NEW TEXTILE TECHNOLOGIES FOR FRP-APPLICATIONS

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Abstract

This paper presents three developments for efficient, waste and time reduced manufacturing processes for semi-finished fibre-reinforced products. The first development is a scaled multi-layered warp knitted fabric for rotor blades, the second one the circular weaving technology for conical seamless tubes and the third shows matrix hybrid semi-finished fabrics.

1. Introduction

In this day and age of globalization and big competition an efficiently, time-reduced and waste-free production becomes more and more important. Furthermore, the resources muste be used deliberate and gentle to save them for future generations. That´s why light weight constructions in particular fibre reinforced plastics come more and more commonly.

Pre-fabricated semi-finished products can help to reduce manufacturing time and costs for the manufacturing of fibre reinforced plastic parts. For this reason STFI acquires in collaboration with different partners permanently technical and technological solutions for the efficient and waste reduced production of pre-fabricated, near-netshaped multi-layered or multiaxial textile preforms.

2. New textile technologies for FRP-applications

2.1. Scaled multi-layered warp knitted fabrics for rotor blade belts

Rotor blades for wind power stations consist of blade shells, belts and the support core. Belts consist only of unidirectional single layers and are placed on both sides of the rotor blade. They are responsible for the bending stresses and load bearing capacity. For example, a belt with length of 50 m consists of 60 unidirectional layers. In that case, the laminate has a thickness of about 45 mm.

There are two challenges. The first problem is, that each layer has a different length. Only the bottom layer has the full length of 50 m. Each follow-up layer is a little bit shorter as the previous, because the thickness of the belt will be reduced in direction of hub and head of blade. The second problem is the high number of layers. To lay-up the textiles in the mold, the people have to walk almost 3 000 m. In this time of maybe 3 hours, the mold is blocked.

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To solve this challenges, STFI developed a textile technology and a special textile machine, which allows manufacturing double-sided scaled, multi-layered unidirectional knitted fabrics in one step. This new technology contains separation, cutting and resupply of single layers. The advantages are a significant reduction of layout-building time, a simplified positioning in the mold and a higher level of precision. The previous lay-up time for rotor blade belts can be reduced by one-fifth.

Figure 1. Scaled multi-layered warp-knitted fabric

2.2. Circular weaving technology

The starting point was to get a seamless preform for fibre-reinforced plastics (FRP), especially conical FRP-tubes, with a very high degree of pre-fabrication. Therfore, the circular weaving technology is predestinated, because of it´s high operating speed, equipment dependability and seamless manufacturing of tubes. Opposite to the braiding process, fibre rovings are laid in machine and cross direction.

Because the aim was to get a preform for conical circular FRP-tubes, the circular weaving technology had to be refined. Usually the diameter of a cicular woven fabric is fixed and determined by a so called weaving ring. To get a conical circular woven fabric, the diameter must change during the manufacturing process. In cooperation with a project partner, STFI developed a weaving ring with a flexible diameter. This allows to change the diameter during the weaving process and the production of conical, seamless, semi-finished weaving tubes. The weft threads will overlay during the diameter reduction or can be cut and feeded later on.

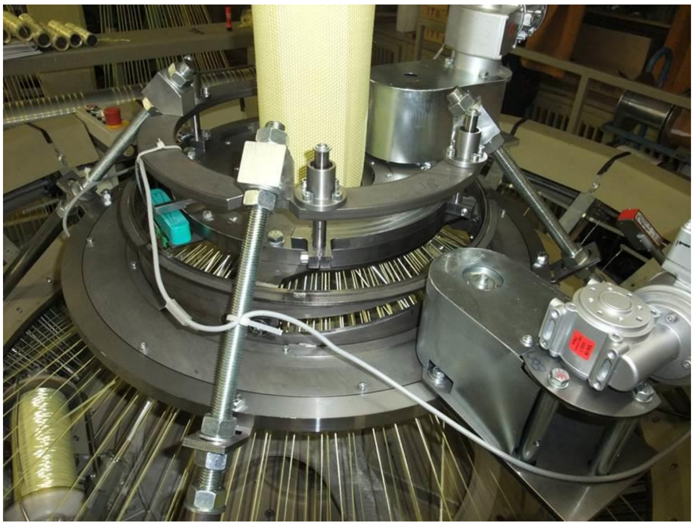

Figure 2. Flexible weaving ring

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With the modified circular weaving technology and device the diameter of the textile product during the weaving process could be changed. The gradient of the cone will be determined from relation between velocity of change of diameter and of rotational speed of the machine. On this way conical and seamless preforms, for instance for FRP-tubes, can be manufactured.

Figure 3. Conical circular woven fabric

2.3. Matrix hybrids

Thermosetting plastics or thermoplastics are used as matrix material for fibre reinforced plastics (FRP). Both materials provide pros and cons for future component properties as well as for suitable processing technologies. The research project „Matrix Hybrids" pursues the objective goal to join both matrix materials into one component.

The basic idea is to combine both matrix systems with the use of a fabric layer whose warp and weft threads switch the side of the matrix alternatingly. The adhesion of thermoset and thermoplastic will be supported by high-tensile reinforcement fibres. This opens up new and innovative options for constructing engineers and technologists with reference to construction methods and assembling technologies.

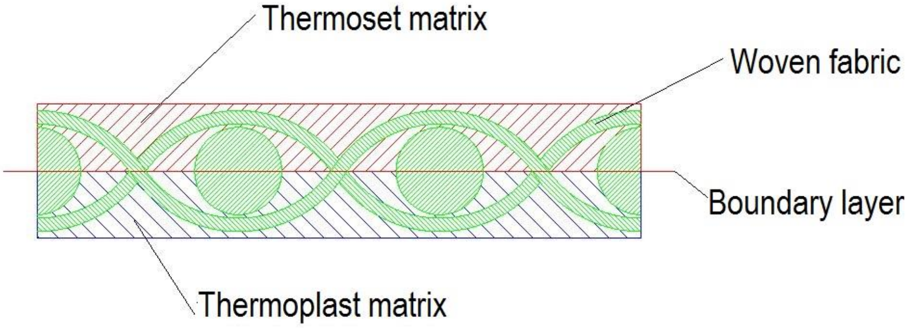

Figure 4. Scheme of a matrix-hybrid compound

Partial-consolidated thermoplastic prepregs, where a fabric layer is compacted up to the middle with the thermoplast, will be manufactured during the first step. Technologies of choice could be compression moulding or calendering. For the second case, the partial-consolidated prepregs come as rolled goods.

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The second technology step can be proceeded as:

- continuous manufacturing of matrix-hybrid prepregs by impregnating the open side of the fabric with resins for further processing by autoclaving or
- element-related cut of partial-consolidated prepregs and texturing of the thermoset laminate layers with a compression moulding or injection process.

The fusion of both matrices was successful done within the project. For future use it´s planed to provide this matrix-hybrid laminats in two ways, as a semi-finished thermoplastic laminat for further thermoset processing or as matrix-hybrid prepreg.

3. Conclusions

The results of three different projects to produce optimized preforms for FRP-parts were presented. The shown technologies can reduce waste, manufacturing time and cost for the FRP production.

Acknowledgments

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