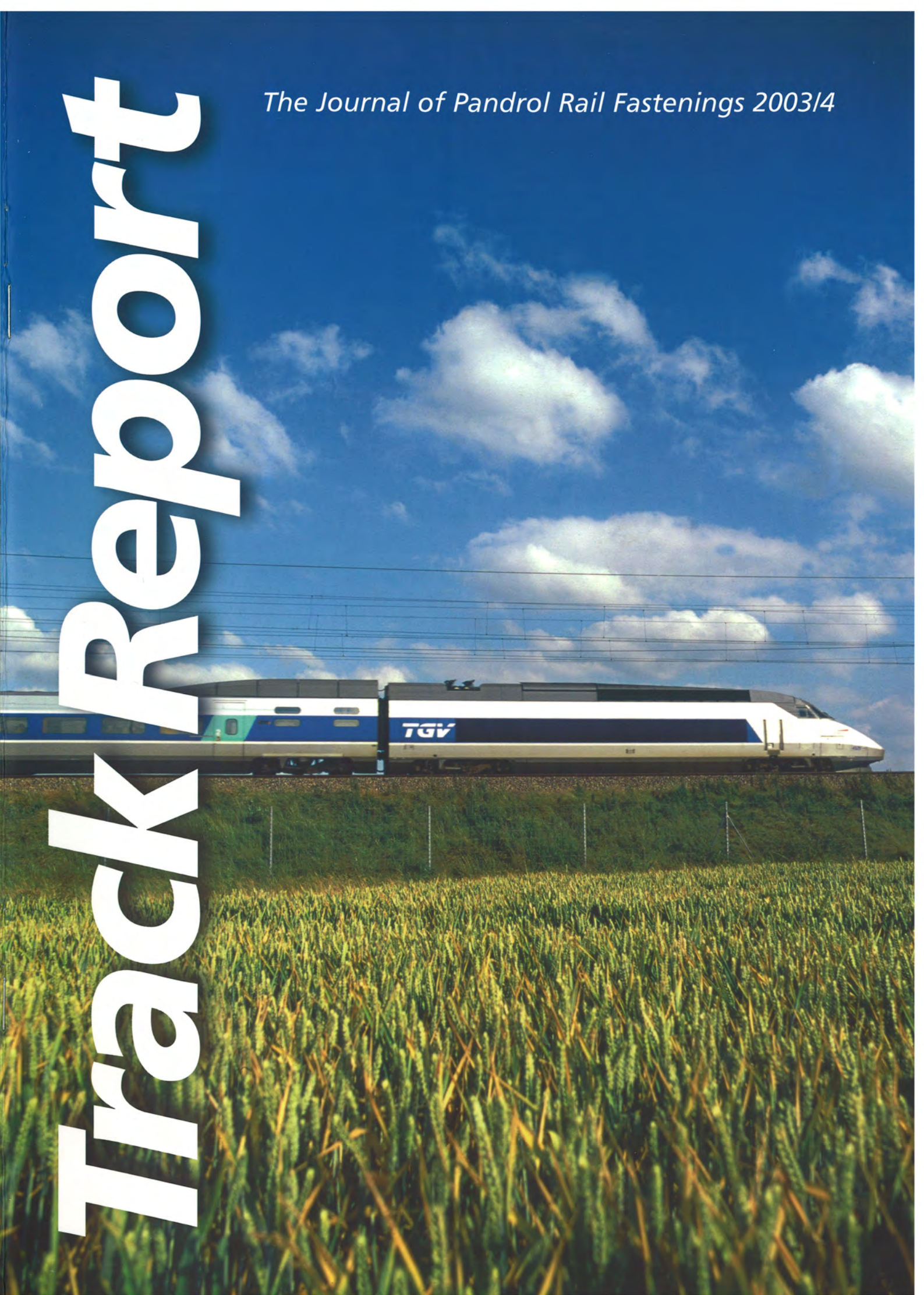




# Track Report

*The Journal of Pandrol Rail Fastenings 2003/4*





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Pandrol Limited gratefully acknowledge the co-operation of all those contributing to the production of this journal and who have given permission for the use of photographs.

The technical information given in "Track Report" was correct at the time of printing, but the company undertakes a continuing programme of research and development, and improvements may have since been introduced.

**PANDROL**

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## DIRECT FIXATION SYSTEMS

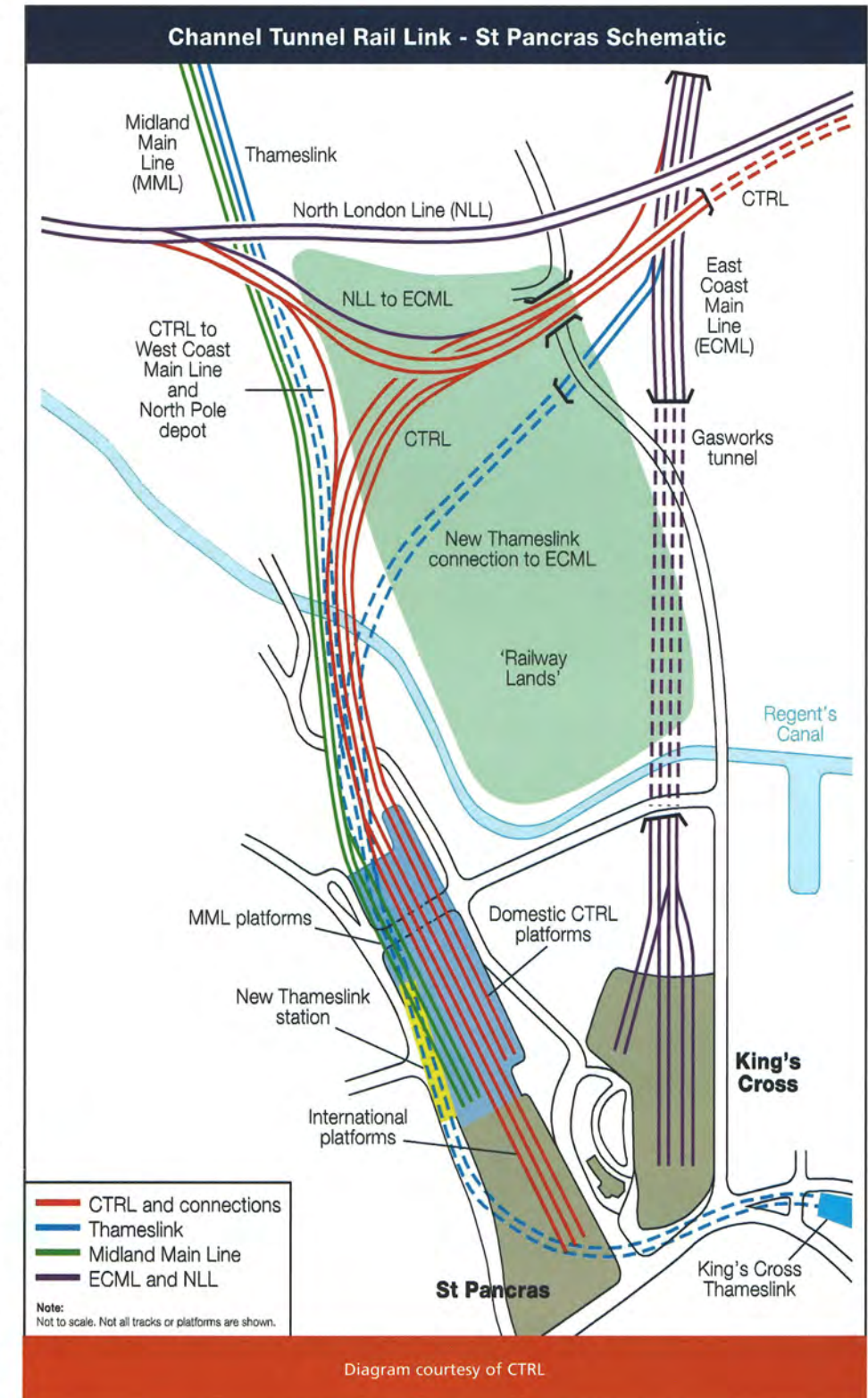
# PANDROL VANGUARD Installation on the Channel Tunnel Rail Link

