Carbon fibre stone (CFS) is perfectly suitable for a variety of applications

Granite becomes lightweight and elastic

Ski cores, seamless cooker surfaces and weight-saving car-bodies, lorry chassis frames, airfoil components or complete ships' hulls – all made from fibre-reinforced stone are a perfectly realistic idea for Kolja Kruse, who has had many years of experience with this material. "Carbon fibre stone (CFS) could possibly become the material of the future, and we have already attracted a lot of interest among visitors to the UN Climate Change Conference in Bali, Indonesia because of its environmentally-friendly properties," says the head of Munich firm Techno Carbon Technologies GbR.

CFS is produced by evenly applying a thin carbon fibre matrix coating to form a solid bond with a thin natural stone slab and by stabilizing it so thoroughly that hairline fractures cannot occur in the stone. This is achieved by preloading, which is applied to the stone during the production process. This way, stone suddenly becomes elastic when pressure is applied – an accomplishment that event surprises physicists.

Kruse can prove and predict the behaviour of stone with the help of a simulation model, which he commissioned specially for prototyping and dimensioning of CFS components. "Our model has already achieved 99% accuracy and we can simulate flexural loads

A 2 x 3 cm CFS bar made from granite is completely encapsulated and stabilized by a 1 mm carbon fibre laminate: high stiffness but flexible and with a consistent length across a wide temperature

Photo: Techno Carbon

on CFS hybrids that we formerly never even dreamed of. The computer predicts the behaviour, we build the component and lo and behold, the stone does what we want," Kuse explains casually. This material could be used to construct flexible oil tankers that could even withstand freak waves – something that is not possible with conventional materials. There would also be a weight advantage, as this material is twice as light. Kuse: "It sounds like a fairy tale but we already know that this would work".

Using natural stone as a material promises undreamt-off technical possibilities, as it is surprisingly light with the specific weight of aluminium, while offering the same pressure stability of construction steel. Techno Carbon stabilizes natural stone with carbon fibres to make it bendable and elastic. This is achieved by means of a specially developed coating technology which involves carbon fibre laminate.

CFS consists of natural stone in different geometries a large area of which is encapsulated, coated on one or both sides with carbon fibre laminate. Techno Carbon acquired a patent on this idea. The

Kolja Kuse (right) and one of his employees demonstrate the two-sided elasticity of carbon fibre-stone-sheet *Photos: CM* elasticity thus acquired can be explained by the crystalline structure of stone, which provides limited potential for volume compression and elongation, and allows carbon fibres to contract and expand within these limits. As carbon fibres have a high stiffness, which only allows minimum expansion, they have to be adapted to suit the stone and its specific properties. The stone can be reinforced with a 2 to 3 mm coating, but thin sheets with a thickness of 1 mm can also be produced for special applications. Due to their preload, they will not break even if the coating is only applied on one side.

Purpose of the application: substituting steel

The construction of stone-carbon fibre structures for car-body engineering for example can provide benefits due to their low coefficient of expansion and their low weight at a high pressure stability and elasticity. In order to use these benefits, the CFS structure can be integrated into the undercarriage of cars or the longitudinal chassis beam of lorry trailers. Modern bonding techniques seem to be suitable for this application. There are no obstacles in the way of constructing airfoils, rotor blades and hulls containing CFS carriage cores with vibration damping properties. Carbon fibre components can be used in the undercarriage of mobile systems of any kind, as damping elements to be integrated in aircraft wings and windmill rotor blades and for making complete hulls more elastic and lighter than steel hulls, simply by creating an adhesive bond with epoxy resin or screwing them to other parts of the undercarriage or other load-bearing or formative structures.

"CFS can provide significant weight reductions in automotive engineering, as this material is about two times lighter than steel sheet," Kuse emphasizes. "Moreover, conventional materials such as aluminium, steel or plastic have a larger CO_2 footprint than CFS composites. Using this material however, requires a new take on processing technology and design.

The material has already been used by the industry in order to replace conventional materials and save weight or in order to open up new product design potential.

CFS could also be used to reduce the deployment of concrete with its large CO_2 footprint. "The load bearing capacity of this composite is three times higher than that of concrete in proportion to its weight," Kuse points out. "This way, we created the most feasible design for building walls."

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CFS has many benefits:

* significantly lighter than steel (factor 2.5 – 2.8), same weight as aluminium
* pressure stability of construction steel, four times higher than that of aluminium
* best damping behaviour of any pressure-resistant material
* high temperature resistance even under changing ambient temperatures
* high fracture strength even for large slabs with a high amount of cut-outs and thin bars or additional stabilising methods
* an extremely low expansion coefficient that can be adjusted to zero.
* CFS bars, panels and sheet are bendable and can be used in construction applications such as in a timber framework.