

Novel Design Carbon Fibre Epoxy Prepreg Rudders and Dagger board Hydrofoils Prove a Winning Combination for A Class Racing Catamarans



The International A Division (or A Class) Catamaran racing world has been set alight by the success of new, carbon fibre (CF) composite dagger board and rudder hydrofoils with a new L/V design. In recent 2014 world championship races in New Zealand at Takapuna, North Auckland, boats retrofitted with these latest design L carbon fibre epoxy rudders with lifting and stabilising foils came 1st, 2nd, 3rd and 5th in the International A division. These highly stable L rudders, now commercially available, were developed by CarbonicBoats, an innovative Australian product design and production company. The novel, 'Paradox' branded composite rudders are referred to by Carbonic Boats as heave-stable 'L' foils (L foils for short). Each of the epoxy carbon foils in the set was low temperature moulded using GSM EP-270 epoxy prepreg system, manufactured and supplied by Australian based GMS Composites Pty. Ltd.

Behind the glitz of World Championship racing single handed A class catamarans is some very sophisticated composite design and production engineering to build boats within class rules, coupled with pedigree yacht racing experience. Dario Valenza, the founder of CarbonicBoats which he set up in 1992, was involved with the Americas Cup for 10 years up until 2011. This provided him with a wealth of experience and knowledge about designing with composites to maximise vessel speed by optimising strength to weight ratios. Competitive racing vessel designs must strictly comply with the international development A class rules, which limit boat dimension to: length 5.5m (18ft), beam 2.3m (7.5ft) and a sail area of 13.9 sq.m (149.6 sq.ft). Rigging and all appendages must also comply with race rules. Boats typically have a carbon fibre mast with a height of 9m (29.5 ft), with the two hulls constructed from a carbon / aramid honeycomb sandwich epoxy laminate. The overall weight of a finished rigged catamaran, ready to race is 75Kg (165lbs). The engineering challenge is to achieve the greatest possible stiffness for the given weight. For CarbonicBoats the design aim was clear: To provide a commercially viable retrofit upgrade package to convert existing A Class racing catamarans to stable foiling, providing skimming flight with minimised drag when in foil-assisted mode, without major structural modifications.

To help create the latest design developments, in 2013 Carbonic Boats invested in new laboratories and in-house test facilities and then brought in two undergraduates from the engineering school of ISMANS (Superior Institute of Materials And Advance Mechanics) in Le Mans, France. The new Paradox L/V foil designs are the result of over 12 months of intensive engineering modelling, simulation and prototype testing, which included trials under real race conditions on prototype test platforms. In Youth division and Grand Masters A class meets, catamarans fitted with prototype foil sets achieved 3rd place in both races. The CarbonicBoats design team has taken a different approach from existing C, S and J shaped foil designs, to address the balance between stability, side force, vertical lift and minimal drag, and for the rudder design obtaining higher heave values for optimised steerage control. There are two differently shaped designs for the two pairs of CF epoxy prepreg parts that make up the new design Paradox A Class catamaran foil set; two polyhedral shaped retractable dagger board foils, one on each hull; plus L shaped rudders mounted on the transom of each hull, linked together to a central helm. The engineering demands on each of the hydro foil parts are extreme. Like an aircraft wing tip, each of the CF epoxy prepreg parts must maintain a level of stiffness, but also be able to have the flexural properties needed to allow for the degree of foil curvature at high speeds; the two lower sections of the dagger board foil can bend in excess of 90 degrees and then must fully recover; the dagger foil shape varies depending on the boat speed, trim and point of sail taken during a race.