by **Sean Ring**, Track Systems Manager, Area 100, Rail Link Engineering.

St Pancras Station is being redeveloped as the terminus for three adjacent railways. The relocated Midland Main Line (MML) terminus, which will continue to operate as part of the Network Rail infrastructure; the London terminus for future high speed commuter routes from Kent, the planned "Reserved Domestic Operator" or RDO services, using the Channel Tunnel Rail Link (CTRL) between Ashford and the North Kent Line, via Ebbsfleet and Stratford stations and as the London terminus for International Services using the CTRL from France, Belgium and beyond.

The existing Grade I Listed, Barlow Train-shed will be retained and refurbished, with major redevelopment of the platforms and concourse within the existing structure and the associated construction of a completely new station deck extension. The new concourse and re-developed undercroft, both situated directly under the platforms, will provide modern, spacious passenger handling facilities as well as retail outlets and the station will provide handling facilities for both domestic and international passengers. Rail transport links at the station via the lower concourse and new escalator links will include the new Thameslink Midland Road Station, which will be an integral part of the new structure and London Underground, Kings Cross-St Pancras stations.

Gradients, headroom clearance over local roads, Listed Building constraints, environmental constraints, construction depth limits and both physical geometry and topography are some of the design constraints in this critical area. Design and construction requirements, which include a significant amount of support structure over tunnels, roads and the Regents Canal, are a few of the challenges which have faced both structural and railway engineers. In particular, the station operator, London & Continental Stations and Properties, requires an appropriate acoustic environment in the concourse and commercial areas of the station undercroft. This requires that the undercroft is isolated from structure-borne noise and vibration generated by trains entering and leaving the station. This isolation can only be





effectively achieved through the track-work. However, the requirement to provide this vibration isolation must be delivered within the limitations of engineering and railway constraints.

For some time, Rail Link Engineering (RLE), Project Manager and lead designer and its client, Union Rail North (URN), have been developing the detail of the station structure and the various railways supported thereon. Construction of the first phase of the new station, comprising a major part of the east deck extension, is well underway. This includes service and road diversions, station structures and new roof by the civil engineering contractor under Contract 105, won by CORBER; a consortium formed between Costain, O'Rourke, Bachy, Emcor Rail and RLE structural

designers and station architects.

An interesting feature of the essential railway "stage-works", necessary to maintain uninterrupted MML and temporary Thameslink services throughout the construction programme, will be the use of the first phase of the east deck as a temporary Eastern Interim Station (EIS) for these services. Thus, a significant part of the eventual international and RDO station will need to support the higher HST train loads of the MML services, for approximately two years. The platforms will be temporarily configured to serve UK gauge trains whilst the western half of the Barlow Shed and the station approaches are de-commissioned and re-built. During this phase, the existing Kings Cross (Moorgate Line) tunnel

will be closed, partially demolished and the structural box forming the new Midland Road Station will be constructed and fitted-out. This sub-structure forms the foundation for the west deck extension, which will eventually support the final MML Platforms.

**TRACK DESIGN & INSTALLATION**

The track interfaces with this deck structure have provided a number of challenges for RLE designers and the railway works contractor for Contract 104, Mowlem Rail. The construction depth and structural limitations, along with the structure-borne noise and vibration constraints and settlement predictions for the structures led

to the definition of technical requirements in a track-form performance specification. This set defined limits for structure-borne noise and vibration attenuation, settlement and movement tolerance and, where necessary, alignment correction. The track constraints included: overall dead-load mass of the track system, the ability to transfer braking and acceleration loads from the rail fastenings to the deck structure, control of forces at structural movement joints and the ability to hold active track geometry within acceptable limits.

At tender, the bidders were provided with considerable background information but left to review the market for contractor led solutions to the identified challenges. They were required to

demonstrate in their tenders how their proposed solution(s) delivered the defined performance and how approval and compliance with both Network Rail (NR) and CTRL track standards could be achieved. In parallel, RLE designers continued to review and vet numerous options, as a means to judge probable performance and compliance against the specifications.

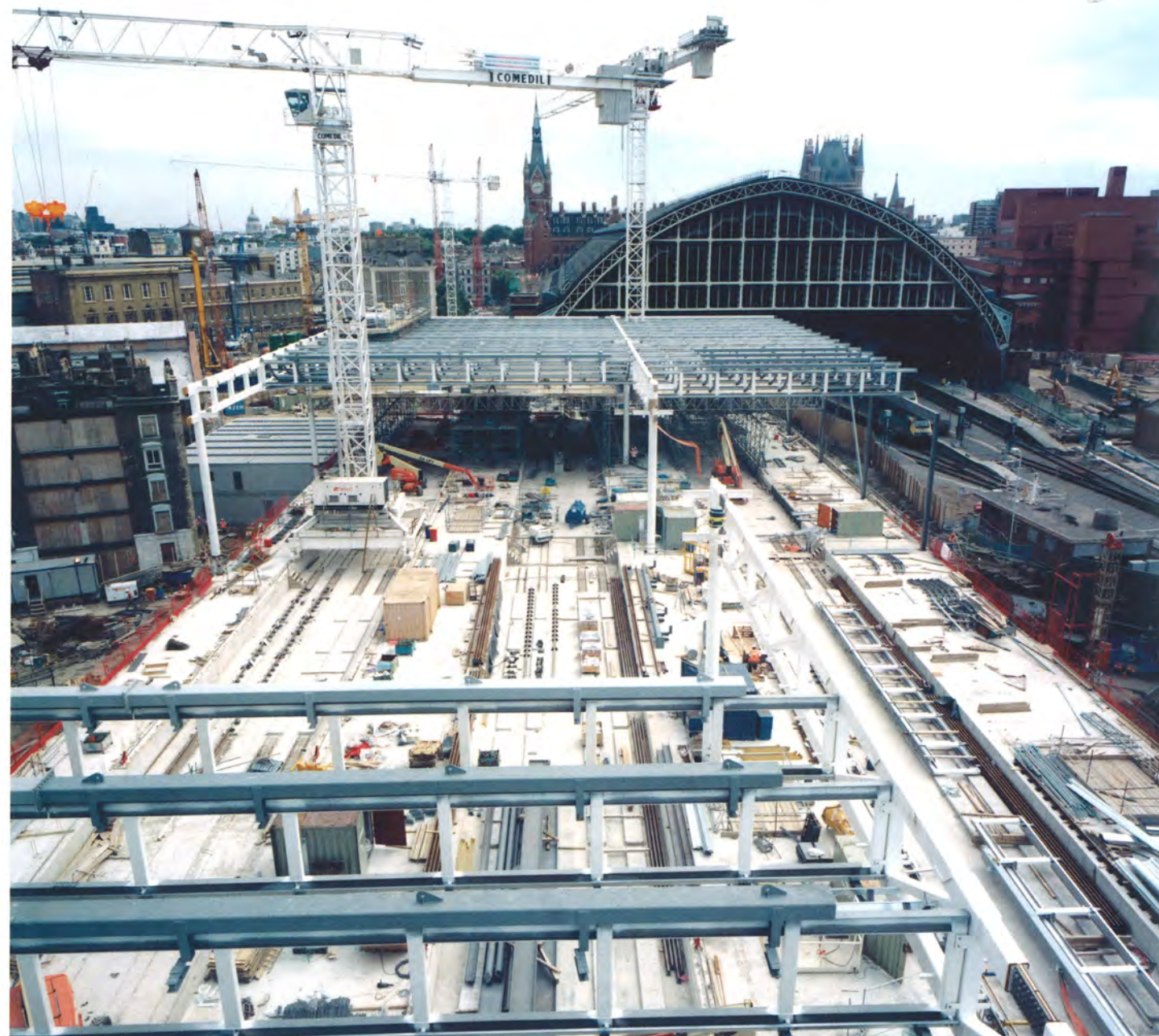
Mass limits and construction depth did not favour ballasted track forms, which in general could not meet the vibration and acoustic requirements without the very significant expense of under ballast mats. Complex floating track-slab systems would have provided the vibro-acoustic performance but would have not met the limitations on mass and construction depth and

