PROJECTS

FASERINSTITUT FIBRE BREMEN

HyPatchRepair

Thermoplastic hybrid structures based on continuous fibre reinforcement for the repair of high-performance fibre composites, adapted to the case of damage

Motivation

In context of lightweight design, increased use of fibre-reinforced plastics is focused by production of parts of airplanes. Actual in aircraft industries the state of the art for repairing skins of airplanes are inspired by repairing technologies for damaged metal parts. Damaged areas are repaired with riveted or glued sheet metal, which means disturbed material structure, reduced aerodynamics and increased weight. This state of the art technology for repairing aerospace structures by riveting is shown in Figure 1. There is a need for a strategy for repairing fibre-reinforced skins of airplanes. This project aims the development of an efficient repairing technology for prospective aerospace structures. For this purpose, a repairing patch with load optimized fibre orientation and a geometry adapted to the damaged area should be integrated into the structure to be repaired.

Approach

In future damaged fibre-reinforced aerospace structures should be repaired with thermoplastic fibre composite patches, which are precisely fitting to the damaged area and offer the restauration of the original surface geometry for maintaining the aerodynamic properties. Two different technologies for production of repair patches are used and compared:

- Additive Manufacturing with continuous fibre-reinforced thermoplastics in the Filament Composite Manufacturing (FCM) process
- Tailored Fibre Placement (TFP) and consolidation of hybrid textile materials

Both technologies allow the production of a precisely fitting repair patch with customizable fibre orientation. The patches are applied to the prepared damaged area by a material-compatible process without producing a weight gain in the repaired structure.

Before the tailored fibre-reinforced repair patch can be integrated, the damaged material has to be milled out. The material-saving milling is realised with a milling robot, which is shown in Figure 2. An example of a milled scarf can be seen in Figure 3.

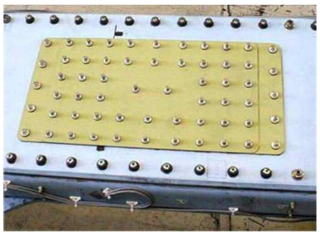

Figure 1: Repair through rivet plate

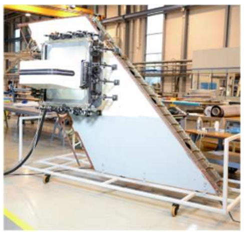

Figure 2: Milling robot on the vertical fin

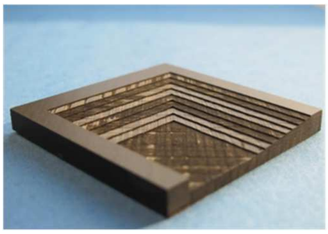

Figure 3: Exemplary scarf of a laminate flooring

After the detection, surveying and removing of the damaged material the realised scarf gets optically measured. The construction of the repair patch results load and geometry tailored to the scarf. The patches are produced by FCM and TFP technology. Before the integration into the structure, the patches are trimmed and the surface are structured by laser process for ideal connection between the material of original part and repairing patch. The integration of the thermoplastic fibre composite patches into the scarf is realised by laser-based joining technology or by pressure welding.

The whole process chain for repairing of a damaged fibre-reinforced composite structure is shown in Figure 4.

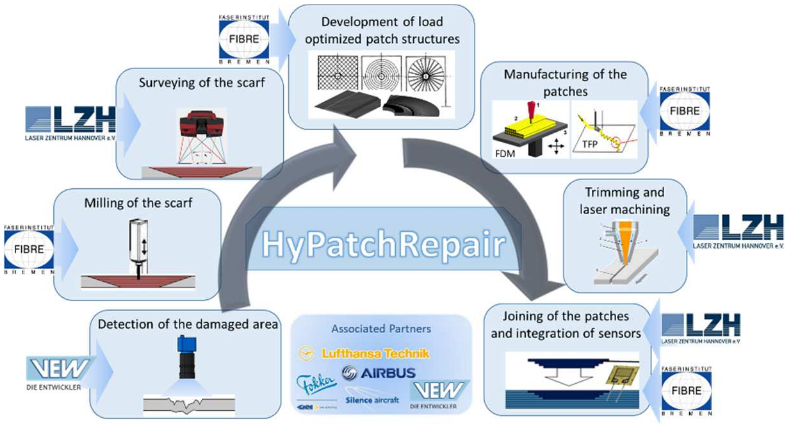

Figure 4: Process chain

Possible Applications

The repair patches, which are customized, load optimized and adjusted to the geometry of the repaired part can be integrated in different aerospace structures in case of damage. Possible applications are damaged parts of fuselage skins, wings and winglets, tail units or other aerospace structures.

The production of repair patches is realised by using existing manufacturing technologies. So different companies can include customized fibre-reinforced repair patches in their product portfolio. Manufacturer and user of airplanes and aircraft components will be able to repair aerospace structures effective and cost efficient.

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Project Partners

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Faserinstitut Bremen e. V.

The Faserinstitut Bremen e. V. (FIBRE) is a scientific institute situated on the campus of the University of Bremen with more than 50 years experience in the fields of characterisation, development and processing of technical fibres and fibre based composites. The development of new processes, increased material efficiency, reduction of cycle times and testing of new lightweight construction concepts are part of the research activities in the department of Composite Design and Manufacturing Technologies.