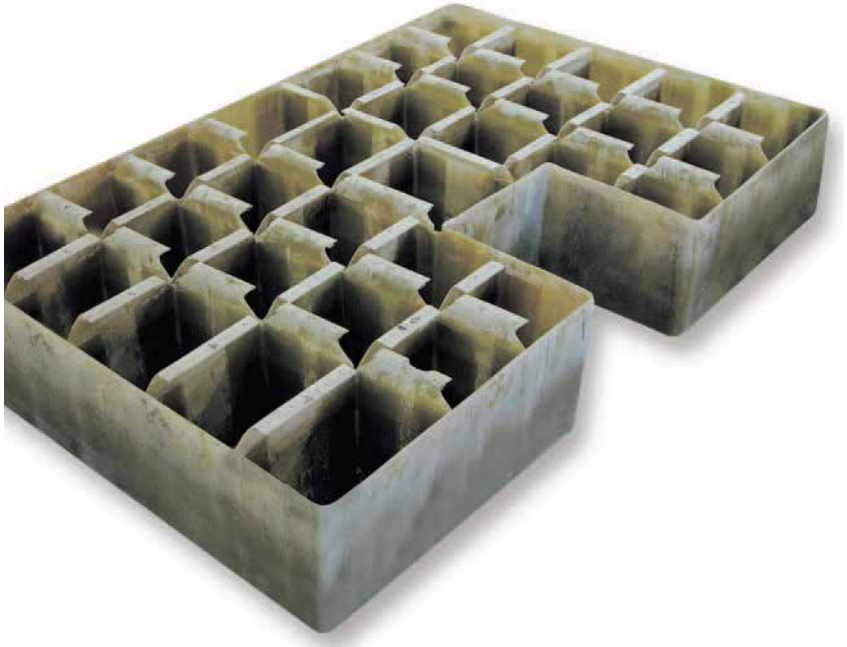


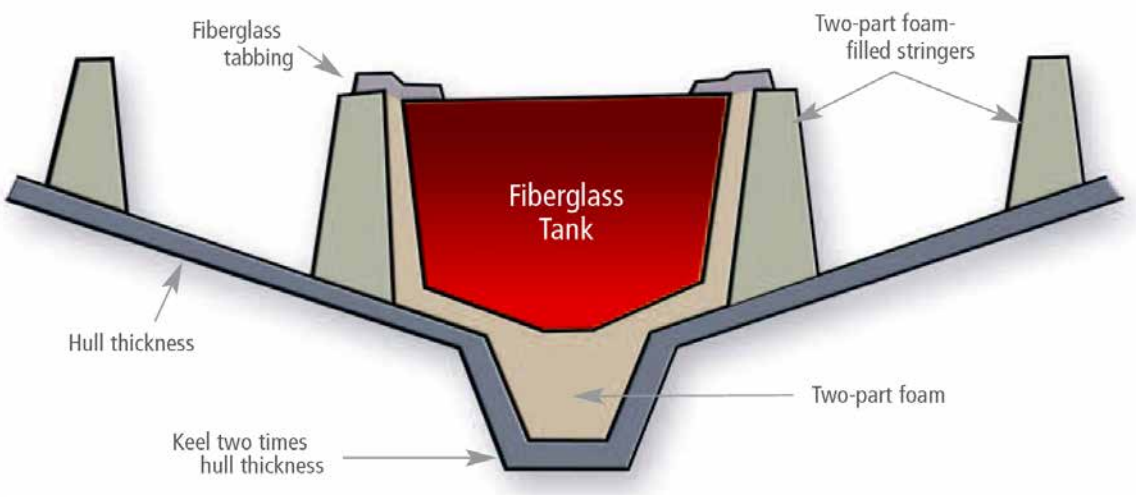
This muffler simplifies the conversion to underwater exhaust by combining the main engine exhaust and bypass line in one simple package. [Centek Industries]



Tanks

Hatteras' fuel tanks use the bottom of the boat as its bottom and the stringer's for its sides with baffles to keep fuel from sloshing. [Hatteras Yachts]





Integral composite 400-gallon water tank fabricated for a Nordhavn 47.

