



# SHIP & BOAT INTERNATIONAL

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## High-fibre diet

Composite materials are enabling owners to customise their yachts exactly as they want them, without having to compromise on stability or aesthetics. *Ship & Boat International* speaks to composite engineering firm Solico Engineering B.V. for an overview of the main benefits and current trends



Carbon fibre is becoming a popular choice for the construction of superyacht masts and booms (image: Carlo Borlenghi)

While all-composite newbuilds tend to be the preserve of the sail yacht sector, larger motor yachts, superyachts and megayachts are also exploring these flexible, performance-boosting materials, and incorporating them into onboard structures and features, to achieve results that would be impossible or impractical when using more conventional metallics.

It's a trend that's been noted by Coen Meerbach, business unit manager at Dutch composite engineering firm Solico. Reflecting on his country's yacht construction sector, Meerbach tells *Ship & Boat International*: "Most of the Dutch yards are focused on steel and aluminium: it's what they're accustomed to, it's their mindset. It's when they run into issues like stability, or usability, that they start to adopt composites."

"They initially had no reason to build in composites, but they came to the conclusion that some of the structures needed to be so thin, it was no longer feasible to build them in metal." Radar masts, tender garage hatches, canopies and watertight doors are just a few of the onboard yacht structures where application of composites has become commonplace.

It's hardly a secret that composites tend to cost more than their metallic counterparts, Meerbach adds. However, he believes that the return on investment, as measured by gains in operational performance and aesthetic appeal, justifies the outlay. And while some of the benefits of composites may appear obvious – among them, their comparatively lightweight nature and high resistance to corrosion – one of the key reasons they appeal so strongly to the yacht sector is their ability to produce unrestricted, organic shapes, complementing these vessels' visually striking looks.

### Hands-on approach

Since 1989, Solico has been providing composite engineering and quality testing services to various industries, including the maritime, automotive, industrial and defence markets. Within maritime, the group has worked on a broad range of vessel types, from yachts and fast ferries to naval craft and cargo ships. The company runs a small test lab in the Netherlands but does not directly produce vessel components itself, instead opting to work with material developers and boatbuilders on both newbuild and retrofit projects.

Meerbach explains: "We don't want to manufacture large parts for clients; we want to be completely unbiased and independent. If a yard comes to us and says, 'We need help with a yacht's swimming pool floor,' we can recommend this manufacturer, or these materials – but if we're producing parts ourselves, we're not independent anymore, and will be giving a biased opinion."

Approximately 60-70% of Solico's contracts comprise bespoke projects. "Yacht mast construction is almost always bespoke, especially for vessels sized 100m+ in length," Meerbach adds, "but those in the 40-60m size range are sometimes built in 'semi-custom' fashion, and these will use repeats of masts that were moulded for previous vessels."

Solico's test lab frequently receives visits for checks and approvals from the major classification societies. In turn, the company takes a hands-on approach to projects, dispatching teams to composite production facilities – and, occasionally, to boatyards – to share and gain experience 'on the shop floor'.

"In most cases, we work for the composite producers, liaising with them directly to identify how they're going to build the vessel and what materials they have," Meerbach says. "Straightaway, we jump onto the production line: we frequently laminate together with the producers, to assure we have the best knowledge of their production methods. Every producer has their own specialism, direction and preferences, so it's important we play with those specific details and maintain our knowledge database."

This approach also permits Solico to obtain material samples and take them back to the lab, to "bend them, break them and test them", ensuring there is a good correlation between the samples' mechanical properties and the desired structural

outcome of the build project. The boatyard visits typically occur when a builder has encountered unexpected problems with a detail of the contracted design – a structure in a certain location being too heavy or thick for purpose, for instance – and requires assistance to keep the project on track. In many cases, this means rethinking the application of steel and aluminium and opting for a composite fix instead.

Meerbach adds: “For larger projects, including a 78m yacht we recently worked on, we will deploy a temporary office in the yard, mobilising our team on site. That way, if we’re dealing with a yard that specialises in aluminium builds, our guys can step in when the yard’s engineers struggle with problems like ‘how do we make a penetration for this cable?’ or ‘how should I lead this duct through this bulkhead?’”

### Complex shapes

Returning to the more ‘obvious’ benefits of composites, weight reduction is an important bonus. Solico estimates that, by using carbon fibre pre-preg or semi-preg materials on mast structures, it has been able to deliver weight savings of 30-50% compared to similar aluminium mast structures. However, Meerbach adds, given that some of the mast structures can span up to 18m in length on the larger superyachts, composites are usually the only viable construction materials if one wishes to retain vessel stability.

Added to that, the ‘typical’ superyacht mast comes with its own set of challenges. “The radar mast on a motor yacht is probably the most complex composite part of the whole boat,” says Meerbach. “You’re always working with an extremely restricted space, with very organic shapes, so it’s quite challenging to get access to locations; it’s always cramped in terms of piping, electrics and lightning suppressors going through the mast.” Radar transparency is also a factor, and it should also be noted that many yachts carry dual radar installations for system redundancy, adding to the ‘guts’ of the mast.

Equally important, the radar mast must look good and match the yacht in terms of shape and detail. In addition to housing vital equipment, the mast must blend in with the yacht’s overall aesthetic feel – something that’s not too much of an issue for radar arrangements aboard ro-pax vessels or warships, where basic functionality trumps appearances.

Owners and designers also need to consider natural frequencies and vibrations. “The way we approach frequencies and vibrations is driven more by client requirements than the requirements set by the vibrations standards, which are relatively easy to comply with,” says Meerbach. “Basically, the mast’s frequency modes are excited by the first blade passing [FBP] frequency of the propeller, so you need to keep the mast away from that.”

