A revolution in sheet piling practice

An innovative new piling system from Balfour Beatty has been used in repairs on a key section of the railway at Westbury in Somerset. In a first for the rail industry, the new King Sheet Piling (KSP®) system was used to shore up the embankment where the line had been reduced to one track for safety reasons.

The problem

This section of the railway embankment had suffered from long-term slope instability and had required regular maintenance. The heavy rain over the winter of 2013-2014 caused yet more ground movement and Network Rail instructed Balfour Beatty Rail, the reactive framework contractor for the area, to develop remedial works.

After detailed investigations working with Bryne Looby & Partners, an international engineering consultancy practice, it was agreed that the best option for the remedial work was the construction of a sheet piled wall to support the bank. Balfour Beatty Rail proposed using the innovative new KSP system, which dramatically reduces costs, increases productivity and delivers environmental and sustainability benefits.

The award-winning system was instrumental in the success of the M25 DBFO widening scheme as well as the M4/M5 Managed Motorways system and a redesigned pumping station at Marston on the A421.

Lee Escrig, Contracts Manager, Balfour Beatty Rail, said: 'The KSP system has revolutionised 120 years of sheet piling practice and shows how committed we are to delivering a more sustainable and cost-efficient service for our customers. It was the ideal solution for supporting the rail embankment at Westbury as it reduces costs and carbon emissions while also being the most sustainable option - the sheet piles are 90% recycled steel and are themselves recyclable in the future.'

System benefits

KSP is a simple, radical innovation, which gives immediate and tangible benefits. Standard sheet pile walls are generally sized for driveability, using heavier sections than the structure of the wall requires. But KSP uses standard sheet piles more efficiently by 'thinking laterally' and making use of surplus structural capacity, combining pairs of Z piles as kings with lighter, shorter Z sections spanning horizontally between them. Placing pairs of normal length sheet piles, alternating with shorter, lighter, sheet piles, can give a four-fold increase in productivity and reduce the quantity of steel required by up to 40%.

The construction process is also quicker, easier and safer as installation is by simple pitch and drive instead of time-consuming panel driving. This minimises working from height risks and also requires a smaller working area with a limited number of operations and interfaces.

With sustainability a high priority in today's world, KSP has the additional advantage of being a much more sustainable and environmentally friendly option than standard sheet piling. It uses considerably less steel, reducing the amount hauled and shipped as well as transport costs and associated emissions. Excavation, material import and waste export are also reduced. The sheet piles are easier to drive and use less energy for installation, decreasing embedded carbon, and can be reused or recycled in the future.

The works

The KSP walls on the Westbury embankment were pitched and driven to depth (intermediates) or to refusal (kings) using a Movax side-grip hydraulic vibrator, and the kings driven to full depth using a percussive hammer suspended from a crane. KSP's lack of clutch friction meant the kings, which made up 48% of the wall, were much more easily driven to full depth substantially reducing vibration and more than halving the percussion driving noise. An additional benefit of KSP for the Westbury embankment was that the short intermediates allowed equalisation of water pressures on each side of the wall.

'All parties were impressed by the increased ease and speed of installation - it took about half the time of standard piling so there was much less disruption for the public and nearby residents,' continued Lee. 'Using KSP at Westbury enabled us to successfully demonstrate the benefits the system offers for remediating unstable railway earthworks. We also needed 41% less steel and saved about 35% of the cost of a conventional steel wall.'

Mike Walsh, Scheme Project Manager, Network Rail, said: 'During the scheme development discussions with Balfour Beatty Rail and Byrne Looby & Partners, we were keen to trial the innovative KSP system. It offered cost, programme and material efficiencies, as well as the potential for enhanced safety during construction and reduced impact on local residents, businesses and train movements.

'Following the completion of the works on programme and in budget, we can confirm all of these goals were successfully achieved. In conjunction with Balfour Beatty Rail, we are now developing a presentation for all the development and delivery teams within Network Rail so the success and lessons learned by using the system can be utilised on future schemes.'

The sheet pile installation at Westbury was completed on 31st March.