Composite Hulls *Sail into the* Future

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Technological advances in composite materials have helped yacht owners maintain their investment value.

By Guy Waddilove

Sailing yachts can be built from a variety of materials including wood, steel, ferro-cement, aluminium and composites, but composite construction has emerged as the winner in terms of market share for modern sailing yacht construction because of the price and performance advantages that it can offer over other boat building materials.

Ferro-cement is usually restricted to the domain of the backyard builder due to its undeserved reputation for inconsistency and unpredictable failure. Because of its weight, steel is normally limited to applications where performance is not a governing factor, whether it be sailing or motoring although steel is still used extensively in superyacht construction for large motor yachts. Wood has been used for centuries in boatbuilding, but with the development of composite and metal construction it has been relegated mainly to specialist boatbuilding applications using cold moulding or strip planking techniques to form hulls. The hulls are usually extremely strong and fairly stiff, but tend to be quite labour intensive and expensive to build. Aluminium and composite are now the two predominant materials used in the majority of yacht builds today because of the advantages they offer in their weight to performance ratio.

Composite materials have been used in the marine industry for around forty years. During this period understanding of the materials' properties and the development of different construction techniques has allowed designers, engineers and builders to get optimal performance from the materials in terms of weight, stiffness and strength; properties desirable for a sailing boat hull.

With respect to yacht construction, the term composite embraces a variety of different materials. Basic composite formation involves the forming of the laminate 'skin' from two components: the matrix, which is a resin (polyester, vinylester or epoxy) and their reinforcements (fibres of glass, carbon or Kevlar). The fibres are infused with the resin to form a strong structure that will bend without cracking. To provide structural strength and stiffness the thickness of panels is increased using a sandwich construction with a foam, honeycomb or balsa core between the outer skins.

Because of the huge variety of different materials that can be used for the matrix, the reinforcements and the core, the components of the laminate can be very accurately designed and engineered to a specific strength for a specific purpose. Even within the varieties of fibre, different weaves of cloth can be specified to produce different strength results depending on the properties desired. For example, around the chain plates on a sailing yacht, a stronger laminate can be formed by using unidirectional carbon fibres to provide the extra strength required to take the high loads from the rig. Areas requiring less strength can be formed with less expensive reinforcements that have lower strength properties.

The thickness of the structure can also be varied where increased stiffness or strength is required with a thicker core or more layers of laminate. The strength, weight and stiffness of sections of laminate can be accurately mapped out for different areas of a hull and deck and the ability to accurately engineer the design in this manner means a yacht can be built to meet an exact specification, whether it be driven by price, weight or performance, or a combination of these factors. It also means the designer is not constrained by the need to design from a uniform plate thickness or standard set of scantling dimensions. This helps to minimise the cost of the project and optimise weight savings.

Composite hulls and components are formed in a variety of ways to optimise production time and cost. Originally composite forms were created using a wet lay-up with resin rolled onto the fibres over a male or female mould. Modern techniques now used for laying up composites include vacuum bagging, resin infusion and the use of fibres pre-impregnated with resin. These techniques allow the boatbuilder to build with an accurate and uniform resin-to-fibre ratio resulting in a laminate without voids that weaken the structure.

The use of composites in building yacht hulls allows the boatbuilder to build to very accurate dimensions. Because of the way the hull is formed in a mould, very little, if any fairing is required so the use of fillers to smooth the outer surface is minimised. The moulds for some decks are now being formed in sections of foam cut by computer numerical control (CNC) cutters which receive input directly from the designer's digital drawing files. Composite construction is used extensively in production boat manufacture and it is the technique used by the majority of production boatbuilders worldwide because of the ease of replication. When the hull and deck moulds are formed, any number or hulls and decks can be built as exact duplicates so production costs decrease.

Buying a yacht built from composites offers many benefits to the owner including low maintenance costs, lower weights and a stiff hull for optimum performance.

A yacht built using composite materials avoids corrosion. Metal hulls must be well protected by paint systems to prevent electro-chemical corrosion, and the integrity of the paint coating has to be maintained to keep the metal surfaces isolated from the corrosive salt of the marine environment. If it is not the metal will be gradually eaten away losing structural strength. Composites are not subject to electro-chemical corrosion in this way and therefore do not need to be protected: they can remain unpainted in a marine environment. Also with composite

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hulls, the issue of galvanic corrosion between dissimilar metals is avoided. With an aluminium hull, stainless steel fittings need to be perfectly isolated to prevent galvanic corrosion and likewise aluminium fittings on a steel hull. Composite materials, being non-metallic, do not suffer from galvanic corrosion. Composite hulls will typically have lower maintenance costs for these reasons.

Early technology polyester fibreglass hulls often suffered from degradation through osmosis, where the underwater surfaces of the hull absorb water. This water, when soaked into the fibres, gradually breaks down the fibreglass structure by destroying the bond between resin and fibres. In extreme cases osmosis can lead to complete failure of the structure. Resin developments has meant osmosis is no longer a problem for owners of more recent composite yachts. These resins are now impermeable.

Also, because composite boatbuilders and designers were still learning the properties of the various materials, the boats were either over-engineered and heavy or under-engineered and flimsy. With better understanding of the materials and the development of materials such as carbon, Kevlar and epoxy, modern composite yachts now do not suffer the problems of earlier builds and can be precisely engineered for their purpose resulting in very stiff, light structures.

The lower on-going maintenance costs of a composite yacht can offset the initial price difference between aluminium and composite construction, and weight savings with composite yachts enable smaller engine or rig sizes to be specified. Smaller engine sizes mean lower fuel consumption, not only saving money, but also less fuel has to be carried, again saving weight. These economies of ownership with a modern composite yacht mean that over a longer term, make composite yachts a sound investment. As well as the financial savings, composite boat owners gain the benefits of increased performance from a lighter hull, whether it be around the race course for sailing yachts or faster passage times for cruising yachts.

The quality of composite boats has increased dramatically in recent years as understanding of the properties of the materials involved has developed. Modern composite yachts offer their owners both economic benefits and performance benefits. It is no surprise that Boeing's 787 Dreamliner, with its wings and fuselage made of carbon fibre composite is being touted as the most fuel efficient and environmentally friendly aircraft to date.

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