ELSEVIER

FEATURE

Now is the time to make the change from metal to composites in naval shipbuilding

Django Mathijsen

For shipbuilding, fiber reinforced plastics have clear advantages over metals, especially in military ships. Still, the navies of the world have not massively changed over to composites yet. There is a sense of urgency though, especially in Dutch and Scandinavian shipbuilders, that now is the time to really make that change happen. We talked to experts from Damen Schelde Naval Shipbuilding in Vlissingen, the Netherlands, and learned about the advantages of composites, but also about the challenges that have to be overcome.

The Damen group has a long history producing ships in composites, going back as far as the 1960s. In the early 1980s for example they were already producing fast, light composites vessels. ''But then aluminum enabled cheaper production, so Damen turned completely to aluminum,'' Joep Broekhuijsen says. He is the general coordinator research and development at Damen Schelde Naval Shipbuilding (www.damennaval.com) in Vlissingen, the Netherlands (Fig. 1).

Since the turn of the century however, the Damen group is investing heavily in composites again. And since a few years, they have a composites shipyard in Antalya, Turkey, producing light, fast ships of up to 25 m in length. ''These are mostly interceptors: fast little boats which are carried on board of the mother ship for giving chase,'' says Laurent Morel, technical specialist composite structures at Damen Schelde Naval Shipbuilding. ''We are producing a series of seventy of them in a factory-like way at a rate of about one a week. We also have two water buses in production there: catamarans for passenger transport. And in all our crew suppliers and offshore supply boats for example, the whole superstructure is already made from composites.''

FIGURE 1

A Damen interceptor flying over the waves: light and fast, thanks to composites.

Damen builds a whole range of ships. And they have the ambition to go larger with composites ships. ''We have a 45 m design on the drawing board and we want to go to 75 m within 5 years,'' says Morel (Fig. 2).

Damen uses thermoset resins and they try to stay with glass fiber as much as possible. ''In smaller ships we do use hybrids with aramid and carbon fibers,'' Morel adds. ''The 11 m long interceptors are made of carbon fiber. The waterbuses are glass fiber. And we are working on a 45 m long carbon fiber ferry. That structure is more critical. Most composite ships are not engineered for strength but frequency. Depending on the ship's type you sometimes have to go to a different material to achieve that frequency. The ship's propeller excites the structure, so the structure has to have a different frequency, preferably above the propeller's frequency.''

Extra advantages for composites in the military

Of course the most obvious advantage when changing from steel to fiber reinforced plastics is weight reduction, which can be used

E-mail address: syncopatedfiction@hotmail.com.

 http://dx.doi.org/10.1016/j.repl.2016.08.003

Please cite this article in press as: D. Mathijsen, Reinf. Plast. (2016), http://dx.doi.org/10.1016/j.repl.2016.08.003

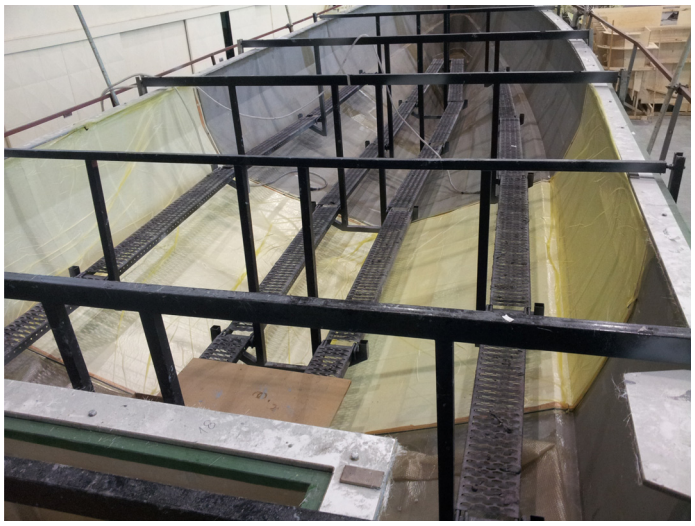

FIGURE 2
Molding a composites hull.

