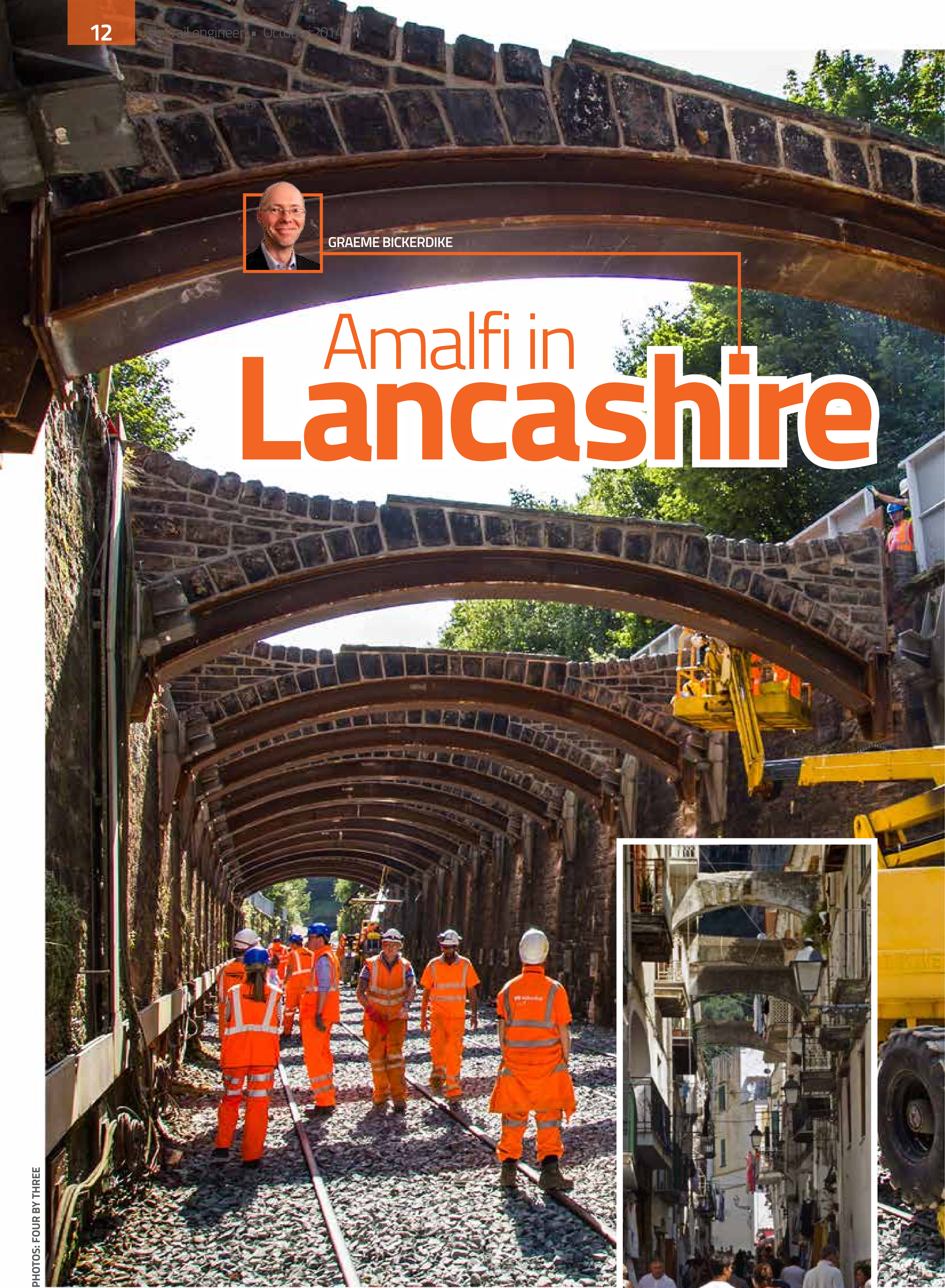
GRAEME BICKERDIKE

Amalfi in Lancashire



PHOTOS: FOUR BY THREE

For civil engineering types who enjoy a busman's holiday, the dramatic landscape of Italy's Sorrentine Peninsula offers much to enthuse about, having tested railway and road builders alike. On the line to Sorrento, the platform at Scrajo Terme Station is mostly in tunnel but its central section glimpses the outside world momentarily whilst traversing a narrow valley, revealing views over the bay towards Naples. Meanwhile the breathtaking southern coast road - best ridden with crossed fingers when Pepe is driving your coach - relies on an assortment of concrete structures for support as it precariously hugs the cliff-face. Construction must have brought boom times for stores selling brown trousers.