### Corrosion and fire safety

Composites’ high resistance to corrosion also gives them a distinct advantage over metals in terms of avoiding water penetration, rust streaks, beneath-coating corrosion and other visual defects that can compromise the yacht’s aesthetics.

“Put simply, composites don’t degrade,” says Meerbach. “Three years ago, we were asked to survey a 35-year old minehunter with a solid laminate glass polyester hull, which was being sold from one government to another. We took a 50mm-thick piece out of the hull and put it through various tests in our lab, to determine its current mechanical properties and then compare those to its original mechanical properties.

“We concluded that the sample was within 10% of the quality of the original laminate. The piece appeared to be slightly stiffer, yet provided only 5-10% less bending strength. Given the material factors and load factors that are applied on such ships, there was a significant amount of reserve left, and the composite components of this 35-year-old vessel were as ready for service as ever before.”

Fire safety considerations, meanwhile, are fairly straightforward: the methods of insulating aluminium to achieve fire safety approval are “not so different to what we do with composites”, Meerbach adds.

The composite mast aboard the 82m motoryacht *Ilona* was certified with engineering support from Solico





## Layout trends

Composites are also enabling the creation of brand new approaches to overall yacht layout, resulting in some exciting new features unique to this vessel sector. Optimising onboard space has become a trend among yachtowners, leading to increased demand for ‘multifunctional’ areas.

Why have a separate helideck, dancefloor and swimming pool if you can merge all three in the same spot? By incorporating sliding/moving floors and hydraulics, a helideck can be recessed below the deck when the yacht is in port or moored up, and transformed into a swimming pool for the owner and guests.

Solico estimates that it has engineered more than 10 of these structures, with another two currently in progress, involving the management of a combination of hydraulics and composites. Again, these projects tend to be bespoke, and involve specific considerations.

“Pool size and shape, the type of helicopter and the deck load ratings all have an impact on the design, as do mechanical details, such as how the floor will integrate with the lifting system,” Meerbach says. The metallic interfaces with the floor lifting/lowering system also need to be examined – and preferably before vessel construction commences. “Interestingly, most of these sandwich composite structures are quite buoyant, so they need to be pulled down and locked in position to form the pool floor,” Meerbach continues. “Teak decking is often used to provide a seamless deck finish when a floor is raised, and a comfortable surface for bathing when the pool is in use.”

The popularity of bigger tenders and toys is driving another trend related to onboard space – the need for roomier tender garages. Meerbach recalls a recent proposal involving a 90m yacht which will carry two tenders – the larger being 9.6m in length – plus a man-overboard response boat, necessitating a decent amount of storage space and a deck hatch larger than 30m<sup>2</sup>. “The largest hatches for tender garages are always in composite, because weight becomes an issue,” he says.

Accompanying this is the desire by some owners to show off these tenders and toys – if you’ve got it, why not flaunt it? “Owners



The radar mast is “probably the most complex composite part of the whole boat”, says Meerbach

find it appealing when the superyacht opens up to reveal the toys they have on board,” says Meerbach. “We recently completed the hull doors on a large sailing yacht, where we cut two massive holes into the middle of the hull, right behind the mast, so that when the hull doors were opened, you could see straight through the yacht.

“From a structural perspective, that is the worst location to put the hull doors: all your mast compression forces are being led here to the fore and aft spaces, and there is a lot of shear going through the hull. But these composite doors are appealing, and look pretty.”

## Fibre selection: “100% bespoke”

As one might expect with bespoke projects, there is no one ‘fits all’ composite: material selection is entirely dependent on its planned usage, availability and the desired effect. “In specific cases, we’re not allowed to use carbon fibre, due to its cost and its effect on radar transparency,” says Meerbach. “We commonly adopt glass fibre – but, for highly loaded structures, it makes more sense to look at carbon fibre. Fibre-wise, selection is 100% bespoke and depends on what the composite producer has, or has the ability to obtain.

“We have clients who, for environmental reasons, are not allowed to process polyester or vinylester resins, so they must use epoxy. Other clients don’t want to use epoxy though, because it’s a little more complicated

and requires more thorough mixing.” He adds that Solico has noted increased demand for natural fibres, such as bio-based epoxy resins, in line with growing popular demand for sustainable solutions.

And then there is the fact that the composites market is constantly evolving, with innovative materials replacing trusted, traditional brands in certain applications. “We’ve seen specific fibres fading out,” says Meerbach. “Look back to the Volvo Ocean Race in the 1990s: the boats often used aramid fibres, but those are no longer used so much by the racing sector.” As a board member of the Dutch association CompositesNL, Meerbach also hosts webinars related to emerging composite materials and construction techniques, and this connection helps the Solico teams to “keep up to speed on developments”.

Graphene, polyfurfuryl alcohol (PFA) resins and flax fibres have all been touted as potential game-changers, for instance. However, in Meerbach’s opinion, certain kinks still need to be ironed out. “People are questioning graphene’s performance, its cost, what it does and what it actually adds in value,” he says. As for PFA and flax fibres, he opines: “These materials are a big move towards sustainability but, at present, they achieve this at the expense of their mechanical properties. We’re still a long way off seeing a complete switch to flax fibres for radar masts. We could perhaps use them already, but it would come at the expense of composite skin thickness, and thus weight.”

There’s a big emphasis on “at present”, Meerbach concedes. “If you look at flax fibres now versus five years ago, you see a significant difference – they’re going through a learning curve,” he says. “A few years from now, there’s a fair chance they could become a popular choice for onboard structures.”

And, as well as addressing existing vessel design challenges, these emerging composite materials could also inspire some innovative, fresh designs in their own right, as naval architects and engineers explore their potential to offer a wider range of options than before to existing and future yachtowners. **SBI**