Bavarian research & innovation

FORCiM³A
Bayerischer Forschungsverbund

Bavarian Research Cooperation for CFRP/metal composite design in machine and plant construction

NEW LIGHTWEIGHT TECHNOLOGY FOR HEAVY MACHINERY

Fibre composite technology is a key technology of the 21st century. It is becoming increasingly important in lightweight design, primarily in the form of carbon fibre reinforced plastic (CFRP). So far, its use is limited mainly to aerospace applications, niche vehicles and sports equipment. However, CFRP has enormous potential for improving performance in machine and plant construction. As well as being lighter and stronger, CFRP can also achieve greater precision and, because unlike metal it shows hardly any signs of fatigue over time, greater durability.

Factors that have so far hampered the use of this material include the high material costs, time-consuming manual production techniques, and lack of expertise in the design of components and systems that satisfy the special requirements of machine construction. For example, the design of each part must suit the material and the transition from CFRP to metal must be designed to meet the demands placed on the component. The part must also be able to withstand the external factors encountered in operation, such as temperature, aggressive substances and frequent load changes.

In some applications steel has already been successfully combined with CFRP. However, in all these cases the material was designed for very limited requirements in response to the needs of individual firms seeking solutions to special problems. This is where the work of FORCiM³A comes in. Its aim is to give these individual cases a broader base. The starting point is a shaft already used in the paper machines of Voith Composites, which serves as a template for transferring the technology to other components. Five other machine and plant parts are being studied as an example to establish whether and under what conditions fibre composites could be used in their construction. The aim is to build hybrid demo components made of metal and CFRP.

Picture collage
CFRP composite design – already the standard in many areas

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CFRP in action: Instrument carriers and complete underwing pod for the research aircraft HALO, developed and manufactured by Aerostruktur

Good tailwind for composites: SGL Rotec uses CFRP for wind turbine rotor blades

RESEARCH TOPICS

FORCiM³A is divided into seven sub-projects reflecting the stages involved in developing a hybrid component:

Innovative hybrid design concepts
The first stage results from the need to create suitable hybrid design concepts for typical machine parts in close collaboration with industry partners and to deduce a corresponding fundamental methodology from this.

Design and calculation methods
Based on the results of the first phase, design and calculation methods are produced for these concepts in accordance with typical engineering specifications.

Material and process technologies
There are many different manufacturing processes for hybrid CFRP parts. In sub-project 3, researchers aim to identify the most suitable material, joining and process technologies for the given requirements.

Material characteristics
The contact surfaces between CFRP and metal in areas where force is applied are crucial to the successful introduction of hybrid CFRP parts. Researchers study in detail the nature and long-term stability of the connections to characterise the material properties.

Generic demonstration parts
The aim of this sub-project is to build generic demos in order to evaluate the results of research and development work as realistically as possible. The partners have a unique set of resources to help them build prototype components.

Testing generic demo parts
In sub-project 6, researchers study both a range of fundamental joining concepts and the manufactured demo parts to assess their deformation and failure characteristics and their lifespan.

System simulation and validation
Sub-project 7 is concerned with continuously evaluating the results of sub-projects 1 to 6. It is during this stage that the maturity of the CFRP technology is appraised. This is done partly by simulating generic complete systems with CFRP components.

Academic Partners:

- AMU Anwenderzentrum, University of Augsburg
- University of Applied Sciences Augsburg
- FhG Project Group for Functional Lightweight Design Augsburg
- TU München
  Gear Research Centre (FZG) Augsburg
  Institut für Werkzeugmaschinen und Betriebswissenschaften
  iwb Anwenderzentrum Augsburg
  Institute for Carbon Composites

Industry Partners:

Aerostruktur Faserverbundtechnik GmbH
AxynTeC Dünnschichttechnik GmbH
Biersack Technologie GmbH & Co. KG
Chr. Mayr GmbH + Co. KG
GMA Werkstoffprüfung GmbH
HUFSCHMIED Zerspanungssysteme GmbH
LEUKA
Multivac Sepp Haggenmüller GmbH & Co. KG
Ott-Jakob Spanntechnik GmbH
SPN Schwaben Präzision GmbH
Voith Composites GmbH

Hybrid-design paper roller at Voith Composites