Doors

Helicopter hanger door developed by Seemann Composites in 2000

E-Glass/Vinyl Ester-Paneled Door Built by Ingalls used in ManTech Topside Project

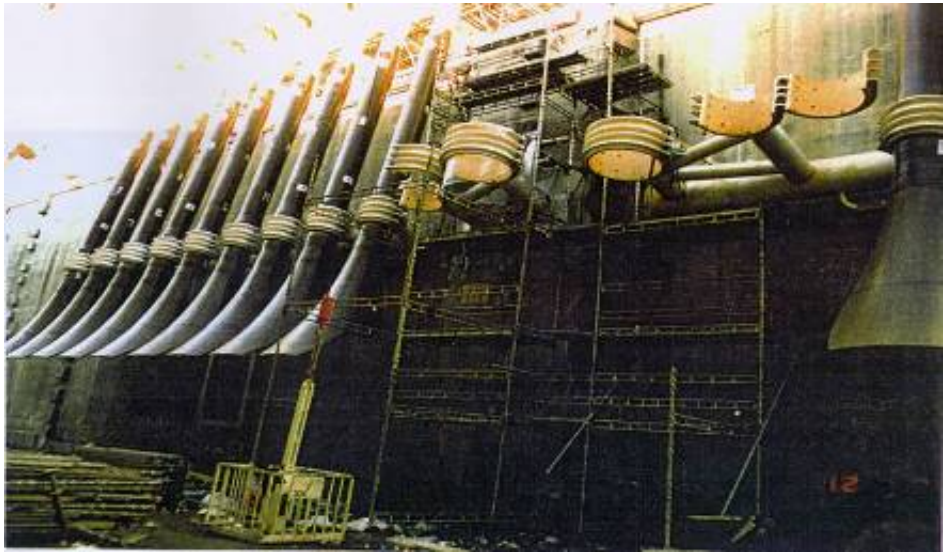
Offshore Oil Production

Carbon fiber rod-reinforced deepsea umbilicals by Aker Solutions [Anadarko Petroleum Corp]

Enclosures reduce equipment noise from 114 dB to 70dB [Sara Black, Composites Technology]