would have proved very costly. Several alternative resilient track systems were reviewed by RLE and Union Rail and upon award of Contract 104H, constructability and detail design issues were discussed with the appointed contractor, Mowlem Rail. There were no systems in the resilient fastenings market that fully met the design requirements and offered existing Type Approval Compliance Certificates. However, PANDROL VANGUARD stood out from the competition as being both capable of providing a technical solution and was close to receiving NR Type Approval for use on slab track.

Working closely with Pandrol, RLE held meetings with both URN and NR, to demonstrate the proposed application at St Pancras and to assist Pandrol in submitting Type Approval applications. A site specific Compliance Certificate was issued in late 2002 and Mowlem Rail were then given approval to place orders for the VANGUARD units.

The VANGUARD unit offers very high levels of vibration isolation as a consequence of the very resilient support it provides vertically for the rail. Such high levels of vertical resilience in a base plate system would also generate substantial rail roll (twist) and possibly unacceptable gauge widening. However, uniquely, VANGUARD holds the rail by its web and hence the high level of vertical resilience is achieved with no increase in rail roll.

The particular configuration on St Pancras train deck includes direct fastening of the VANGUARD units, with bolts into cast-in inserts,



▲ View of new platform, looking South during construction. Barlow shed in background. Roof partially completed. Photo by Urban Exposure, courtesy of CTRL.



▲ Looking North. Assembled rail with VANGUARD assemblies - about to be craned in to position for final concrete pour (top down construction). Photo by Mark Maher, RLE Senior Track Engineer.



▲ VANGUARD assembled on rail. Photo by Mark Maher, RLE Senior Track Engineer.

generally supported on longitudinal concrete plinths. These form a series of "concrete waybeams" along the deck, which support the rails and provide load transfer to the main structure through shear reinforcement.

The installation of the VANGUARD units is by "top down" construction. Mowlem Rail and Pandrol developed support methods to set the rail





▲ VANGUARD fully assembled on rail, ready to be positioned for top down construction final concrete pour. Photo by Mark Maher, RLE Senior Track Engineer.



▲ VANGUARD compression tool, used to pre-compress the rubber support elements. Photo by Mark Maher, RLE Senior Track Engineer.

to design line and level, supported by jack-leg frames, with the VANGUARD units, base-shims and bolted anchors attached. The rig supports the rail fastenings within the plinth shutters and care is taken to ensure that the reinforcement does not clash with the fixing bolts. Mowlem Rail then places the concrete up to the underside of the baseplate system. Residual maintenance adjustment in the VANGUARD unit is supplemented by the bolt configuration and slotted holes with serrated locking washers. In combination these systems provide a total of 36mm vertical and up to 50mm lateral adjustment.

Owing to the impact of the piled substructure and tunnelling works, predicted structural movements include a mixture of differential settlement and heave. Therefore, RLE engineers elected to pre-set the VANGUARD units on two 3mm shims, such that up to 6mm of track lowering can be used to balance any alignment adjustment between heave and settlement. Pandrol estimates that the VANGUARD units will develop approximately 1.5mm gauge widening and permanent vertical displacement, during



▲ Pre-assembled VANGUARD assemblies on a length of rail waiting to be moved into position, prior to final concrete pour. Photo by Mark Maher, RLE Senior Track Engineer.

initial use, due to "bedding-in" between the rail and resilient blocks. They will also be subject to active vertical displacements of between 4mm and 9mm, subject to train type and axle load. Both of these factors have been considered in setting out the relationship between the rails and platform copers. This has resulted in an initial track gauge of 1432mm, installed, with expected settlement to 1435mm over the first weeks of operation with gauge remaining constant thereafter. To compensate for the predicted bedding-in and active displacement under train loads, it has been necessary to review normal platform clearance tolerances and impose tighter control to avoid the risk of non-compliance in either construction or operational clearances and stepping distance.

The overall construction programme has not permitted continuous platform access to Mowlem Rail, as CORBER has to manage delivery of both the supporting structure and roof construction overhead. This has meant that the potential for slip-forming and continuous track production could not be realised and traditional methods of ply shuttering have been employed, albeit that the majority of the rail plinths have been standardised at 4625mm long with 275mm gaps. These gaps provide drainage and cabling paths, convenient breaks in the construction and sufficient clearance for thermic welds. Some early

problems with concrete placement resulted in trapped moisture and residual voids beneath the baseplates. These are being addressed and alternative methods include final grouting and cast-in support blocks are being considered. Complex programme interfaces dictate that initial methods and any necessary adjustments have been retained until any revised approach is accepted but with some 85% of the total track slab still to be completed, improved methods will still deliver major benefits.

**DEVELOPMENT**

In general the selected track-form addresses all of the constraints that contributed to the design and construction challenge. However, Pandrol has significantly extended the original concept of VANGUARD, through design development and testing, in support of the RLE track designs.

The EIS stageworks will be used for load and deflection testing, to determine the optimum fastening centres that can be used to support NR axle loads, this will reduce the capital and renewal cost of the system in the final MML platforms.

The ability of VANGUARD to maintain rail clamping forces, whilst accommodating between 20-25mm longitudinal rail movement, without slip or creep, has been demonstrated by laboratory test. This effective "rail-free" property is being used to allow the free ends of the deck

structure to expand and contract without developing unacceptable rail strain. This will allow full stressing of the rails over consecutive long-span structures, by replacing rail expansion/movement switches or jointed track with VANGUARD and CWR. Pandrol has also tested the rail resistance to determine the necessary CWR anchor lengths that are required with this continuous VANGUARD system.

