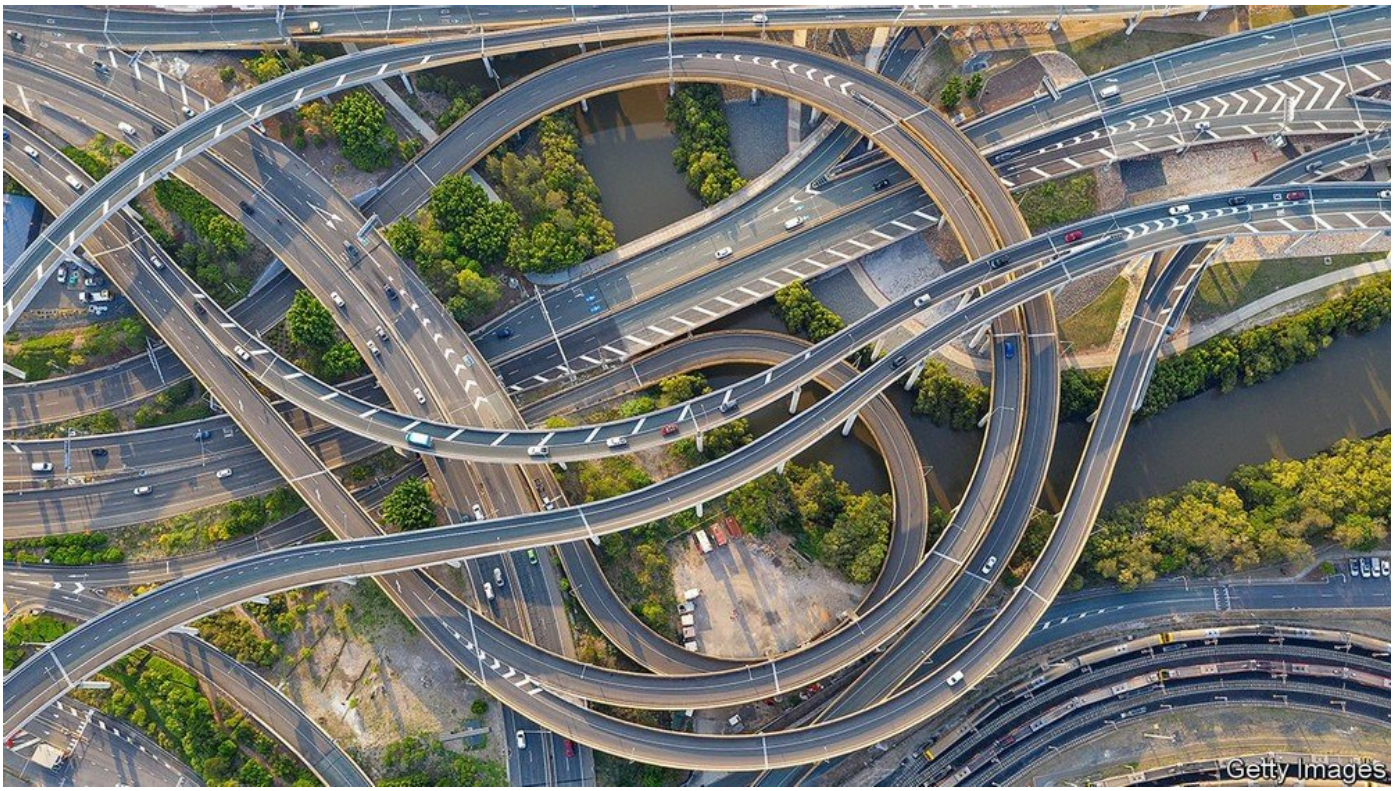
Engineering

Knitting a road with stones and string

Greener road-building



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SINCE THE Romans began doing it with great panache more than 2,000 years ago, road-building has been a sweaty, grubby business, involving heaving great quantities of rocks and stones into place and, in more recent times, covering the surface with asphalt or concrete. Now a group of Swiss researchers think they have come up with a more elegant solution. Strange as it may seem, this involves knitting.

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Martin Arraigada and Saeed Abbasion of the Swiss Federal Laboratories for Materials Science and Technology use a robotic arm to lay out string in a series of elaborate patterns. As the knitting takes shape, layers of stones are added and tamped down. The string entangles the stones, keeping them in place. The result is a structure that is surprisingly stable and strong. In one experiment a section of pavement put together in this way withstood a load of half a tonne. The encapsulated stones hardly moved at all.

Roads and pavements are usually made from layers of different grades of sand, gravel and stones. Once these are in place the surface is treated with an aggregate that is sealed and bound together with cement to form concrete, or mixed with bitumen to make asphalt. Neither method is environmentally friendly. Making cement produces huge amounts of carbon dioxide, while bitumen, a sticky tar-like substance, is obtained from oil.

Knitting roads creates fewer emissions. And the stones and string are easily recyclable, says Dr Arraigada. The group tried various materials for the string, settling eventually on recycled textiles reinforced with polyester, a type of plastic. Polyester resists rotting and can also be recycled, although the group hope to find biological materials which can do the same job.

They got the idea of knitting roads from work carried out by the Gramazio Kohler architectural research group at ETH, a university in Zurich. In one of this group's projects, led by Gergana Rusenova, now at Swinburne University of Technology, in Australia, a Stonehenge-like structure with 11 columns was built in a similar way. A mobile robot, which moved on caterpillar tracks, laid down 120km of string in geometric patterns while 30 tonnes of crushed stones were added. The resulting three-metre-high columns comfortably supported a nine-tonne capping stone.

There is, though, some way to go before knitted roads become a commercial proposition, cautions Dr Arraigada. He and his colleagues are testing various set-ups and modelling on a computer how different patterns of string can be

used to hold the stones. They will then carry out more tests—including ones that apply the sorts of rolling pressure generated by the wheels of moving vehicles.

Concrete and asphalt road surfaces are usually impervious to water, and are shaped so that rain flows off them into gutters running alongside. If water gets caught in surface cracks, it can cause potholes—especially if it freezes and thereby expands, opening up more cracks. Binding aggregates with string would produce a permeable road surface, which might result in fewer potholes. It might have other advantages, too. The researchers think, for example, that a porous road could help water reach the subsoil below, reducing the impact that covering so much land with roads has on local hydrology. Just like knitting a nice cardigan, success will depend on starting with a good pattern. ■

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