Well Head Covers

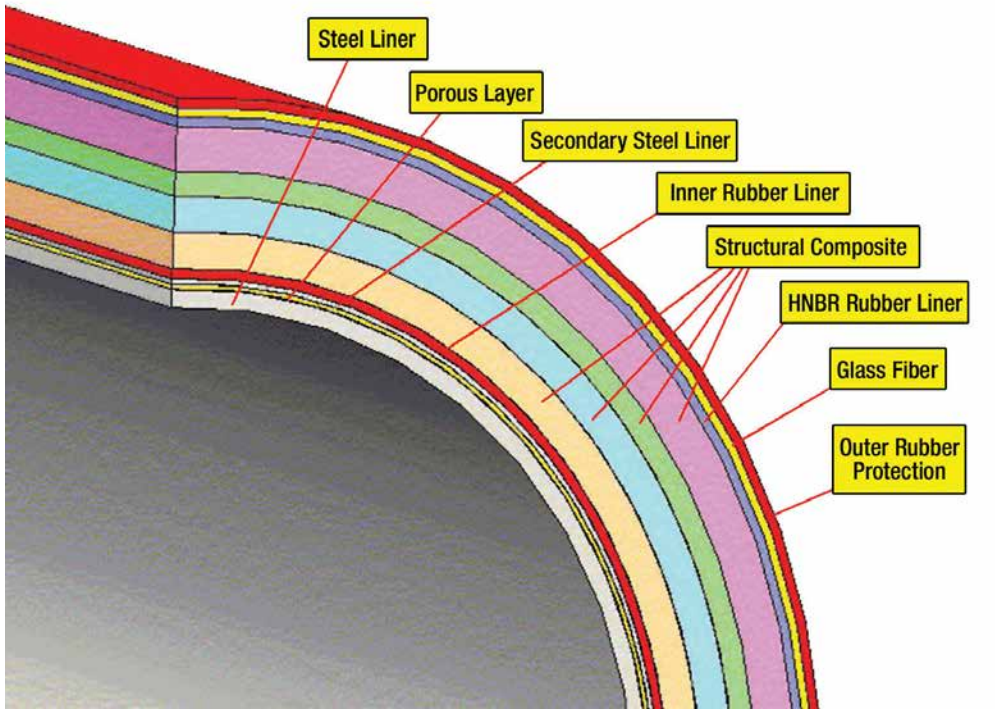
Drill Riser Fairlead Tubes



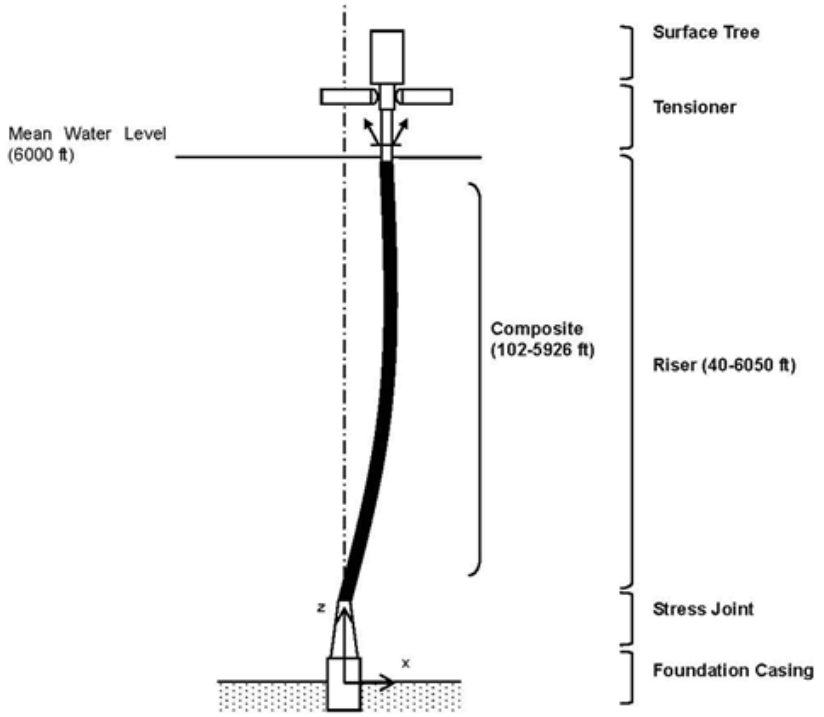
Umoe Mandal of Norway Claims over 50 Years of Submerged Life for These Composite Offshore Structures

Risers

The layers that make up a composite riser pipe [ABS]

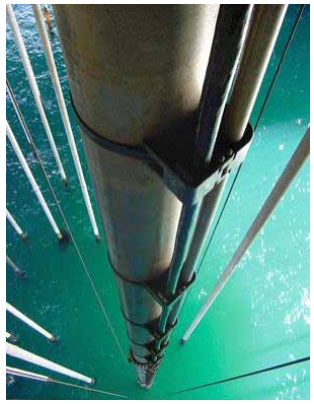


Composite riser system configuration [Ozden Ochoa, 2007]