Based upon Pandrol data, transitions from the direct fastened trackform to conventional ballasted track will comprise Pandrol VIPA on the fixed end of the station deck adjoining a section of Pandrol VIPA on plain S&C bearers. This will provide an intermediate stepped transition in the track modulus, between the train deck and conventional sleepers on ballast.

Continuing testing will allow these and other properties of VANGUARD, particularly at transitions, to be incorporated into further elements of the St Pancras project, to help solve design challenges on the East Coast Main Line crossing.

RLE are Project managers for CTRL Section 2, on behalf of Union Rail (North) Ltd. Messrs Pandrol UK are suppliers to Contract 104H main contractor Mowlem Rail. ■

Sean Ring is a Director of Beazley Sharpe (Railwise) Ltd, and is on contract to Rail Link Engineering through member company, Ove Arup & Partners Ltd.



# BART Investigates the Benefits of Lower Track Stiffness

by Michael O Brown, Special Projects Manager, Way and Facilities Division, BART, USA.

**BART (Bay Area Rapid Transit) is an inter-city rail transit system that serves San Francisco, Alameda, and Contra Costa Counties in northern California. Connection between the West Bay (San Francisco) and East Bay (Oakland) is made through the Transbay Tube, a tunnel underneath San Francisco Bay on an alignment roughly parallel to the Bay Bridge.**

Approved by voters in 1962, construction for the original 150 track-mile system began in 1964, with revenue service beginning in 1972. With constructions of extensions to the original system over the last eight years, including the recently opened San Francisco International Airport Extension, BART now consists of over 220 miles of track, forty-three stations, serves 300,000 riders daily, and offers interchange service with the San Francisco Municipal Railway (MUNI),

Caltrain, (via Caltrain) the Santa Clara Valley Transit System (VTA), California Capitol Route (San Jose to Sacramento), California San Joaquin Route (San Jose to Bakersfield), and Amtrak. BART is now in early design to extend service south from its terminus in Fremont to San Jose and Santa Clara, in partnership with VTA.

BART is somewhat unique among rail transit systems in that its track gauge, at 66 inches (1.65m), is significantly wider than standard. It is comprised of ballasted concrete tie track and direct fixation track assemblies on both aerial structures and in tunnels. Bolted assemblies were selected as the fasteners of choice on both concrete ties and direct fixation assemblies at the time of the system's construction. Pandrol resilient fastenings, introduced during construction of BART's recent extensions, have performed well and remain the BART standard

fastening for all new concrete tie construction. A Pandrol-designed rail fastening retrofit for ageing concrete ties on the original alignment is under consideration.

BART is presently considering alternative fastening assemblies to mitigate corrugation / noise and vibration concerns. A Research Results Digest article titled "Rail Corrugation Mitigation in Transit," published in June, 1998 in conjunction with a Transit Cooperative Research Program (TCRP) study sponsored by the Federal Transit Administration, concluded that while not unique to transit systems, rail corrugation and its resulting vibration and noise are a particular concern to rail transit systems because of their urban and suburban locations.

Corrugation on transits, according to the study, is most evident on curves, particularly on the low rail, and in areas where braking/acceleration takes place. One method of corrugation mitigation recommended was the use of reduced-stiffness rail fastenings. Realising its existing direct fixation fastenings were likely a significant contributor to its corrugation problem, BART Engineering turned to Pandrol for an alternative assembly.

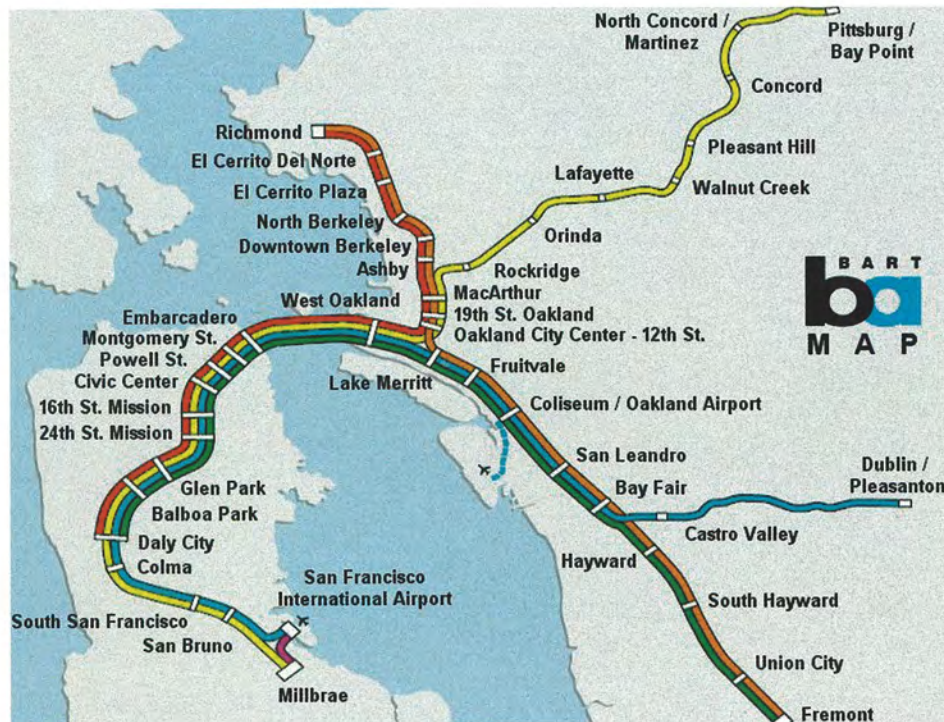
Pandrol's VIPA-SP has been determined to be over 60% more resilient than the bolted direct fixation assemblies currently in service on most of BART's DF track. A trial installation of 420 VIPA-SP units was installed at 36 inch (90cm) centers on the northbound track of the Richmond Line near Albany, CA in August 2002. The curve selected for the trial is 6,000 feet in radius (1,800m) with 2.75 inches (70cm) superelevation and is located on an aerial structure just north of a tunnel portal. With a train speed of 70mph (110kph) at this location, noise has traditionally been a neighbourhood concern. The south-

bound track rail fastenings were left undisturbed for comparison.

BART's very narrow weekday work windows necessitated a weekend track outage to install the VIPA-SP. Preparatory work done in the preceding days facilitated the work. No modification to the third rail was necessary.

Noise measurements in the area were taken by Pandrol in the test area prior to installation of the VIPA-SP fastenings. Initial post-installation noise measurements were inconclusive because the rail had not been ground in the interim. Grinding has since taken place, measurements retaken, and a formal report is pending. However, feedback from residents of the surrounding neighbourhood has been positive, indicating an audibly noticeable change.

Attention is being paid to VIPA-SP's ability to mitigate reintroduction of corrugation in rail at the trial site. BART considers one year its trial period, so the jury is still out, but indications are that VIPA-SP is performing as anticipated. ■



▲ Map of the BART System.



▲ PANDROL VIPA-SP Assembly.



