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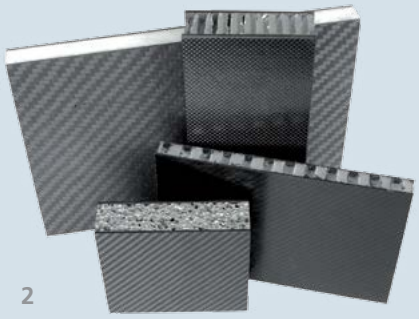

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1 *FRP-aluminum sandwich*
2 *FRP-sandwiches with different core materials*

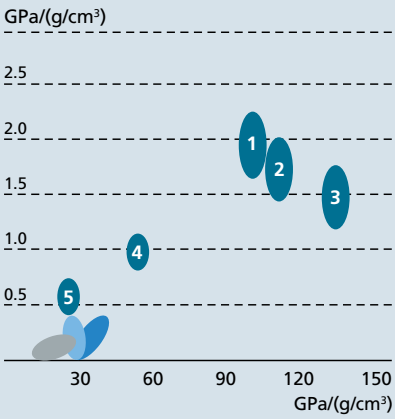
LIGHTWEIGHT CONSTRUCTION BY HYBRID-DESIGN

Material lightweight construction

Weight saving with the same or a better stiffness, operability and cost efficiency are demands which can all be realized by consequent lightweight construction. Lightweight system and lightweight structures are two out of three fundamental pillars of lightweight construction in conventional metal construction. An even greater weight saving could only be possible due to high-strength or high-rigid but at the same time very light materials by material lightweight construction which forms the third pillar of lightweight construction.

Especially Fiber Reinforced Plastics (FRP) feature high specific strength and rigidity and are therefore very well suited for lightweight materials. Moreover, regarding endurance strength, attenuation and thermal expansion, FRPs are far superior to conventional lightweight materials.

Comparison of specific strength and specific stiffness



1 CFRP HT UD
2 CFRP IM UD
3 CFRP HM UD
4 AFRP UD
5 GFRP UD
aluminum
steel
cast iron

UD = unidirectional, HT = high-strength,
HM = high-rigid,
IM = medium stiffness, medium strength

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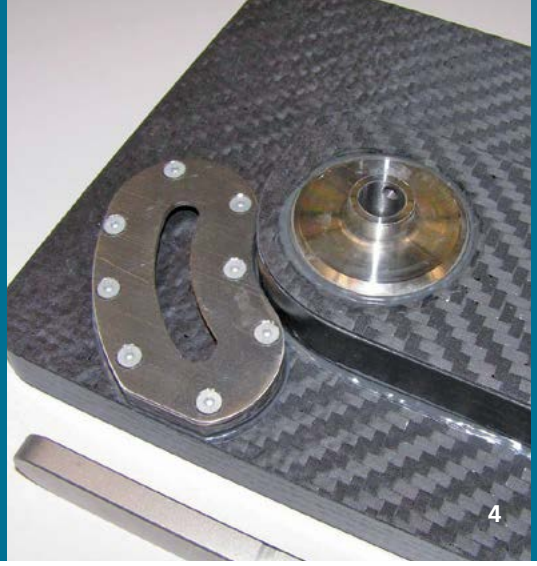
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Hybrid design

One way to combine the best properties of different materials is by hybrid-design. Smart combinations of different materials are for example FRP combined with aluminum foam, synthetic foam or with honeycomb material. In the sandwich structures presented, the high-strength and high-rigid CFK-toppings take on the transmission of heavy loads on small displacement. The function of the sandwich core is to prevent buckling of the topping and at the same time ensures good damping properties in the case of aluminum foam. Hybrid design enables the production of complex, high load bearing, geometric structures and additionally a notable weight reduction.

Use in the mechanical engineering and construction sector

In case of the pictured laser cutting system the particular challenge was to raise the acceleration capacity of the approx. 3.5 m long crossbar to 2.5 g. The desired dynamic range could not be reached only through metallic materials as the forces which would occur at high acceleration would have led to a post-deviation at the laser head. This would be incompatible with the high quality of cut required.

With the collaboration of Fraunhofer IWU an ideal crossbeam in CFRP-hybrid design has been developed by which the defined goal of halving the mass while doubling the component stiffness has been reached. Finally, comprehensive analyses with regard to automation of manufacturing technologies and cost-saving potential show that additional costs of this CFRP-version is likely to be profitable after 3.5 months due to productivity increase.

Thanks to the development of the crossbar it has been proven that the use of FRP components in the mechanical engineering and construction sector are worth both in a technical and in an economical sense. Another example for effective lightweight construction is the displayed prototype of a welding gun arm which has been done in CFRP-hybrid-design.

Developments in medical technology

We developed a base plate in CFRP-sandwich design for a well known producer for medical instruments with the objective target to reduce mass. Apart from a weight reduction of 40 percent, with almost the same costs, the X-ray transparency increased, too.

Further fields of work

At the moment, further investigations in the sections of GRP, hybrid fibers as well as fiber-reinforced composites and metal foams are in progress. In addition, the use of thermoplastic matrix-systems in combination with oriented continuous fibers, especially with regard to manufacturing processes, is subject of current investigations.

The study of cost-effective joining concepts and the integration of connection devices or inserts in hybrid sandwiches likewise represent a very interesting field of activity.

Success through lightness

Lightweight constructions enable us to major weight savings. However, they also require precise knowledge of the applied loads and appearing tensions in the component. This is particularly the case for FRPs. Detailed knowledge on principal stress directions for every loading condition is indispensable as this is the only way of adjusting optimal properties as well as to guarantee an operational stability.

With the Fraunhofer IWU as a knowledgeable contact you will not only receive customized solutions for the design and calculation, but we also ensure that the construction, optimization and the construction of prototypes and small series in cooperation. Furthermore, we experimentally determine the mechanical properties of the prototypes in order to secure the construction and the capability.

3 *Laser cutting system*
4 *Base plate in CFRP-sandwich-design – prototype*
5 *Welding tongs in CFRP-hybrid-design – prototype*