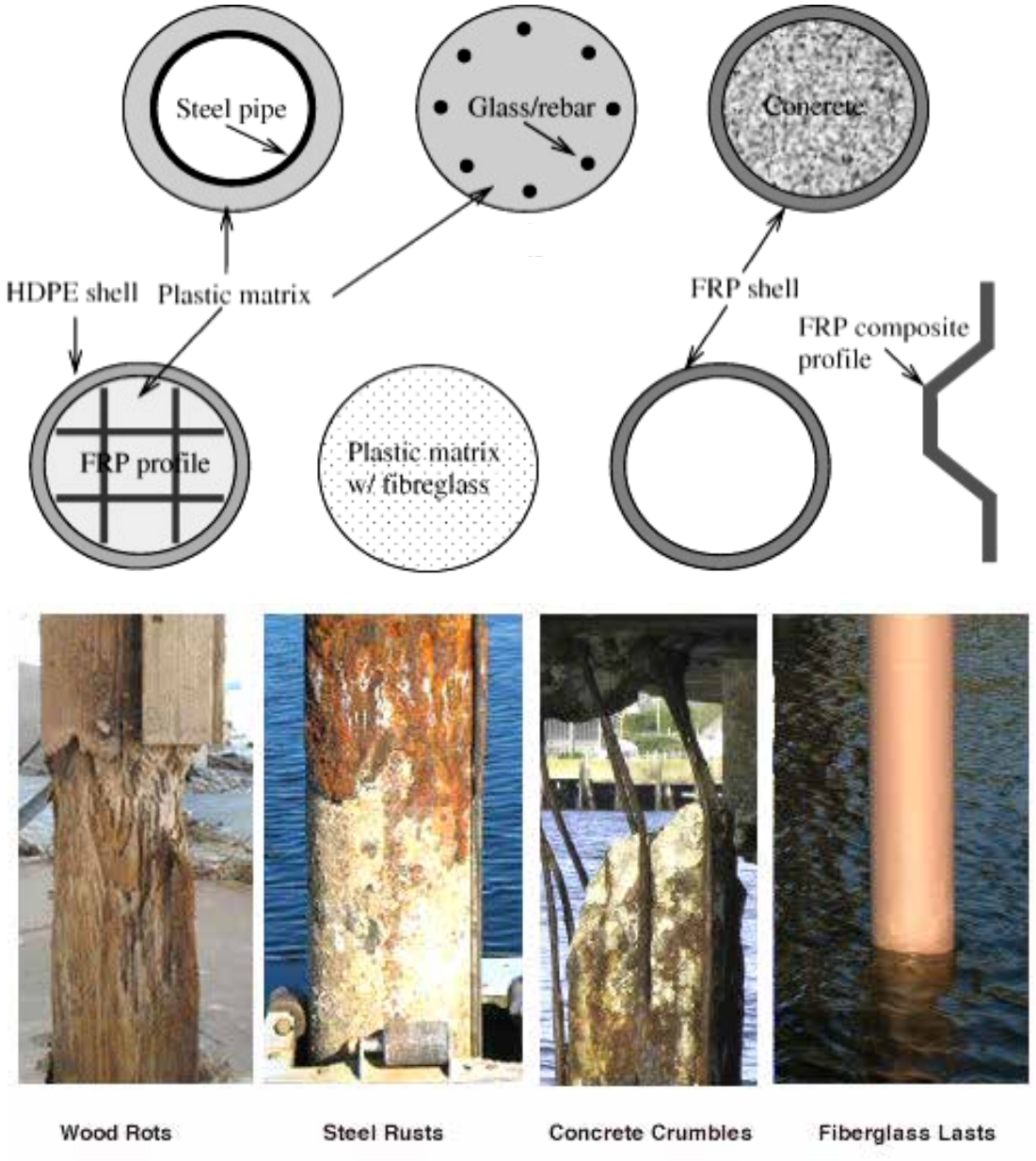


Composites used to repair offshore riser corrosion and damage [Clock Spring, Houston, TX]

Composite high-pressure drilling riser joint in service [Aker Solutions]



Pilings

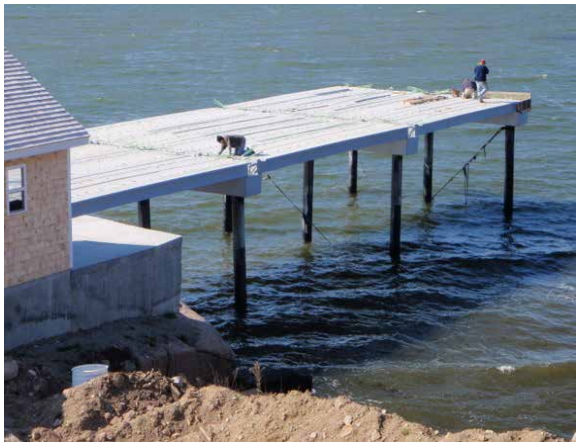


Ernesto Guades , Thiru Aravinthan, , Mainul Islam and Allan Manalo, "A review on the driving performance of FRP composite piles," Composite Structures, Vol 94, Issue 6, May 2012

Pearson Pilings, Fall River, MA

Docks

Composite decks and floating docks for Downeast Institute [Harbor Technologies, Brunswick, ME]



Two 56'x11'x4' cruise ship stand-off floats for Cruise Terminals of America, Seattle, WA (left) and Bridge Fender with HarborPiles on Beach Boulevard Bridge over Forked River, NJ (right) [Harbor Technologies, Brunswick, ME]

Carbon Fiber, Really?

The 26-pound (empty), $10,000 Thetford Tecma X Light carbon fiber head

The Hublot $20,000 watch

The 11-pound, $20,000 Blackbraid urban bike

The $80,000 Blacktrail BT-01 electric bike