GMS Composites prepreps replaced another epoxy system in the very early prototyping stage, after comparative tests proved that the GMS EP-270 grade was ideal for this foil application, providing both the very high mechanical performance properties in use and production processing benefits. Dario Valenza explained: *“For our L/V foils, stiffness, accuracy, dimensional stability, reliable consistency in performance properties and a very high quality surface finish are all very important. Using GMS EP-270, we can fabricate foils 2% thinner than competitive foil designs, with a trailing edge thicknesses sub 1mm. This is only possible with a good stable resin matrix. GMS prepreps allow us to accurately replicate the specified design characteristics with no needed to compromise, and finished parts remain stable in use.”* Valenza went on to say: *“GMS prepreps have good ‘tack’ so they can be easily positioned and worked into curves for efficient mould, with a relatively short recommended cure time of only 60 mins at our preferred 110 °C mould temperature, with the ramp up and dwell times overall being shorter than the previous low temperature epoxy system used.”*

According to CarbonicBoats, improvements in stiffness and foil stability were achieved with GMS epoxy prepreg material; for the same section shape and fibre stack, the finished foils fabricated from GMS EP-270 showed 8mm less deflection over an 800mm span when subjected to a weight-bend test on the bench. The higher mechanical performance of the GMS Composites epoxy carbon laminate system combined with the proprietary design and shape of Paradox L/V foils enables a single dagger foil to support the full weight of the boat plus the dynamic loads when racing at high speed. The design of the rudder foils is somewhat different, having shorter chords, thinner sections and greater span, with more slender elevators (so more bending moment), being overall 5% lighter and with a lower failure rate.

Design work continues at CarbonicBoats to evaluate faster and lighter options with an aim to provide elegant, ergonomically correct, efficient and responsive solutions. To find out more about CarbonicBoats and Paradox A Class catamarans go to www.carbonicboats.com .

For more information about GMS Composites full range of moulding and tooling resin systems and custom prepreg design services visit the company’s new website at www.gmscomposites.com .

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Websites featured in this article

www.gmscomposites.com

www.carbonicboats.com

Photos & Captions:

Photo 1 (a) and (b)



Photo 1(a) and (b) caption:

In recent 2014 World Championship races, A Class Catamarans retrofitted with the Carbonic Boats latest design 'Paradox' L carbon fibre epoxy rudders and dagger board lifting foils came 1st, 2nd, 3rd and 5th place.

Photo 2

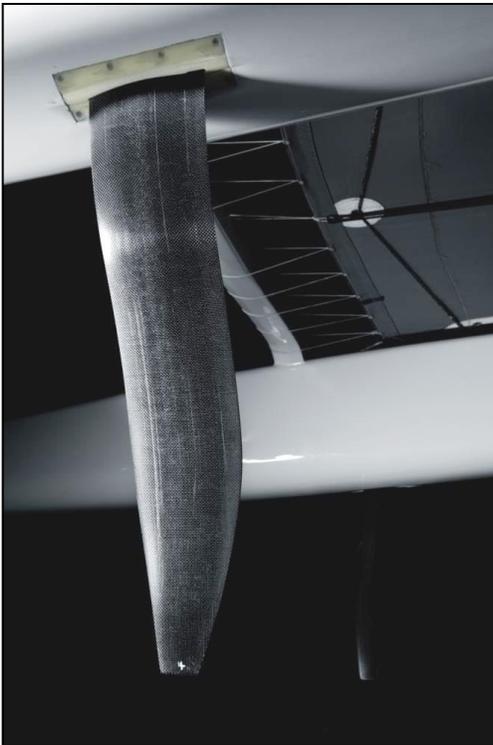


Photo 2



Photo 2 caption: The higher mechanical performance of the GMS Composites epoxy carbon laminate system combined with the proprietary design and shape of Paradox foils enables a single dagger foil to support the full weight of the boat plus the dynamic loads when racing at high speed.

Photo 3 caption: The Paradox L design of the rudder foil is different to obtain higher heave values to optimise steerage control. Also moulded from GMS EP-270 epoxy resin, the rudders have shorter chords, thinner sections, a greater span and more slender elevators for a greater bend, but with a lower failure rate.

About GMS Composites

GMS Composites is located in the Melbourne suburb of Dandenong South, Victoria, Australia, where they have their R & D, production and warehousing operations. GMS Composites has been manufacturing epoxy prepregs for over 12 years and now have an established range of over 10 different prepregs resins systems, which cover a wide range of industries including: aerospace, defence, ballistics, rail, motorsport, automotive and tooling. GMS Composites also provide CNC machining services and distributes nationally across Australia a wide range of vacuum consumables, reinforcement fabrics, cores and mould release agents from leading global ancillary and reinforcement suppliers.

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