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THE BIO BRIDGE PAVING THE WAY

A 66m bicycle bridge made from plant-based polymers is being built in the Netherlands. Could this be the start of sustainable materials on a large scale, asks Helena Russell

Plant-based materials and innovative designs that minimise the amount of material needed to build bridges are being explored by structural engineers in pursuit of sustainability.

Fibre-reinforced polymer (FRP) has been in use for decades in the bridge industry; its light weight, high strength and resistance to corrosion make it a good choice for long-lasting, maintenance-free structures. But now a local authority in the Netherlands is going a step further by using natural rather than manmade fibres as the basis for a new bicycle bridge. The bridge, in Friesland province in the north of the country, is being built using a biocomposite of flax fibres infused with bio resin, and is expected to be open by the end of the year. It will be 66m long and feature two spans, one a swing span to provide access for vessels on the Van Harinxma Canal.

The intention, says programme manager Sjoerd Vrieswijk, was to create a material that maintained all the physical benefits of FRP, but with a smaller ecological footprint. Replacing carbon or glass with flax fibre — readily available as a byproduct of linseed oil production — makes a major difference right away. As yet, the resins used to hold the fibres together are only around 50% bio-based. Whether it would be possible to build a fully biodegradable bridge is open to debate, given that longevity is generally considered a desirable characteristic.

The circular economy is increasingly important in the Netherlands, and Friesland aims to lead the field not just nationally, but across Europe. Vrieswijk says it also wanted to set an example in alternative materials for infrastructure. "Nature supplies us with enough options for replacing traditional materials, but using them is difficult because not a lot is known about their behaviour, durability and so on," he says. "As an early adopter, we hope to encourage others to join this movement. And once we've succeeded in using flax and resin on this scale and for this type of structure, we're sure more people will follow."

The biggest challenge was to establish the physical properties and behaviour of the flax fibres and the composite — and to persuade permitting authorities that the structure would be safe and easy to maintain. Over two years, the team investigated a range of plant-derived fibres — from flax, hemp and bamboo to banana leaf and even cotton — and tested characteristics such as tensile, compressive and shear strength, UV degradation, fatigue and creep. Flax was found to have the closest tensile strength to glass fibre, and its sustainability attributes, including the fact it is grown nearby in Belgium and France, scored it highly for this application.

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MATERIAL GAINS: THREE MORE BRIDGE INNOVATIONS

PROMISE OF PRINT

Examples of 3D-printed bridges already exist in steel and concrete, but a Dutch engineering firm has announced plans to create the world's first bridge printed with FRP. According to Royal HaskoningDHV, additive manufacturing enables material use to be minimised, as the construction process allows it to be placed only where it is needed. Production and implementation can be carried out locally, more quickly and with less disruption, and any damaged or worn sections can be reprinted and fitted quickly and easily.

TRIMMING THE FAT

The sustainability of bridges built with traditional materials can be improved by reducing the amount of material used – and consequently the size of their foundations. A new footbridge near Stuttgart, Germany, uses a double-curved shell of stainless steel as thin as 20mm to form its main structural member – users walk directly on the upper surface, which is coated with a non-slip material. Structural engineer Schlaich Bergermann Partner laser-cut a series of holes in the stainless-steel shell, removing surplus material not needed to resist the forces on the bridge when in use.

GOOD WOOD

Timber has been used in bridge construction since time immemorial, but new ways of building with it are bringing it back into favour. The local authority in Baden-Württemberg, Germany, chose timber for the deck of a new footbridge over the Neckar River, and structural engineer Ingenieurbüro Miebach designed a system that enabled flat pieces of wood to be stacked vertically rather than having to be cross-cut, reducing wastage. The wood is detailed to minimise water penetration and has a moisture detection system built in, to eliminate the need for chemical treatment.

ILLUSTRATION BY WAYNE MILLS