Construction using concrete reinforced with renewable materials

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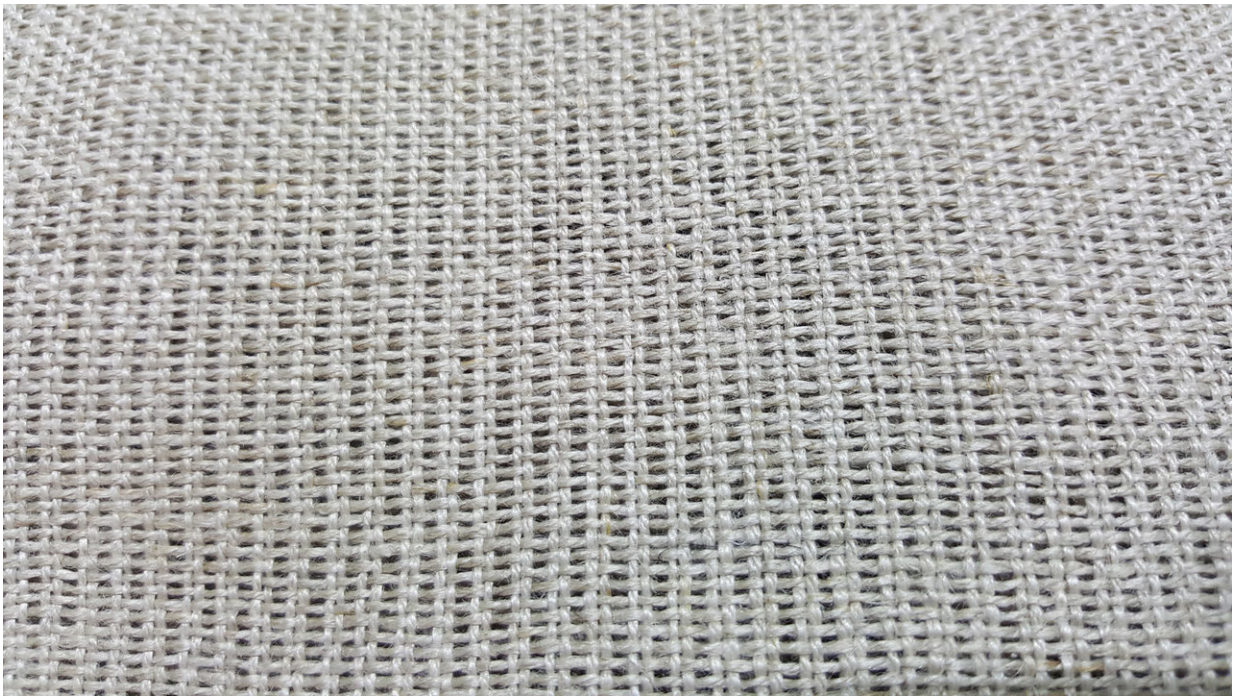


Plain-woven flax fabric. Credit: Jana Winkelmann

Tomorrow's building material is here today. Textile-reinforced concrete (TRC) is durable, formable in diverse shapes and suitable for lightweight construction. As the name suggests, conventional TRC is reinforced with carbon or glass-fiber fabrics rather than steel. A research team at the Fraunhofer Institute for Wood Research, Wilhelm-Klauditz-Institut WKI is now replacing these fabrics with eco-friendly natural fibers. These