FIGURE 3
The Alkmaar-class MCMV's, like this Zr. Ms. Urk, developed from 1974, has been in service in the Dutch navy since 1983. Its 52 m long, glass fiber reinforced polyester hull was quite revolutionary at the time. Which concept is going to replace it?

to reduce fuel or carry more payload. ''In commercial ships it turns out the best strategy is to take more payload because then you earn back your investment more quickly,'' Morel says. ''In cruise ships payback times of two to three years are achievable. In general, ships have a life expectancy of 25–30 years.'' So the life cycle and running cost of a composites ship are lower than that of a steel ship, also because it requires less maintenance. Unfortunately, that does not work as a selling point yet as Morel explains: ''The client has two separate budgets: one for purchase and a different one for maintenance.'' So the client will generally decide which ship to buy, still based on purchase cost, not on life cycle cost.

The lighter weight of a composites superstructure can also lead to a lower center of gravity for the ship, increasing its stability, meaning: reducing the risk of the vessel capsizing. But according to Morel the main reason for going back to composites for these ships below 25 m in length is because they are now cheaper to produce than aluminum ones: ''That is because they were reengineered to enable modular design and series production. We can now for example put together different superstructures with the same molds.''

For military applications a ship or superstructure made of composites has the additional advantage of a lower signature, as for example a lower radar cross-section. This is especially the case if you compare it to a lightweight metal structure. A metal ship's radar cross-section can be lowered by giving it a clever shape with flat, angled surfaces, but according to Broekhuijsen that is not so easy: ''If you want to build in aluminum or thin steel, the welding processes will lead to warping, leaving the ship less esthetic and also more visible on radar.''

Last but not least, the underwater magnetic signature of a ship made of composites is lower, which is especially worthwhile for mine countermeasure vessels (MCMV's). MCMV's are larger than 25 m. And the Dutch navy is supposed to be replacing their MCMV's soon. ''That is currently a main focus of ours,'' says Broekhuijsen. ''Can we scale up the manufacturing technology of those small composites boats so we can build larger platforms if the demand comes from the Dutch defense organization?'' (Fig. 3).

Mine countermeasures vessels

Damen is conducting a lot of research into the next generation of MCMV's. For that, composites vessels of up to 75 m long are being considered. ''That is a rather large composites platform,'' Broekhuijsen says. ''Something that has not been done very often yet.''

But the defense organization has not ordered those new MCMV's yet. They are dragging their feet because there are two different strategies in dealing with mines. The defense community has not decided on a clear preference yet.

The first strategy is to have an MCMV with a low magnetic signature (i.e.: a ship made from composites) that can detect mines before they detect it. Also, the instruments on board have to be made of nonmagnetic materials or locally equipped with a degaussing system, so you can get close to the mines without triggering them.

The other strategy is to have an ordinary, steel mother ship that always stays outside the minefield area and sends in small unmanned vessels to track the mines down. Those unmanned vessels are planned to be 10–20 m long and made of composites. They will have to carry quite a lot of payload in systems for charting the minefield.

''The defense community is waiting to see how fast the development of those unmanned systems will be,'' Broekhuijsen says. ''So the cost-performance comparison is very difficult to make at the moment. We want to be able to make a good comparison and support the defense organization as soon as the request comes, so we can show them which manufacturing techniques and materials are worthwhile.'' It is also not clear if it will truly be possible to guarantee that a mother ship in service will be able to stay clear of the minefield under all circumstances. ''We try to be ready for both strategies,'' Morel says. ''But for me the challenge is clear: the purchase cost for the composites vessel has to be at least as low as the cost for the steel hull version. That is the only way to stop the debate.''

The loads that navy ships have to be able to withstand are of a different order than those in commercial ships. MCMV's for example have to be able to take an unintentional mine detonation.

Please cite this article in press as: D. Mathijsen, Reinf. Plast. (2016), http://dx.doi.org/10.1016/j.repl.2016.08.003