

We use seashells by the sea shore – in our concrete

How many environmental ambitions can you fulfil at once? A project using recycled seashells in road surfaces to prevent flooding ticks multiple boxes. **KATIE COYNE** reports

Lots of products now use recycled content. But not many try to harness the natural properties of a material, minimise processing, and use bespoke local formulas to address local environmental problems.

A project using seashells to create permeable road surfacing is doing all this and juggling a range of environmental ambitions including recycling, reducing carbon, diverting from landfill and mitigating the climate change risk of flooding.

During the course of a three-year project, scientists have developed a sustainable drainage concrete for low-load applications out of recycled seashells. The project has been a collaboration between French and English scientists and organisations who set out to address the issue of flooding on cycle paths, car parks and other surfaces.

Climate change, combined with the covering over and urbanisation of soil, has made flash flooding in cities a common occurrence, causing economic and social damage. Traditional concrete surfaces are not permeable and water runs off them quickly into drainage systems. Alternative permeable surfaces such as gravel and soil require a lot of maintenance and resurfacing.

Flash flooding can also contribute to the increasing instances in England and Wales of the use by water companies of storm overflows (discharge of excess sewage) and pollution of waterways.

Seashells, however, are permeable and a natural waste product without a developed market for their use. Scallop shells can be

used for decorative purposes by restaurants and as soap dishes, but these are not huge markets. Up to eight million tonnes of seashells are landfilled or thrown back into the ocean globally.

The Concrete solution dRaining for the CLimate and Environment (Circle) Project has developed a draining poured-in-place concrete pavement based on seashell waste, with lower environmental impact. The material's unique properties mean it can hold on to water but does not create surface pooling, and water drains away slowly into the surrounding land.

The project has found that, as well as using a material that would otherwise have gone to waste, adding seashells to concrete can substitute for aggregates. This then also preserves a non-renewable material.

So far, seashells have been used to replace aggregate in permeable concrete material at a level of 20% substitution. Scientists are measuring the robustness of the shell surface with the 20% level of sub-

stitution against standard permeable concrete. However, the project is also experimenting with higher percentages of substitution looking at whether there is any additional benefit in using more of the material were it available.

But this is not an entirely new idea. Lots of research has looked at the use of waste seashells in concrete. Some projects have studied the behaviour of concrete containing crushed shells, while others have looked at the addition of powdered shells heated at high temperatures.

There are also projects that offer concrete-like tiles that contain crushed seashells which have been added to binders. Concrete uses a lot of carbon in its production and the construction industry is keen to find ways of reducing that.

How is Circle different? It is trying to do as little as possible to the shell waste, harnessing the material's natural qualities instead, and transporting it only short distances.

Karl Williams, professor and

director at the centre for waste management at the University of Central Lancashire (UCLan), said: "We are trying to minimise the amount of processing that we do with the shells because every time we do something, we're adding carbon to our product."

"So part of this project is to look at what the carbon impact is for every square metre of our formulation compared with other types of surfaces that can be used."

So how is the Circle project different? It's got a very strong focus on carbon, on diverting material from landfill and on providing local solutions to local issues."

The Circle project has been supported by the Interreg VA France (Channel) England European Cross-border Cooperation Programme, co-financed by the European Regional Development Fund.

It has brought together six French and British partner institutions. These include Builders Ecole d'ingénieurs as lead partner, building materials company Eqiom, French local government organisation CA2BM, the University of East Anglia, UCLan and the Golfe du Morbihan area of Brittany.

While based either side of the English Channel, Circle is trying to develop a product that can be applied to all coastal areas, wherever there is seafood processing and waste seashells. But, at the same time, the formula used will be bespoke to the locality and the available mix of local seashells.

In France, scientists are looking at using scallops and oyster shells while the UK is using mixes of shells including scallops, cockles



Permeable pathway: in Preston, tanks measure flow of water through the surface



PICTURE: CA2BM

In situ: part of the Eurovelo 4 cycle way

and whelks. This is because, unlike France, the UK does not have huge amounts of one particular shellfish in any one area.

The UK side of the project has been working with shellfish processors in Fleetwood, Norwich and Southend. The seafood industry is seasonal and species are harvested during different months, so the project is determining how to work around that aspect too.

Why use seashells at all? Williams said that shells offer strength, structure, composition and shape.

"We are trying to substitute another material that is hard and creates voids within the structure of the concrete – and connected voids so that water will be able to percolate through. It's like a sponge but it's a hard sponge."

"We are trying to use the properties of the shells to improve the porous properties of the pervious concrete, using the shells in the best way possible rather than just trying to stuff them into concrete," he added.

"We are trying to come up with a solution that maximises the use

of the properties of those shells, their shape and structure."

As well as recycling and diverting from landfill, the project also aims to use the material to address local environmental problems, such as flooding in coastal regions. Working this way also reduces the carbon emissions produced during transportation.

"For all our solutions with these shells, we will be looking at using them along the coast," said Williams. "We wouldn't be trucking shells from Portsmouth all the way up to Birmingham because the carbon footprint would be really high. However, we could use the shells that are produced in Portsmouth for solutions that are local to Portsmouth."

The processing of seashells in this project is minimal due to the project's ideals, and boils down to cleaning, crushing and sieving. But this too this will also change depending on local factors. Depending on which processor the seashells have been sourced from could, for example, mean more or less cleaning.

A shellfish processor in Fleet-

wood working with the project automatically cleans the shells as part of processing the seafood. Another processor working with the Circle project simply leaves the old shells outside for six months to a year because the business has lots of outside space. Bacteria break down any biological material left on the shells completely during that period so they are also clean when they arrive.

Several kilometres of path using the permeable seashell material have been laid by local authorities in northern France (pictured opposite).

Meanwhile, UCLan has been carrying out testing at a facility in Preston. Researchers have set up a two metre by one metre stainless steel tank (see picture) in which they are measuring the flow of water through the surface of the

material. The UK side of the project will also shortly lay its version of the permeable concrete in a real-world situation at a Blackpool community garden.

Williams said the project had reached the stage where the material was ready to be used and needs to be rolled out.

"We are trying to commercialise it and many different stakeholders are required – it's like any new material," he said. "But there is a drive for sustainable and low-carbon concrete."

"The Environment Agency when it's looking at flood defences is looking at low-carbon concrete. The shift is towards low-carbon materials for sustainability, the circular economy and using things locally. So our product does fit in there and we are looking to develop it commercially."

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