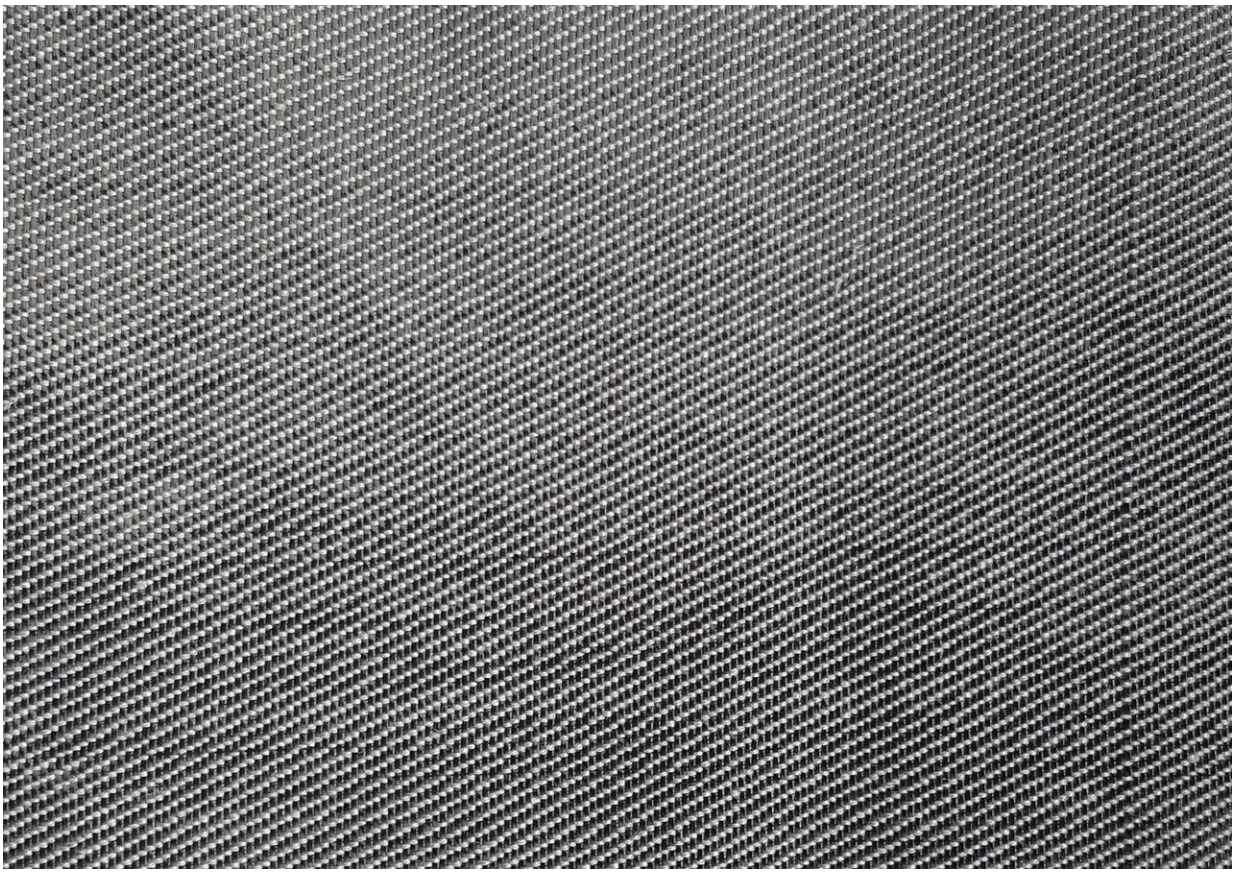
alternatives rival conventional concrete's performance, but leave a smaller carbon footprint, and cost less to make. Researchers will present a prototype of a natural fiber-reinforced concrete bridge at the BAU 2019 trade fair in Munich on January 14 to 19, 2019.

Germany's bridges are in sad shape. TÜV Rheinland says that one in every two is decaying. Reinforced concrete corrodes easily. Oxidation takes a toll on the reinforcing steel well before any telltale sign of damage is visible. Now the industry is looking to relegate cracks in concrete, and rusting steel, to history. Engineers and architects are opting for textile-reinforced concrete, a noncorroding building material with a long service life and the same structural properties as reinforced concrete. Components made of this material can be as thin as a few centimeters. It may be cast to make delicate, lightweight structures with reinforcing textiles that bend into practically any shape. Alongside bridges, the material is also suitable for facades and ceilings. Designers use it for seating furniture and sculptures.

The secret to this high-performance concrete is that it is reinforced with carbon, glass or polymer fibers rather than steel. Researchers at the Fraunhofer WKI in Braunschweig want to replace these fibers with a textile based on renewable raw materials, a move that would pay big dividends for the environment and climate. They are going with local products, in this case flax, which may be spun or woven. The researchers can add strands of polymer fiber to the flax to create a hybrid fabric tailored to the given component's requirements. The scientists at Fraunhofer WKI's Application Center for Wood Fiber Research HOFZET® use a double-rapier loom with a Jacquard attachment to weave this material mix. With this weaving machine – the only one of its kind in Europe – experts are able to produce innovative lightweight composite materials with complex, application-specific textile structures and integrated functions. The machine combines conventional and sustainable materials in a way that is both cost efficient and technically

sophisticated. They are then embedded in high-performance concrete with the structural density that protects the fibers almost completely against weathering. This weave is also modified with natural resins.

Shrugging off adverse environmental impacts



Flax/carbon hybrid twill. Credit: Jana Winkelmann

The flax-based textile is embedded in the given component in layers. Its stiffness is variable, so it can be arranged in the desired shape. And it could conceivably be cast to create curved contours such as domes and rounded wall elements. The liquid concrete, specially developed in-house

at Fraunhofer WKI's Center for Lightweight and Environmentally Friendly Buildings (ZELUBA®), is then poured on the textile. Ecological sustainability was very much on developers' minds; they went to great pains to make do with low quantities of primary raw materials. The material mix consists of a very fine

aggregate, water, concrete additives and admixtures, and a reinforcing textile made of flax. "The quality of reinforced concrete made with a flax fabric is higher than that of the reinforced concrete in bridges. The matrix – that is, the structure – is so dense that harmful substances cannot penetrate the component. This results in a far longer service life of several decades," says Jan Binde, a scientist at the ZELUBA®.

A composite with remarkable longevity

The combination of flax and concrete proved in trials to be an ideal composite, as confirmed by durability and load-bearing tests on the new, eco-friendly textile-reinforced concrete. "The natural fibers mesh very well with the building material, which is also attributable to the fact that we can control how the textile is fixed in the concrete. The textile's specific surface is variable," says the researcher.

TRC made of renewables enables builders to erect light and lean bridges that may also be crossed by motor vehicles. "A reinforced concrete bridge with a span of 15 meters would be about 35 to 40 centimeters thick, while its flax counterpart would be considerably slimmer at 12 to 16 centimeters. This saves a lot of material. Thin layers are doable," says Binde. Researchers' efforts to optimize the innovative building material continue while approval from building authorities is pending.

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