Mrs B has long since resigned herself to my admiration of such things - even when off duty - but she gave a look that would crack vases as we walked up the narrow main street in Amalfi, past tasteful little jewellery shops and purveyors of Limoncello. "Blimey, looks like Chorley!" I announced. On reflection, that was pushing the envelope a little. But if you cast your eyes upwards, the Chorley influence was undeniable. Preventing the crowded houses from becoming ever more intimate were four flying arches.

(Below) Adjustments are made to the FRP barrier above the retaining wall.

PHOTO: FOUR BY THREE

(Inset left) The flying arches across Amalfi's main street.

Novelty struts

For non-civil engineering types, you probably need some context. The Bolton & Preston Railway opened as far as Chorley in 1841, leaving a three-mile missing link between the town and Euxton Junction where it would join the North Union Railway, today's West Coast Main Line. But ground conditions through this section were problematic, with running sands, glacial till and a high water table. Construction work suffered accordingly. Attempts to bore a tunnel under the Chorley-Preston turnpike road (or A6 as we now know it) "baffled every effort", eventually resulting in the road being dug out and the tunnel formed by cut and cover.

Beyond its north portal, the line entered a cutting about 60 feet in depth. Whilst dry higher up, the excavation became wet and silty close to formation level, with large quantities of clay exposed which split from top to bottom as the weather got to it. Concerned by this expansion but keen to avoid the expense of erecting thicker retaining walls, engineer Alexander Adie introduced 16 struts - the "flying arches" - across the railway at 15-foot centres, their role being only to generate side thrust which would resist any lateral movement in the walls. Each strut comprised two masonry arches placed back to back, sharing the same stonework through their central portion which was topped with flags to keep the joints dry. Very neat.

In 1844, Professor William Hosking - a noted bridge design academic - cautioned that "the lower arch…might be thrown up by severe lateral pressure and that the same pressure would have a tendency to make the upper invert segments push up the tops of the walls against which they abutted." But 164 years later, removal of the Grade II listed arches was not driven by defect, rather an urgent need to resolve a developing formation failure which had resulted in a 20mph speed restriction being imposed. They were replaced by temporary steel props but have been reinstated this summer, as required by the listed building consent, during a blockade of the Chorley-Euxton Junction line for track lowering, a precursor to wires going up.

PHOTOS: FOUR BY THREE

(Above) Weep holes are inserted below the retaining walls' ground anchors.

(Top) Dropping the tracks by 500mm through the tunnel has created space for overhead line equipment.

Power to the people

The North West Electrification Programme is tasked with installing overhead line equipment on routes connecting Liverpool, Manchester, Preston and Blackpool by the end of 2016. Delivery of this £400 million investment is split into five phases, the fourth of which takes in the line through Chorley. Regrettably Alexander Adie had not foreseen that electricity - just a scientific curiosity in the 19th century - would increasingly power trains in the 21st, so his tunnel was not proportioned with OLE in mind, a reality confirmed through a LaserSweep survey and ClearRoute gauge modelling. Network Rail's Advanced Structure Clearance Team has then been required to re-engineer it before the equipment could be accommodated. Their remit also involved achieving W12 loading gauge for freight traffic.

Successful in tendering for the design-and-build contract - valued at £4.2 million - was Murphy; they procured the consultancy services of Amey to develop the final design. A range of options were considered for the tunnel, including demolition, but cost and a moratorium on arch 'notching' drove the choice of a track lowering scheme. With this came the need for a blockade of the line from 19th July to 31st August, resulting in Chorley being served for six weeks by a weekday rail shuttle service from the south and buses from the north.

Given the impact on passengers, it was of course incumbent on Network Rail to maximise the opportunity afforded by the closure, so the River Chor aqueduct and Harpers Lane overbridge have also been replaced. Progress was made with an earthworks scheme to resolve a historic landslip adjacent to the tunnel's Chorley portal, involving a regrade and soil nailing. Maintenance has made headway with many of those low-level high-volume jobs that can prove difficult in traffic - deveging, sign painting and the like. At weekends and overnight, the blockade's southern limit was extended as far as Lostock Junction to encompass two more bridge replacements - fulfilled by Story Rail - and a collection of Babcock track renewals.

These activities all added variables to the project's critical path; some blocked the line from time to time, bringing further complexity to the planning of engineering train movements. There was no scope for slippage anywhere within the programme given the likely impact on logistics. As each overbridge site demanded road closures, considerable effort had to be invested in community drop-in sessions and liaison with local councils. It's been a busy one for all concerned. Team members even helped out as stewards for the Adlington carnival, the normal route of which had been severed by a missing bridge.

