Fibre-winding technology can save money in rubber parts

By David Shaw, ERJ staff
dshaw@crain.co.uk

Spin-off company based near Delft University offers sophisticated fibre winding system that can save money and improve performance.

IF A REINFORCING FIBRE is stressed purely along its length it can support a full load, but allow that fibre to deviate by just 5° from the optimum, and its ability to carry load falls by 50 percent (see diagram, right). This is the thinking behind a start-up company called Taniq, born in Delft University of Technology in the Netherlands.

Three MSc technologists have developed a system that allows fibres in complex mouldings and shapes to follow isotensoid lines. This means first that the fibres are aligned with the stresses and so can support the maximum load per fibre. This allows product designers to reduce the amount of fibre used, or to use the same amount of fibre, but use a cheaper, lower-strength grade.

Secondly, the requirement for a strong bond between fibre and rubber is substantially reduced. When a fibre is perfectly aligned with the direction of stress, it is being stretched. But since the fibre (in comparison to rubber) is a rigid element, there is no stress at the fibre/rubber interface. When the fibre is misaligned, however, the stresses tend to pull the fibre through the rubber, leading to stresses at the interface. This, in turn, leads to a need to bond the fibre into the rubber.

The technology grew out of research work on the science of composite aerospace structures. While many of these structures were rigid, the work included studies of flexible systems, such as inflatable lifting bags.

Meanwhile, the three experts who are taking the idea forward have won numerous prizes for innovation and for their entrepreneurial spirit. Heading the threesome is Siebe Nooij, who has the title of managing director, and is responsible for new business development at the start-up.

According to Nooij, Taniq aims to develop ideas together with its clients. The aim, he said, is to spend a period of time working with the client and at the end of that time — typically 12 months or so — to deliver a number of prototypes and a scheme for full-scale production to the client. The scheme includes production recommendations, design models and costings. "There should be synergy. We know everything about winding fibres, but they know everything abut treating and preparing rubber."

"We will work together with them and their specialists on the total concept, but we will be responsible for the winding part," he added. Nooij added that Taniq keeps the intellectual property of the basic idea, but licences it out to each client for each specific project.

Nooij said the Taniq analysis may propose a small change in geometry to achieve a true geodesic shape, but this would tend to lead to lower stresses in the component anyway, as the stresses are all taken up by the fibre, rather than diverting some of the shear stresses into the rubber.

The project fee, said Nooij, would be typically six figures, ranging from the low end of €100k for a very simple project up to €1 million or more for complex or large projects.

While the benefits vary from client to client, said Nooij, the savings would typically come from reduced fibre consumption, or the ability to switch to a cheaper grade of fibre, and possible process savings in terms of fibre pre-treatment.

Another benefit, said Nooij, is "You can save on rubber. If you do not have any shear stress any more, you need a lot less material."

Nooij said, "the basic idea has been tested in a proof of concept — we made a prototype and it works really well." He said the three had built a 360 mm diameter test-piece similar to a turbo-charger hose with a bellows section. The convolutions of the bellows were designed to be geodesic in shape with reinforcement designed to be isotensoid. That means the stress in the fibres is unidirectional and that each of the aramid fibres has the same level of stress as its neighbour.

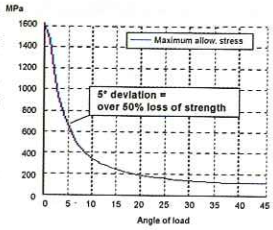
A theoretical analysis of the fibre reinforcement showed that the absolute maximum burst pressure would be 100 bar, assuming every single fibre was stressed up to the ultimate tensile strength of the material. In the event, the sample burst at 90.7 bar, showing that the product used over 90 percent of the available reinforcing capability. This is extremely efficient use of reinforcement, where typical products use 50 percent or less of the theoretical maximum available strength.

Furthermore, he added, the failure mode was by tensile failure of the fibres. A cut through the failed piece showed dry fibres within the rubber. Nooij said that the sample was prepared with dry, untreated fibres. "if you look at the prototype. between the two layers of rubber it is completely dry fibre. We made the prototype with raw dry fibres. There was no problem with that. We did not get fibre movement, it all stayed in place. The failure was by breaking of the fibre and nothing else."

Commercial expertise

Nooij acknowledged that the three founders do not have broad commercial experience. He said, however, that they have recruited an experienced commercial manager to offer support and advice in the field of client relations.

Nooij said the biggest benefits come from convoluted shapes that are under pressure compared with the ambient conditions. He said turbocharger hoses are a major application and that other convoluted shapes could also benefit from this approach. *erj*



Nooij (top) says fibres lose their ability to carry stress as they become misaligned (middle) with the direction of stress. Typical components can be modelled on computers (below)