Technology Offer

Fiber composite anchoring pins for the connection of several components

Technologie-Lizenz-Büro
der Baden-Württembergischen
Hochschulen GmbH

Abstract

An additive joining technique developed at the University of Stuttgart makes it possible to connect individual components with each other positively using fiber-reinforced pins without the need for post-processing steps in the manufacturing process or foreign materials in the part. The technology thus opens up new possibilities both for the connection of individual components and for interlaminar component reinforcement.

Background

Currently, adhesive or rivet connections are used to connect two fiber-reinforced solid bodies with each other.

Problem

These connections, especially the adhesive connections, are usually supported by a surface treatment of at least one of the two components, which can result in damage to the component even during production. In the case of any occurring tension loading, a riveted connection can even be the weakest point of an entire component group.

Solution

In this process, which has been developed at the University of Stuttgart, anchoring elements (pins) are applied to the component at the same time as the supporting textile structure. A needle guiding the fiber material is pierced through the textile preform into the foam (supporting material) (figure 1A). The fiber material remains in the foam as a loop when the needle is pulled out. During the impregnation of the textile preform, the matrix penetrates not only the flat textile, but also the puncture holes in the foam and wets the loops.

After cross-linking of the matrix material, the foam is dissolved, and a fiber composite component is created – two or three dimensional – with integrated connecting elements (figure 1B). The pins either protrude into a component interior to be filled or jut out of the two-dimensional layer. By interlocking two facing elements, a form-fit within a joint can be achieved. The number of pins per unit area, their size, orientation, and arrangement can be flexibly adjusted to create a connecting element that can be individually tailored to the component group.

The presented method is suitable for all lightweight applications where adhesive connections or outer layers on inner cores need to be reinforced. By using the fiber anchoring pins, such connections can be significantly strengthened, especially in long, structurally stressed components from the aerospace and wind turbine sectors, but also in automotive engineering, shipbuilding, or construction.

Contact
Dr. Dirk Windisch
TLB GmbH
Ettlinger Straße 25
76137 Karlsruhe | Germany
Phone +49 721-79004-0
windisch@tlb.de | www.tlb.de

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Service
Technologie-Lizenz-Büro GmbH has been entrusted with the exploitation of this technology and offers companies the opportunity to obtain a license or purchase a patent.

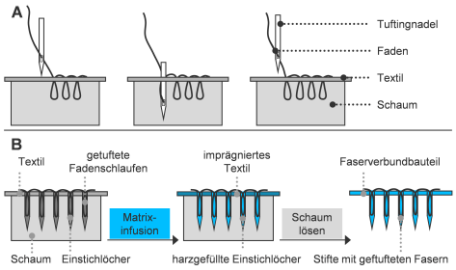

Figure 1: Schematic diagram (A) Introduction of fiber material as loops; (B) Impregnation of the loops with matrix and removal of the foam structure. [Image: University of Stuttgart (ITFT), L. Born]

Figure 2: Reinforcement of joints with reinforcing pins. [Image: University of Stuttgart (ITFT), L. Born]

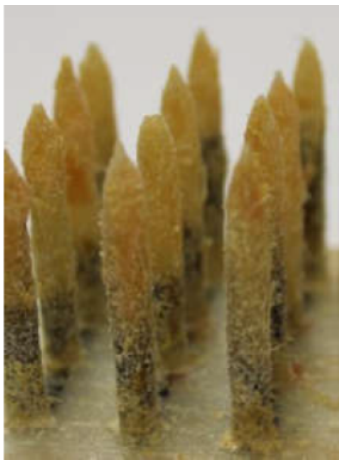

Figure 3: Fiber-reinforced pins protruding from the two-dimensional component. [Image: University of Stuttgart (ITFT), L. Born]

Advantages

- Reinforcement of FRP components and joints
- Transmission of flow in the composite component continuously ensured
- Resistance to temperature fluctuations due to material homogeneity in the joint
- High quality and reproducibility guaranteed by automated process
- Two-dimensional and three-dimensional components can be produced using flat or slotted foam

Fields of applications

Example: Rotor blades for wind turbines

The presented method is particularly suitable for strengthening the bond joint between the spar caps and the shear webs in the area of the wing body. However, bonding at the rotor blade trailing edge can also be strengthened using the method according to the invention. The two half-liners to be connected could be provided with reinforcing pins which interlock with each other when the half-liners are glued together. The interlocking would create a three-dimensionally reinforced joint that can also be subjected to three-dimensional loads such as thrusts and shears. The fiber loops of the reinforcing pins can already be automatically inserted during the textile stacking process into defined areas while producing the half-liners. A Z-reinforcement, a connection between the individual textile layers and in particular the sandwich layers, is thus simultaneously created in the entire component. Using such an interlaminar connection, the strength properties of a component are demonstrably improved, especially those exposed to load changes with deflections in which the layers are subjected to thrusts against each other.

Example: Aircraft construction

Similar to rotor blade reinforcements, the presented method can also be used to reinforce structural bonding in the aircraft wing area, especially in the spar and rib area. Within the aircraft fuselage, this method could be used in all areas where long structural components, such as longitudinal stiffeners (stringers), are used.

Example: Construction

Long support elements made of fiber-reinforced plastics could be reinforced using the presented method. A combination with other building materials such as concrete is also conceivable to create a stable connection. The anchoring pins can, for example, prevent the concrete from losing contact with the plastic component due to shrinkage during drying. Another application could include concrete-filled structural elements with a fiber-reinforced plastic shell.