PHOTOS: FOUR BY THREE

Managing the water ingress was one of the project's biggest challenges.

Buying time

Before any excavation in the tunnel's southern approach cutting, the retaining walls had to be anchored back throughout their 230-metre length. Adie had built the walls on layers of engine cinders which he preferred to concrete in wet conditions, but their footings were shallow by today's standards and certainly insufficient given the extent of the track lower which reached 492mm in the tunnel. To stabilise the walls against overturning or sliding, around 200 Ischebeck Titan injection anchors - each 15m in length - were inserted at 2.5m centres, this product saving time as a result of being self-drilling.

With water ingress anticipated in significant volumes, sheet piles were driven down the face of each retaining wall to aid water management, effectively acting as cofferdams. The piles extended above the toe of the walls to prevent any wash-out of running sands. The approach mirrored that implemented successfully in the north cutting back in 2008, although additional anchors had to be installed there due to the planned excavation depth. To get ahead of the game, this work was mostly completed during the first of two 54-hour possessions prior to the blockade. The second saw the establishment of an over-pumping system which operated at capacity for prolonged periods.

From the bottom up

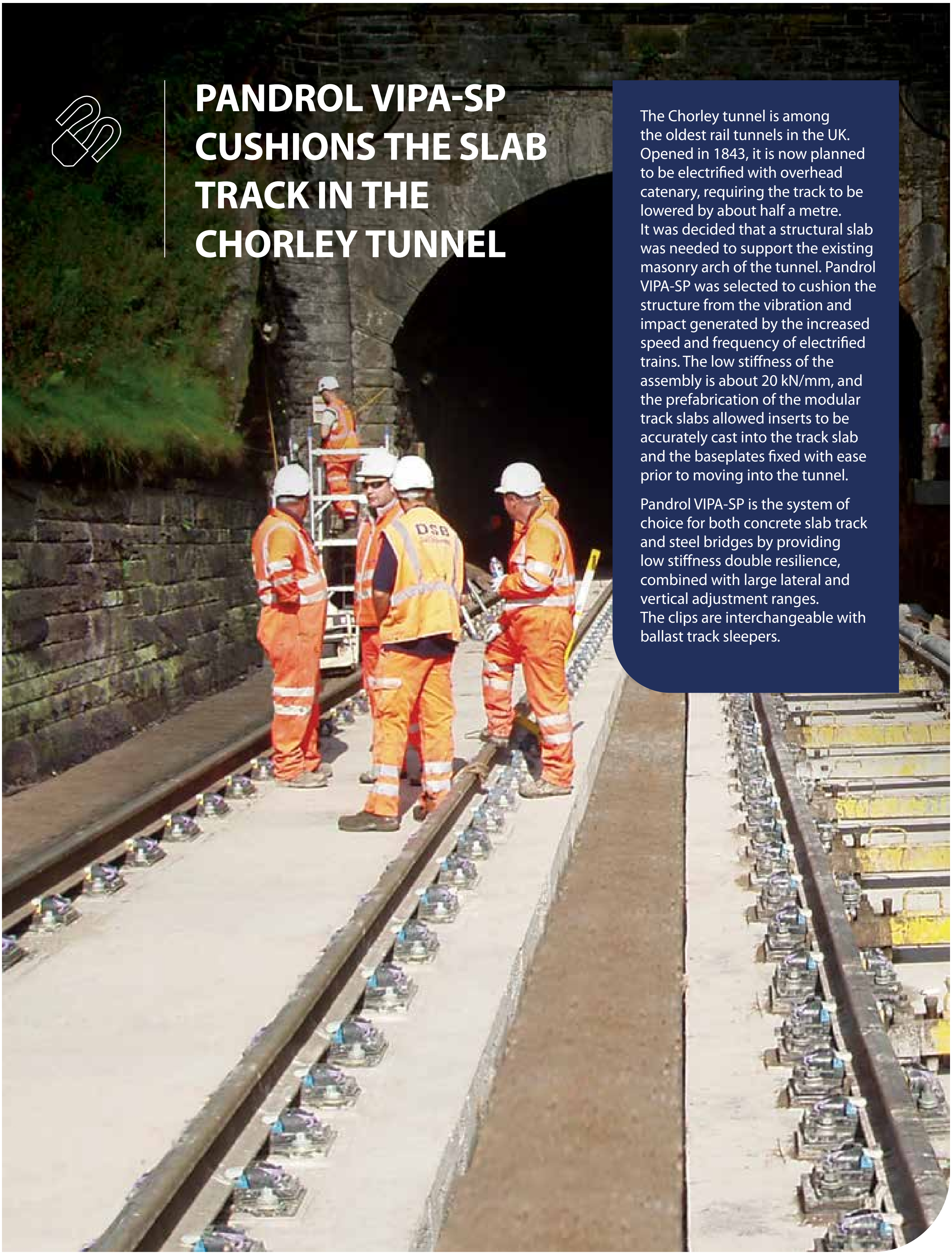
Just 113 metres long, Chorley Tunnel features vertical masonry sidewalls with a segmental arch in sharply dressed stone. Below, built on a 200mm sandstone slab, is a brick invert - 550-600mm deep, measured vertically. Whilst ballasted track could have been engineered for electrification purposes, achieving W12 loading gauge through the tunnel necessitated a track slab solution to limit intrusion on the invert, although notches still had to be cut into it to create the space needed. Ground investigations had helped to build an initial profile of the invert - as best as you can using trial pits - but only after it was exposed and surveyed during the blockade could the depth of the notches be confirmed: mostly around 300mm, with 400mm as a worst case.

