

THE EVEN KEEL

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Leading Edge Boat Designs Requires Diversification From Keel Builder

There is an age old argument among engineers around the question of what drives new technologies. Is it the fundamental change in design that brings forward new materials, that allow the improvements to become realized? Or is the invention of new materials and applications that drives improved design technology?

In boat building the introduction of modern materials such as fiberglass, epoxies, and carbon fibers has allowed for significant advancements for the yacht designer and builder. These materials have allowed the structure of boats to become lighter and stronger. With sleeker designs and lighter weights came higher speeds, creating greater stresses on the structural elements of crafts.

Keel Design Keeps Pace

Mars Metal has met the challenge of these advanced designs with high strength, light weight keels that feature minimum wetted surface areas, while maintaining low centers of gravity. **MarsKeel Technology**, in concert with designers and builders, has evolved progressive manufacturing techniques to provide the solutions these new designs require. This, along with a strong knowledge of metallurgy, coupled with an inventory of leading edge materials, places **Mars Metal** as the experienced leader in keel construction.

An example is the marriage of cast fin sections to lead bulbs, Casting materials range from Steel, Iron, Ductile Iron, and Stainless Steel to hybrid alloys including Nickel-Aluminum-Bronze. These metals may be used 'as cast' or 'heat treated' to increase tensile strength. For example, the strength of cast Stainless Steel increases in excess of 60% when heat treated.

Top Plates are integrally cast with the fin or cast individually and welded to the keel section. These plates require milling, drilling, tapping, and welding of the keel bolts in place to exacting tolerances.

Alternate and equally progressive keel designs include fabricated mild steel and stainless steel fin sections. These fins are seam welded for strength and are water tight. They typically include welded horizontal and/or vertical stiffeners. The hollow interior cavities provide options such as fuel or water storage compartments.

As with fin construction, the method of attaching the bulb offers a



Stainless Steel Keel Fin with integrally cast Antimonial Lead Bulb for 40" sloop, "Gray Wolf"
Designed by:
Rodger Martin Yacht Design
Built by:
Lyman-Morse Boat Building Co.
Keel by:
MarsKeel Technology

variety of options. Integrally casting the bulb to the fin, though technically difficult in manufacturing, is the preferred method. Eliminating bolts and the necessary joining hardware reduces opportunities for damaging corrosion to take place, and at the same time, delivering a completed keel eliminating on site assembly.

Other bulb attachment alternatives include casting the bulb separately and through bolting it either vertically or horizontally to the keel fin section. Bulbs bolted vertically require nut pockets cast into the fin section, while bulbs bolted horizontally are usually cast with a cored cavity which matches the fin tip. The horizontally drilled bolt holes match corresponding fin bolt holes to allow easy attachment.

Material characteristics that the keel designer chooses are a balance of strength, hardness, compatibility and corrosion resistance.

Material Choice is Critical

For keel bolts 304 or 316 Stainless Steel, Aquamet, Seashaft and Nitronic are preferred. Type 316 Stainless, with a higher nickel content, has good resistance to corrosion. Higher performance applications require the use of Aquamet, Seashaft or Nitronic bolts.

Aquamet, Seashaft, and Nitronic bolts have superior tensile and yield strengths and good resistance to pitting and galling. Generally speaking, these bolts are used in high performance racers that are faced with high in service stressing. The hardness of these bolts provide a further benefit on dry-sailed boats, where keel removal is routine, since the bolts are less likely to be stripped when the keel nuts are replaced.

Antimonial Lead alloys are used for casting today's 'leading edge' keels and keel bulbs. Pure lead has a Brinell Hardness of 4.0 where Antimonial Lead (4%) has a hardness of 10.1. Mars uses the range of 2-4% Antimonial lead, where the combined hardness and density values are most efficient.

Mars Metal's innovation provides designers, builders and sailors, flexibility in materials and design applications, in high performance keels and keel bulbs.

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