# The Rehabilitation of the New Jersey Transit (Bergen Tunnel North)

by James Galvin, Senior Construction Manager, New Jersey Transit.



New Jersey Transit (NJT), the State of New Jersey's public transportation corporation, provides bus, rail, and light rail transit linking major points in the state with New York City and Philadelphia. It covers an area of over 5,300 square miles and is the nation's third largest transportation provider.

At NJT's Hoboken Terminal, connection can be made to PATH (Port Authority Trans Hudson) trains serving Jersey City, Newark, and midtown Manhattan; to Manhattan-bound ferry service; and the Hudson-Bergen Light Rail System. It is in one of the pair of two track tunnels that connects the former Erie and Delaware-Lackawana railroads with access to Manhattan that NJT has installed a Pandrol Single Resilient System Direct Fixation Assembly as its designated track fastening.

Construction started in 1875 on the North Tunnel which was excavated through the Palisades. The South Tunnel, adjacent to the North Tunnel, was opened in 1908. The two are separated by only twenty five feet of rock. Rehabilitation work for the approximately one-mile long North Tunnel was advertised for bid in the spring of 2001 and an award and notice to proceed was made in June 2001. The scope of work included enlargement and waterproofing of the tunnel as well as rehabilitation of the track structure.

The excavation for the enlargement work proceeded with extraordinary caution because of the proximity of the South Tunnel, which remained in service throughout the project. Once excavated and enlarged, the process of re-installing track and the catenary (overhead contact wire system) began.

NJT, after consideration of other products including Pandrol VIPA-SP and an "Egg" type fastening, selected a Pandrol SRS assembly featuring FASTCLIP rail fastenings as its track fastening for this project. The decision was based not only on cost, but on the Pandrol product's lateral adjustment capability (it allows up to 1/2" adjustability at the four anchor bolts), its ability to service 40 ton axle loads, and the fact that it is fully insulated electrically. The Pandrol SRS FASTCLIP Assembly was tested to, and

passed, rigorous performance standards prior to selection.

The joint venture general contractor of Merco / Obayashi performed the tunnel rehabilitation work as well as the track construction. The method of track construction selected was bottom up. After pouring the invert, holes were drilled for the plastic anchor inserts to be installed. The inserts were epoxied in place and the plates were then secured to the invert with the anchor bolts. Although the track is tangent, four anchor bolts were installed. Additional tests were performed on the anchors in track to prove the contractors installation method.

Alignment was checked and adjusted as necessary with the vertical serrations in the SRS assembly. Height was checked and the plates were shimmed or the invert was ground as required to ensure a level track surface. Once this procedure was complete, NJT track department reinstalled the rail. The rail installation was completed by securing the rail with the FASTCLIPS.

▼ PANDROL SRS Assembly secured to the invert with anchor bolts.

The North Tunnel was re-opened to revenue service in the spring of 2003. Rehabilitation of the South Tunnel is anticipated to take place in

the next few years, incorporating the same materials and tunnel rehabilitation procedures as utilised in the North Tunnel. ■





# PANDROL FASTCLIP Concrete Sleeper Renewal on SNCF

In September of 2003, the joint venture of SECO / TSO was contracted by SNCF to re-sleeper 35 kilometres of track, between La Rochelle (in the Charente-Maritime region) and Niort (in the Deux-Sèvres Region) in Western France.

The existing track was laid with timber sleepers and was nearing the end of its useful life.

The work involved the removal of the existing timber sleepers, excavation to allow adequate ballast depth, and replacement of the sleepers

with 52,500 twin-block concrete sleepers equipped with the SNCF approved PANDROL FASTCLIP FC1504 rail fastening assembly.

The installation and destress was carried out through the month of September, utilising full-day possessions. The track was then re-opened at night to allow the passage of goods trains delivering new sleepers for the next day's possession.

A Matisa Type Track Laying Machine was employed during the relay. The sleepers,

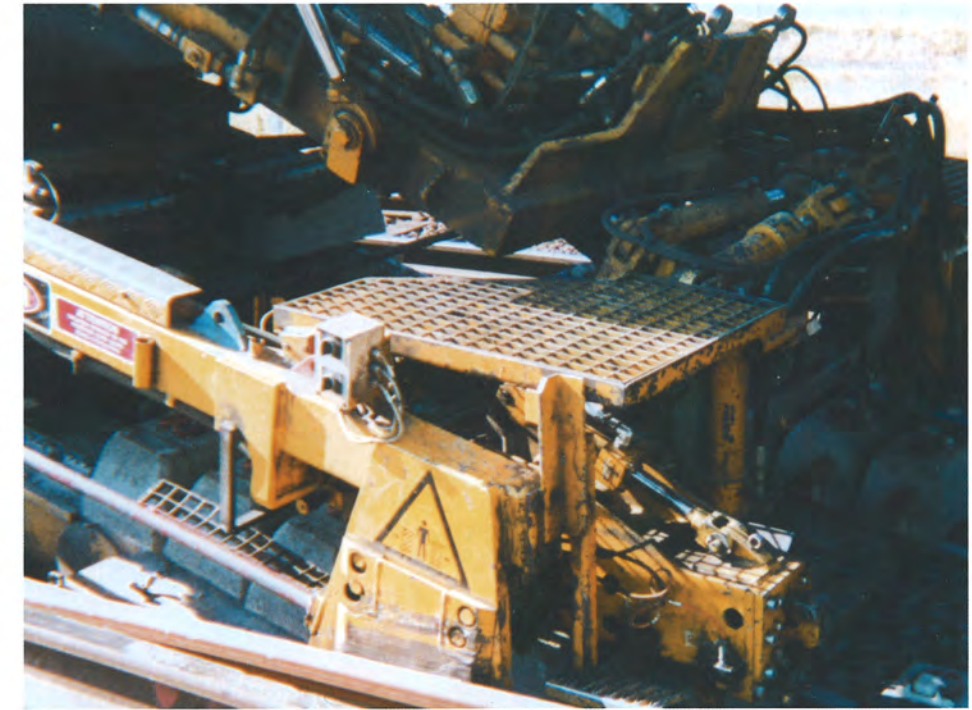
manufactured by Sateba, were pre-assembled with FASTCLIP fastenings, insulators and rail pads in the factory, prior to transporting them to the track site for loading onto the Track Laying Machine.

The Matisa machine threads the rail out of the track, and then picks up the existing timber sleepers, the original rail fastenings having already been removed. The Track Laying Machine then prepares the ballast bed, and lays the new concrete sleepers, on which the fastenings,

insulators and rail pads have been assembled in the 'rail ready' position. The rails are then mechanically threaded into the rail seats.

A SECO-designed clip drive unit integrated into the Track Renewal Machine drove the PANDROL FASTCLIP into its working position, holding the rail to the sleeper. The clip application operation is therefore fully integrated into the Track Laying Machine, and fully mechanised.

The destressing operation was straightforward, with the FASTCLIP fastenings mechanically moved back to the 'rail ready' position (using either a Geismar AP11 or a Pandrol Mk4 machine). This allowed the rail to be destressed then pre-tensioned prior to welding. The FASTCLIP fastenings were then driven back into their working position using the same machines, completing the process. ■



▲ New concrete sleepers fed through the track laying machine.