Stobart Rail, the p-way sub-contractor, and Murphy proposed a precast concrete ladder system for the track slab rather than an in-situ pour, mostly due to time constraints. Shay Murtagh Precast manufactured the slab track or specialist ladder beams each 4.525m long 2.257m wide, 34 no. upline and 34 no. downline with an overall length of 307.7m. Pandrol Vipa baseplates were specified to provide the high degree of fixity needed for clearances of at least 50mm and a minimum-width six-foot.

An installation methodology was developed to keep the length of open notch as short as possible at any one time. Starting with the Up line, work progressed cyclically - cut the notch, position the ladder beams, grout up - generally in 15-metre bays; this was reduced to 5 metres in critical areas where a deeper notch was required, thus ensuring any stresses were temporarily transferred into the adjoining brickwork. Thereafter the Vipas were fitted - their holding-down sockets having been precast into the ladder units - and new rail installed. Lessons learned on the Up side, in relation to such things as notch cutting and water management, allowed techniques to be refined when attention turned to the Down line.

The extent of the track lower can be gauged by floor level in the refuge.

PHOTO: FOUR BY THREE



PANDROL VIPA-SP CUSHIONS THE SLAB TRACK IN THE CHORLEY TUNNEL

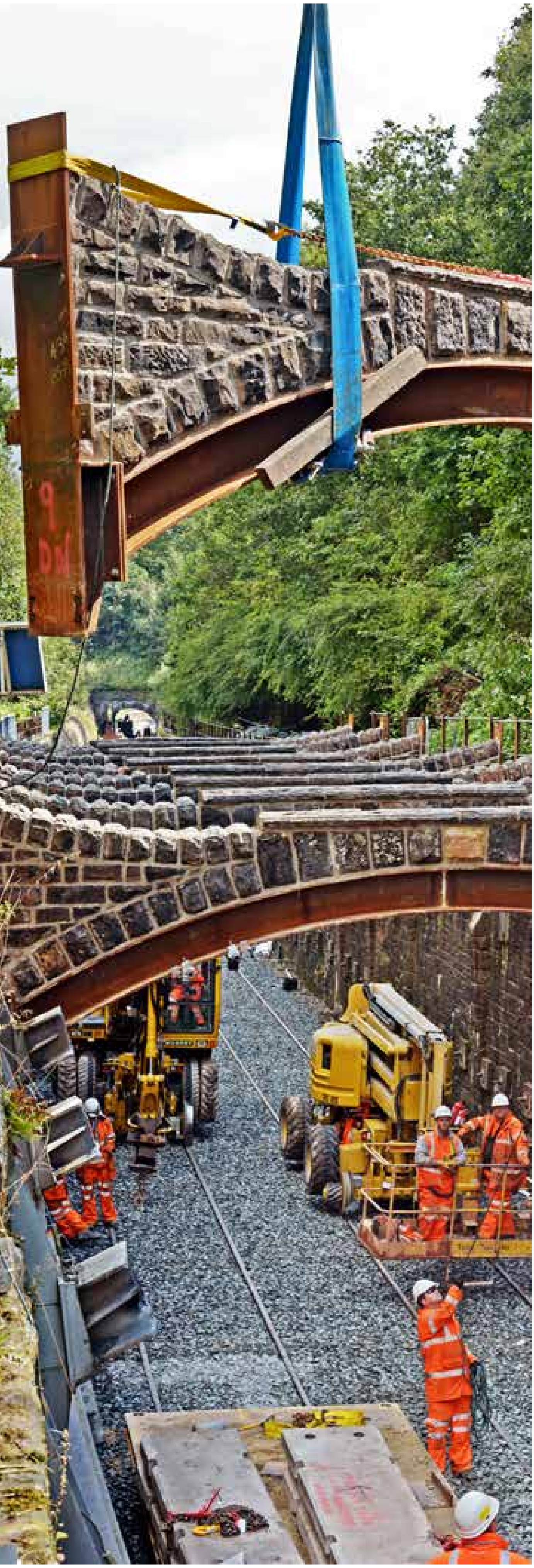
The Chorley tunnel is among the oldest rail tunnels in the UK. Opened in 1843, it is now planned to be electrified with overhead catenary, requiring the track to be lowered by about half a metre.
It was decided that a structural slab was needed to support the existing masonry arch of the tunnel. Pandrol VIPA-SP was selected to cushion the structure from the vibration and impact generated by the increased speed and frequency of electrified trains. The low stiffness of the assembly is about 20 kN/mm, and the prefabrication of the modular track slabs allowed inserts to be accurately cast into the track slab and the baseplates fixed with ease prior to moving into the tunnel.

