Electrifying new method

A project on the A21 has marked the first use of electrokinetic geosynthetics to strengthen a slope, with the new approach hailed as offering a less disruptive and environmentally friendlier option

CASE STUDY
KATIE BARKER

When an embankment alongside the A21 Tonbridge Bypass in Kent started to lose its structural strength, the Highways Agency faced a problem: it needed to stabilise the embankment but the area was rich with wildlife, much of which would have to be removed in order to use traditional slope repair methods.

Joint venture Balfour Beatty Mott MacDonald was brought in as designer and supervisor on the scheme, where they suggested using electrokinetic geosynthetics to stabilise the slope.

"A shallow slope failure occurred on an embankment of the A21 Tonbridge over a length of 160 metres," says Balfour Beatty Mott MacDonald geotechnical team leader Michael Tandy.

"The slope was 8 m in height and with an average slope angle of 26 degrees, although the slope failure had formed localised sections of slope that were as steep as 45 degrees. The failure posed a risk to the A21 and the safety of road users, as progressive failure of the slope crest would undermine the foundations of the safety barrier."

Failure of the slope would have undermined the foundations of the road's safety barrier

Work began on the project last year and marked the first time the electrokinitic geosynthetics technique had been used for this purpose in the UK. "Our regular inspections showed some embankments along the A21 had been starting to lose structural strength and we needed to stabilise them to prevent them causing damage to the roads in the future," says Highways agency geotechnical expert Jan Marsden.

"This particular section had many mature trees which local people were, understandably, keen to retain; it is also a rich wildlife habitat. So we decided Stocks Green would be a good place to try this new technology out."

Defying tradition

Slope strengthening traditionally involves clearing the slope of vegetation and requires lane closures while heavy equipment strips soil from the embankment surface and the compact earth beneath. Soil nails are then installed to hold the slope in place.

Instead of this disruptive process, EKG uses electrodes inserted into the soil to drive water towards cathode draining pipes, causing pore water suction, which serves to consolidate and strengthen weak distributed soils (see box).

"The rig was small enough to move around and between the trees on the site, meaning only ground vegetation clearance was required, along with minor pruning of tree branches to provide headroom," says Mr Tandy.

"The rig was also lightweight enough so as not to cause any damage to the tree rots during mobilisation and working. This resulted in the preservation of approximately 90 per cent of the trees and ensured that screening of the A21 for local residents is entirely maintained, as is the existing habitat."

40%
Cut in carbon due to EKG compared with traditional methods

Using this method meant no traffic management was required on the A21, so motorists were not disrupted, and topsoil was left in place to allow regrowth. EKG also generates less waste compared with conventional methods of strengthening.

"Thanks to reuse of the anode/cathode wiring for other projects, the only waste generated on the Stocks Green project was a small amount of vegetation that was cleared to allow site access," says Mr Tandy.

"However, this was reused on site as wildlife hibernacula, and therefore no transport emissions were generated as a result of waste movements."

He goes on to explain that the scheme was very cost-effective and had a lower carbon footprint than traditional methods.

"The EKG method produced a carbon footprint 40 per cent lower than an adjacent site that was stabilised using traditional soil nailing methods," says Mr Tandy.

HOW EKG WORKS

"Electrodes are installed which deliver the electroosmotic ground improvement," explains Mr Tandy.

"The anodes (positive charge) were driven using a percussive action and the cathodes (negative charge), which comprised composite electrokinetic drainage and filtration functions, were installed into holes created by a continuous flight auger.

"The anode tubes and EKG drains were connected to a DC transformer unit, run from a 275 kVA AC generator. A controllable voltage was applied across the electrodes for seven weeks. During the electrokinetic treatment phase, water was driven by electroosmosis towards the cathode drainage pipes resulting in pore water suction, which consolidated and strengthened weak disturbed soils. This improved both the drained and undrained shear strengths.

"The improvement in soil strength develops first around the anodes and then towards the cathodes. As well as improving frictional characteristics of the soil, an enhanced bond between the anode and the soil is created.

This is exploited after active treatment is completed: the anodes are converted into soil nails by the installation of a centralised tendon – grouted in the tube to reinforce the soil long term. The EKG drains release the water during the treatment process and then remain in place as a permanent slope drainage system."