▲ Matisa Track Laying Machine.



▲ GEISMAR AP11.



# The PANDROL SFC Baseplate Assembly on a Tram Project in Istanbul

by **Fatih Yildirim**, Railway Engineer and **Aydın Kayış**, Railway Engineer, **KB Thermit A.Ş.**, Turkey.

In 2002 a new tram project was tendered in Istanbul by IETT which is a branch of the Greater City Municipality of Istanbul. This project is one of the major steps which has been taken to solve the traffic problems of Istanbul. The line that starts from Sultançiftliği and extends up to Edirnekapi is a vital transport artery. This vital artery has been occupied by buses and mini-buses to date which are not as efficient and comfortable as trams. The aim of this project is to provide the passengers with a comfortable and high standard of transportation.

Transstroy-Ünüvar-Hazinedaroglu Consortium was chosen as the contractor for this new project, in charge of constructing the total system. KB Thermit has been determined as a subcontractor by this consortium, in charge of constructing the track.

The line has been built for 90 kN axle load and an average speed of 20 km/h, with a 20 mm maximum superelevation of the outer rail in curves. The track is 25km in length and utilises Ri 59/R13 grooved rails. PANDROL SFC Baseplates with two anchor bolts were chosen as the fastening system. These assemblies were directly fixed on the 20 cm concrete slab with 75 cm and 65 cm intervals depending on the curve radius. The stations will be on the street level in order to blend better with the environment.

Top-down construction method was preferred for the installation. During the construction, the rails were suspended by support chairs and gauge holders were used to provide the nominal gauge. The installation of PANDROL SFC Baseplates was carried out using PANDROL supplied hand tools when the rails were suspended. Simple jacks were used as a support under the baseplates to stabilise the baseplates during the installation process. The final alignment of the track was made after the installation of all SFC Baseplate assemblies.

The fastening system components were delivered individually to Turkey. Pre-assembly of the system was completed in a small workshop in the storage area.



▲ During construction, rails were suspended by support chairs whilst gauge holders provided nominal gauge.

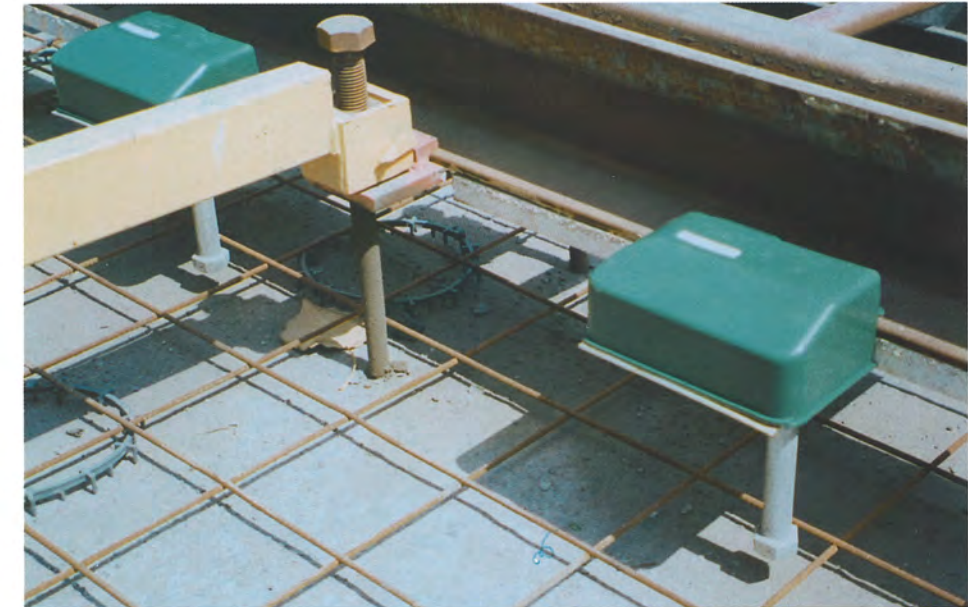
The conforming pads were attached to the baseplates using adhesive prior to installation. The anchor bolts were assembled after the installation of the baseplates on the rail. PANDROL soft faced hammers were used to achieve the required position of the baseplate on the rail.

In order to provide a level crossing along the track, the track was filled with concrete and asphalt up to the head of the rail, but in order to protect the fastenings from the concrete fill, plastic covers were placed over the SFC Baseplate assemblies. These covers were manufactured by a local supplier, KARCAN, located in Istanbul. They were also used during the slab concrete casting in order to protect the fastenings from the concrete. By the use of this economical solution, the SFC Baseplates remained clean. These covers were easily installed on the FASTCLIP assemblies by the use of a clip inside the cover.

By the proper design of the slots with serrated clamp plates on the baseplate the lateral adjustment of the track was established without any extra cost. The SFC Baseplates are designed to have +/- 15 mm lateral adjustability which gave the opportunity to correct minor misalignments. Furthermore, gauge modifications can be achieved by using different thicknesses of side post insulators. This is a specially important advantage in a tram project since gauge increments have to be provided in the very tight curves of the depot area.

Stray current is one of the most important issues in this kind of project owing to the steel and reinforced concrete structures, such as pipes, below the street level. Toe and side post insulators have provided the necessary insulation from stray current. On the other hand, plastic covers block all contact points between the SFC Baseplate and concrete fill. This provides additional security for SFC baseplates against stray current.

At the end of the project approximately 70,000 SFC Baseplates will have been installed. PANDROL SFC Baseplate assemblies have more than met our expectations for the project. ■



Top: PANDROL SFC Assembly.

Middle: Locally manufactured plastic covers protect assemblies from the concrete fill.

Bottom: Completed track.



# Restoration of PATH Tunnels, New York

by John Zuspan, Balfour Beatty Rail / Metroplex Corporation.

On September 11, 2001 two hijacked airliners were flown into the Twin Towers of the World Trade Centre in New York by terrorists, bringing the towers down and killing 2800 innocent people. PATH (Port Authority Trans-Hudson) trains were trapped on the bottom floor as the towers collapsed, but all passengers were evacuated to the New Jersey side at Exchange Place. No PATH passengers were injured owing to quick reactions and smart despatching of PATH trains. When the twin towers fell, they ruptured all the main waterlines. This coupled with fire lines began to fill the PATH tubes under the Hudson River at a rate of 3,000 gallons per minute. Massive water pumps were mobilised. It was feared that the tubes would implode owing to negative pressure, so 2-5 foot thick concrete plugs



▲ Interior of 'The Tubes'



▲ The Bathtub.

were poured on the New Jersey side in order to save the entire PATH system. The plugs were later removed and the water pumped out. A \$300,000,000 "cost plus" job was awarded to the tri-venture of Yonkers/Tully/Pegno to re-build and restore the infrastructure in order that passenger trains could move from New York to New Jersey once again. The project was then broken into 3 distinct regions; "Exchange Place", "The Tubes" and "The Bathtub". After a year of debris removal and recovery, it was time to secure a track contractor. The Port Authority of New York and New Jersey along with the Tri-Venture began negotiations with Metroplex. It was finally agreed that Metroplex would build all the trackwork to accomplish the goal on a lump sum basis amounting to \$17,000,000.