Pandrol VIPA-SP is the system of choice for both concrete slab track and steel bridges by providing low stiffness double resilience, combined with large lateral and vertical adjustment ranges.
The clips are interchangeable with ballast track sleepers.

For more information about Pandrol's wide range of rail fastenings visit www.pandrol.com

Pandrol Track Systems
TEL +44 1909 476101
FAX +44 1909 482989
EMAIL Info@pandrol.com

PANDROL TRACK SYSTEMS
© DELACHAUX GROUP



The slab extends out from the tunnel by 20 metres at both ends to ensure approaching trains are absolutely vertical when they enter. Beyond that is a 30-metre transition of variable formation thickness, comprising a 6N fill reinforced with a geotextile membrane. In stiffness terms, the Vipa baseplates are designed to emulate ballasted track so the effect of the transition will only really be felt over time as the adjacent ballasted sections become softer through normal track deterioration.

Whilst an open channel provides excellent drainage in the tunnel, renewal of the six-foot drain through the southern approaches has brought much-needed extra capacity. As part of the earthworks scheme on the cutting's east side, formal drainage has been installed above the portal and retaining wall to collect water coming down the slope. This is discharged into the central drain via an under-track crossing. These interventions should greatly improve longstanding water management issues and generally ease the maintenance burden.

Going home

For almost six years, the flying arches had been sitting in cradles at Kirkham yard, secured behind palisade fencing. In advance of the blockade, they were brought back to site, disassembled, labelled and rebuilt in compression on new steelwork, a task undertaken by the skilled hands of masons from Bolton Stone Restoration. Each arch had been 3D-modelled in 2008 to ensure they could be returned as closely as possible to their original form.

...they were keen to retain this railway's link with its Victorian roots and the engineering feature for which it is noted.

There are though hidden dowels and anchors within the joints to hold everything in place, securing long-term durability and robustness.

Key to the installation sequence was the need to maintain sufficient propping of the retaining walls. Strain monitors fitted to the temporary props identified any that were subject to compressive forces, suggestive of movement at the top of the walls. Using this knowledge, the team adopted a one-out one-in approach at these locations; elsewhere it was three-out three-in.

Removal of the arches six years ago relied on a pair of road-rail vehicles working in tandem, however things have moved on since then. The lifting work for their reinstatement was done by a conventional 40-tonne mobile crane, modified to incorporate rail wheels. One of only two in the country, this machine - supplied by Road Rail Cranes - offered far greater capacity and flexibility than typical RRVs. It performed impressively, the consensus being that the industry will find many uses for it going forward; indeed it was also deployed to install the new River Chor aqueduct.

Don't tell anyone I said so but the arches do look a little uncomfortable back in their old home. They no longer serve any structural purpose, sitting 750mm higher than before on new weathering steel struts; these do all the work and might yet have overhead line equipment clamped to their bottom flanges. With 25,000 volts on the way, substantial FRP protection barriers now run along the retaining walls. Together with blue-brick pilasters to mask the arches' end-plates, all this visual clutter inevitably detracts from the stonework.

But it's all about compromise. English Heritage was consulted throughout the design process and fortunately, given the £500,000 cost, they seem very happy with it. The arches are unique - there are no other examples of this type anywhere on the network - so they were keen to retain this railway's link with its Victorian roots and the engineering feature for which it is noted. You can certainly buy into that perspective. They might bask in Italian sunshine but Amalfi's flying arches are, by comparison, permanently in shadow.