

# Preventing Hook-a-likes

**JAMES ABBOTT** reports on Network Rail Southern Region's landslide avoidance strategy

**A** landslide on an embankment at Hook, near Basingstoke, on 14 January 2023 resulted in serious disruption to the South Western main line (p15, March issue). The lines are paired by direction here, with the formation Down Slow, Down Fast, Up Fast, Up Slow. This is a racing stretch, with a linespeed of 100mph – top speed on the Southern.

The slip took place on the Down Slow side of the embankment.

With the two Down tracks out of action, Southern Region reacted promptly by making crossovers from the Down Fast into the Up Fast in the neighbourhood of the slip, making the four-track railway into a two-track one round the obstruction and permitting traffic to continue. 'This very creative solution was suggested by Professor Andrew McNaughton and the University of Southampton' reports Derek Butcher, Principal Geotechnical Engineer with NR Southern Region. It is believed to be the same strategy employed in a similar landslide



It's happened before: landslide at Hook in 1960. Courtesy Network Rail

that took place on the other side of the line near here in 1960.

This is plainly an unstable stretch of line, leading NR to look more closely into the nature of the structure. 'The Victorians didn't know that if you put London clay over alluvium, which is what we have here, you create an unstable structure' says Mr Butcher. 'That's compounded as the slope angle is too steep – it is about

double the steepness that would be set by modern design standards. On top of that we had five months' worth of rain in three months, so it was all very wet.' Drainage issues had already been reported at the toe of the embankment in exams, and the drains were potentially not functioning at full capacity. The result of all this was a large rotational failure.

The slip took place while the line was under possession for track work, with a Class 66 locomotive close to the slip with a works train. 'Was the slip due to the weight of the train? We're looking at that theory' relates Mr Butcher.

The remedy was to insert a sheet pile 60 metres in length at the bottom of the embankment, joining up with an earlier repair dating from 2010. 'This embankment has been fixed previously, so it clearly has history.'

All four lines were open to traffic again on 24 February.

## PREVENTION STRATEGY

'It is becoming more and more difficult to predict the next earthworks failure,' says the Geotechnical Engineer, as unusually heavy rainfall and other events related to climate change put structures under unprecedented stress.

Twenty years ago, Network Rail began paying more attention to this issue. The initial approach was

Major slip: track workers inspect the damage at Hook in January. Courtesy Network Rail





simple, with extra visual inspections while walking the track to check which structures looked in a poor way. 'This allowed us to deal with the worst examples and the most obvious candidates for a slip.'

More recently there has been extra emphasis on drainage, with the disaster at Stonehaven in 2020 underlining the importance of understanding what is going on with water flows. A subsequent report for Network Rail by Lord Robert Mair in February 2021 had the overriding message that soil pore water pressure is a key parameter in determining the past and future stability of earthwork assets. The report called for a holistic approach to water management, drainage inspections and application of modern monitoring and surveillance methods, including use of helicopters and drones.

A sophisticated approach is being devised for Control Period 7 (2024-29). 'We have a programme of earthworks assessment planned that will take into account all sorts of factors, such as the properties of the soil, the soil strength, the geometry of the slope of the cutting or embankment, plus the underlying geology. We will undertake slope stability analysis with computer modelling, which will give us ideas about where to undertake remedial work' explains Mr Butcher.

'The aim is to intervene at the right time in the right location. It is a difficult thing to do: Hook was in the mid-range for earthworks at risk – we didn't identify it was in the process of failing.'

A key message from Lord Robert Mair is that we should use technology to help us anticipate when earthworks might fail. On Southern Region we have installed 22 miles of remote condition monitoring at a cost of £22.5 million. We have chosen high risk cuttings and embankments in the worst condition, with extra emphasis on difficult places such as the approaches to tunnels, where evacuation of people



Stitch in time: remediation work on the cutting north of High Brooms last year. Courtesy Network Rail

would be particularly complicated if a derailment did occur.'

### MONITORING

After a pilot programme in which three different sensing systems were trialled, Southern Region has selected InfraGuard sensing technology from Senceive and that company is devising systems that are particularly suited to rail use, with a view to extending the technology to other Regions.

More than 17,000 nodes have been installed on earthworks on Southern: these devices detect when there is movement and send messages to a control centre. In addition, 670 cameras have been installed to complement the nodes. 'If a node sends a message saying: "I've moved", the cameras check on whether there is material that has slipped on to the track – that's much quicker than sending out a Mobile Operations Manager to check' explains Mr Butcher.

Senceive says this is the world's biggest deployment of wireless remote monitoring technology for slope management.

The system has already proved its worth, with the Senceive nodes detecting when there was movement in a cutting at



Keeping tabs on the slope: installation of the InfraGuard system on a slope. Courtesy Senceive

Barnehurst on the Kidbrooke line on 11 February 2019. Camera shots showed that at 19.35 on the 10th and 03.23 on the 11th all was well, but at 04.25 there was vegetation all over the track. 'It was fabulous that we could see all that with infrared monitoring' says Mr Butcher.

Further proof of the value of the system was provided when it prompted emergency repairs to a cutting north of High Brooms on the Hastings line last year, while in January this year the remote condition monitoring gave advance warning of another potential cutting failure on Wessex Route. 'It is helping us to predict and prevent trouble in future' says Mr Butcher. 



Monitoring system: the InfraGuard nodes monitor the stability of the slope, while the solar-powered camera mounted on the pole allows visual monitoring of any slippage that does occur. Courtesy Senceive

## CLIMATE CHANGE IMPACT

Soil mechanics – the scientific study of the engineering behaviour of the ground – and its application through geotechnical engineering, is a relatively recent branch of civil engineering. Our modern understanding based on the principle of effective stress (that is, the difference between the total stress and the pore water pressure within the soil) dates from the early 1920s, by which time most of the UK's railway earthworks had already been built. Advances in geotechnical engineering are often practice-led, with research

filling the gaps in theoretical soil mechanics knowledge later.

Research in the 1960s and 1970s established that high groundwater levels (pore water pressures) within the soil, as may occur when the ground becomes saturated during a prolonged wet period, are generally detrimental to slope stability. More recent research has shown that the seasonal cycles of shrinkage and swelling, to which the combined effects of weather and vegetation subject our earthworks slopes, can eventually cause a fatigue-type failure

– rather like repeatedly bending and unbending a copper wire.

Climate change is doubly damaging. Extreme weather events (such as periods of intense rainfall) have become more likely, while the magnitude of the seasonal fluctuations in soil moisture content have increased. The first can bring rapid failure. The second is like bending the copper wire a bit further each time – fatigue failure will occur after fewer cycles.

While it is difficult to say categorically that a single event such as the Hook slippage was caused by climate change,

it is undoubtedly one of a class of occurrences that has become much more likely as a result of climate change.

The temporary track slew at Hook may well have had precedents and been obvious with hindsight, but neither detract from its ingenuity and elegance. It enabled a near-normal service to be resumed far earlier than would otherwise have been possible, for which I and tens of thousands of passengers on the railway between Southampton and Waterloo were very grateful.

*William Powrie, Professor of Geotechnical Engineering, University of Southampton*