The direct fixation track consisted of 115lb CWR with Pandrol SRS (Single Resilient System) assemblies using FASTCLIP fastenings. The rail was supported by PIP (Poured In Place) jigs to the proper elevation and the SRS assemblies were attached to the rail with the FASTCLIPS. The anchor inserts were then attached to the SRS assemblies to set proper insertion depth.

The concrete was placed using the "top

down" method which allows for 100% electrical isolation between the rail and the concrete. A second series of the Pandrol SRS assemblies were also used which incorporated a UIC restraining rail for tight radius curves. These were installed in the same manner. Pandrol also assisted the contractor by modifying insulators to allow 100RB rail to be used in similar assemblies at Exchange Place station platform.

## EXCHANGE PLACE

While the Tri-Venture continued blasting rock and creating a new tunnel, Metroplex forces began construction of the trackwork. This work consisted of 8 turnouts and 4,000 feet of track with 3rd rail and coverboard. All material was brought in by way of the PATH operating system, including ballast, ties, rail and switches. Work was performed 24 hours per day, 7 days per week for an on time completion for revenue service commencing in June of 2003.

## THE TUBES

The 2-one mile tunnels under the Hudson River were completely stripped down to the original rings. New duct banks were installed prior to building the track. Metroplex completed the 2 miles of direct fixation track using "top down"

methodology in a record time of 6 weeks. The third rail coverboard was installed and again we were successful in performing this work on time.

## THE BATHTUB

When the Twin Towers were built in the late 1960's, a slurry wall was poured around the entire excavation site in order to prevent water from the Hudson River from flooding the site. When the towers went down, the slurry wall was compromised; however the original tie backs were re-tightened and prevented the total collapse. Metroplex built the loop tracks for the return trip to New Jersey. This work consisted of 8 turnouts, 3,000 feet of ballasted track and 3,000 feet of direct fixation track within the temporary World Trade Center station. Again, we were on time for the test train in July.

## SUMMARY

This was a very risky, high profile project which called upon the patriotism and motivation of all Metroplex employees involved. We salute them for their hard work and dedication. We also appreciate the support of their families in this time of sacrifice. Let us never forget the innocent lives that were lost. God Bless America. ■





# Renewal of the Bramhope Tunnel, Network Rail, UK

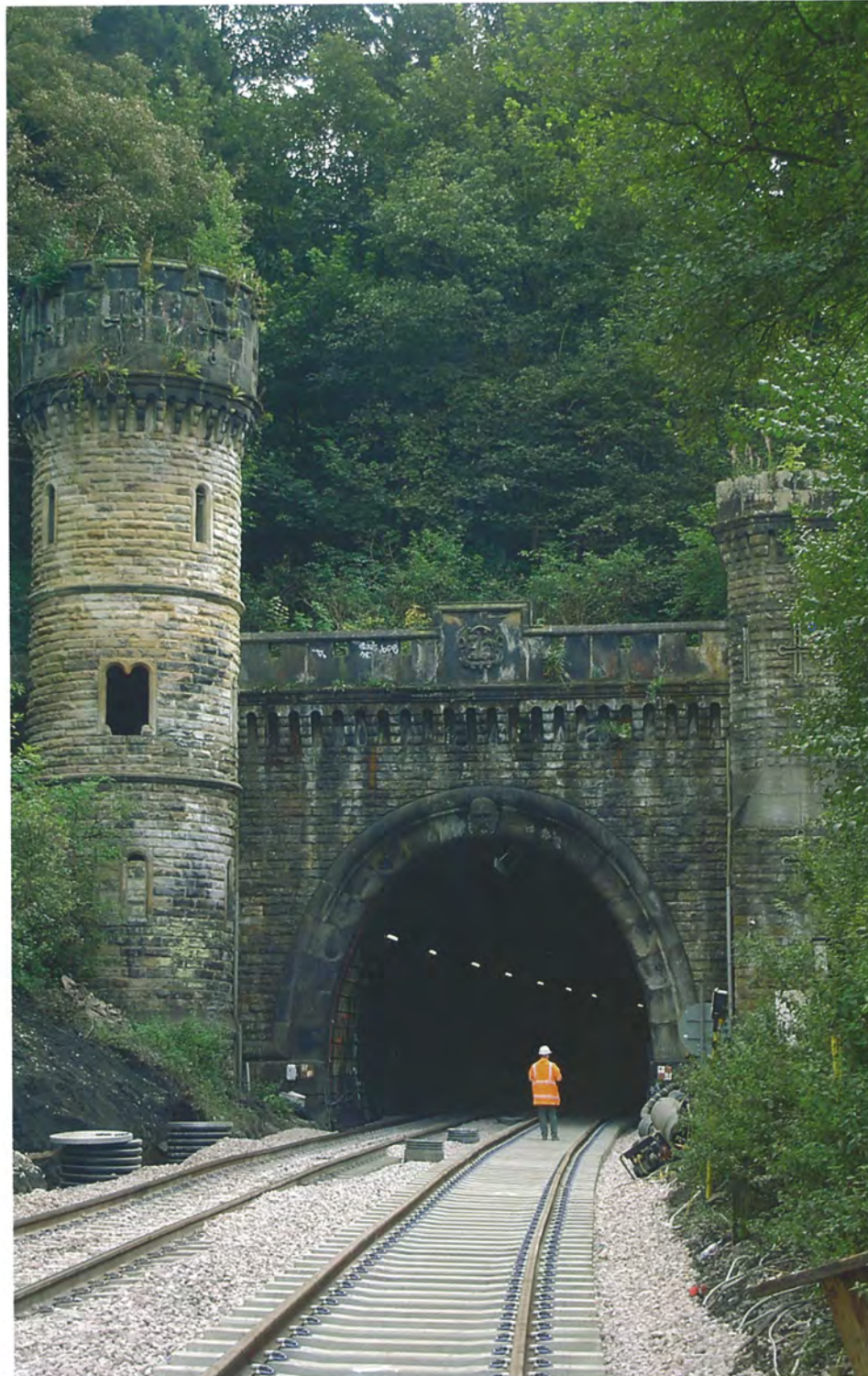
by Peter Wilder, Corus Rail Consultancy

Bramhope tunnel, 2 miles 243 yards / 3441 metres long, is on the Horsforth to Weeton section of the Leeds and Thirsk Railway, built by James Bray, an iron and brass founder from Leeds. Construction began on 20th October 1845, a clear path through achieved on 27th November 1848. The official Grand opening was on 9th July 1849. The portals are very different, representing an era that displayed its pride for all to see. The southern Horsforth entrance is plain, with the keystone displaying the face of a young Nordic Warrior. The northern entrance is a magnificent Victorian Gothic castellated portal with a tall tower, which accommodated railway staff. The keystone is again a warrior, but at this end, Arthington is an old man, helmeted and heavily bearded.

During its lengthy construction, using gunpowder, picks and shovels, the recorded death toll reached 24, commemorated in Otley churchyard by a memorial in the form of a replica of the Arthington portal.

The constant threat of flooding during its building has been a problem to railwaymen ever since opening. The tunnel burrows beneath the ridge that separates Airedale from Wharfedale, and it acts as a huge drain. The average daily outflow of the tunnel drainage system has for the last 150 years been slightly under 1½ million gallons per day from intercepted water courses and through the roof of this 25½ feet wide, 25 feet high, 1 in 94 gradient bore. This water flow has given rise to the problem inherited by Network Rail, and a solution sought.

The project design was created by Corus Rail Consultancy, based at its Head Office in York, and involved design, survey, site investigation and review of historical records to collate data to enable the most appropriate engineering solution to be undertaken. A drainage scheme was required to replace the Victorian stone box-culvert that existed in the 6 foot, which had become severely degraded in many locations. A track lowering scheme allowed increased clearances for modern freight and passenger stock.



▲ Northern entrance to the Bramhope Tunnel - the tower used to accommodate railway staff.

The criteria for relaying are, as always, to reduce maintenance costs by extending component life, ease and simplicity of placement/replacement, standardisation of track and most appropriate use of materials. A major problem in this, as other wet tunnels, is corrosion of track components, not only from the harsh environment of falling water from the tunnel walls and roof, but also from the leaching of chemicals contained within the rock.

FASTCLIP possesses an advantage over other rail fastening systems in that it does not require the clip to be inserted into a housing, with the resultant 'rusting in' effect that this generates. Sheradised clips inserted mechanically ensure that the clip is not damaged when moved to the retention position, and that the life span of the clip is extended by the pre-treatment process. The specially designed pad, with its water exit paths, ensure that any water present between sleeper and pad, or rail and pad, is transmitted from the pad out to the ballast, thus extending both rail and sleeper life.

Track installation, by both Road/Rail Colmar 10,000 tandem lift, and twin-jib track relaying unit, was efficiently undertaken by contractor First Engineering. This production process of modern plant and traditional railway relaying practice complemented and gave flexibility to enable speedy progress. G44 sleepers, some 11,000 in total, were moved to site by a dedicated service of EWS supplied loco's and track carriers. Progress was at times difficult, with

the various processes of drainage, excavation, removal of spoil, import, tipping, spreading and compaction of ballast, all intricately interwoven, but the final product is a fine testament to the planning and execution of the work. The ease of placement of the sleepers, with their 'captive' components of clips and insulators, mechanical

'clipping up' without loss of either component or damage to the sheradised clips, has ensured that the frequency of replacement of rail retention units is greatly reduced, along with the assurance that when it is necessary to replace the rail it is a simple, speedy process. All in all a tidy job, well designed and specified, well executed. ■



▲ Pandrol MK4 clip application machine, capable of installation and extraction.



▲ G44 Sleepers pre-assembled with sheradised fastenings ready to be installed.



# Trial Installation of the Pandrol K-Lock Assembly on Belgrade's Railway Maintenance Section, Serbia and Montenegro

by **Ognjan Rakic**, Chief Engineer for Railway Lines, Belgrade's Railway Maintenance Section.

In accordance with the decision of the Public Railway Transportation Enterprise 'Belgrade' to carry out implementation of an elastic fastening system, Pandrol offered its resilient K-Lock fastening system, to be installed on wooden sleepers.

The Pandrol K-Lock system provides a simple, effective and economical method of converting existing rigid fasteners to resilient elastic fastenings. The assembly has been designed in order that track can be converted by replacing the existing fastenings, with no disturbance to any other components of the superstructure.

The assembly consists of a Retaining Plate, which is placed into the dovetail slot and onto the foot of the rail. The plate provides a ramp over which the K-Lock fastening is driven and also provides an effective anti-vandal feature to the assembly.

Keeping in mind that a suitable trial section should be an area with characteristics typical to the network, a trial section was chosen between railway section 15 + 246 to 15 + 306 on the Beograd – Mladenovac – Nis railway line, between Resnik railway station and passing point Pinosava, Belgrade's Section for Maintenance Railway Lines. Possession of the railway line was planned from 08:15 to 11:15 on 28th October 2003.

Installation of the K-Lock system was the responsibility of a Gang from the Topcider Maintenance Section, whilst Pandrol provided components for the fastening assembly – retaining plates, fasteners as well as handtools necessary for installation and extraction. Also in attendance was a representative from Pandrol Ltd, who supervised the installation procedure.

The basic characteristics of the railway line are:

- Axle Load 225kN
- Maximum Speed V = 70km/h
- Gradient 4.8%, toward passing point Pinosava
- Radius of curve R = 300m
- Superelevation of the track h = 115mm



▲ Pandrol K-Lock Assembly.

The basic characteristics of the railway track are:

- Track Gauge 1435 + 7(8)mm
- Rail type 49, which was replaced 11.07.2001
- Wooden sleepers 16 x 24 x 260cm, distance between centres of sleepers 60cm. Most sleepers were replaced in 1998, but a few dated back to 1982.
- The existing assembly was a 'K' system, with ribbed baseplate, fastenings plates, hook bolts, spring washer, sleeper screw, and rubber pad between rail foot and baseplate.
- The ballast was a crushed stone, thickness of the ballast bed is 25cm measured from the lower side of the sleeper. Ballast cleaning had been carried out on 27.07.2001.
- The track is continuous welded rail, using the aluminothermic procedure.

## INSTALLATION OF THE K-LOCK ASSEMBLY

All preparation activities were completed before the installation commenced.

Replacement of the rubber pads under the rail foot was predicted when planning the installation. After unscrewing nuts on the outer rail, and removing nuts, washers, fastening plates and hook bolts the rail was lifted to replace the existing rubber pads with wooden impregnated pads. Increasing influence of stresses in the rail caused by lower rail temperature (5°C) made the released rail slip. As the rail was positioned back into the appropriate place and fixed by the original 'K' assemblies in strategic places, work on driving the new K-Lock fasteners began, but this operation took a great deal of effort, and it was apparent that the wooden pad was too thick – 8mm instead of 5mm. Unfortunately handtools suitable for UIC60 rail had been delivered to site, not hand tools for Type 49 rail. Although able to assemble the fastening when retaining the rubber pad it was not possible if the oversize wooden pad was installed. For these reasons, work continued without replacing the rail pads.

Finally work came to the end successfully. The agreed initial installation of K-Lock fastenings

was for 100 wooden sleepers, and the final result was 107 wooden sleepers installed with the new resilient fastenings. The work was completed on time, 5 minutes before the first train passed.

## TESTING AND CONTROL

During the evaluation on the aforementioned trial section, the following parameters will be measured and periodically controlled:

- Track Gauge
- Longitudinal and lateral movement of the rail
- Vertical and lateral wear of the rail
- Superelevation of the track

## MACHINES AND HANDTOOLS

Machines and tools used during the installation were:

- Unscrewing machine for unscrewing nuts
- Installer handtool (1 pc)
- Extractor handtool (1 pc)
- Hammer and miscellaneous handtools

## CONCLUSION

All participants present at the installation were very interested in seeing this new product installed on the Serbia railway network. There were a lot of questions related to the installation and behaviour of the K-Lock system under

different exploitation conditions. We expect that results from the trial section will confirm the reliability and good quality of Pandrol assemblies,

and are looking forward to meeting with Pandrol with a presentation of the PANDROL FASTCLIP system. ■



▲ Detail of K-Lock installation tool.

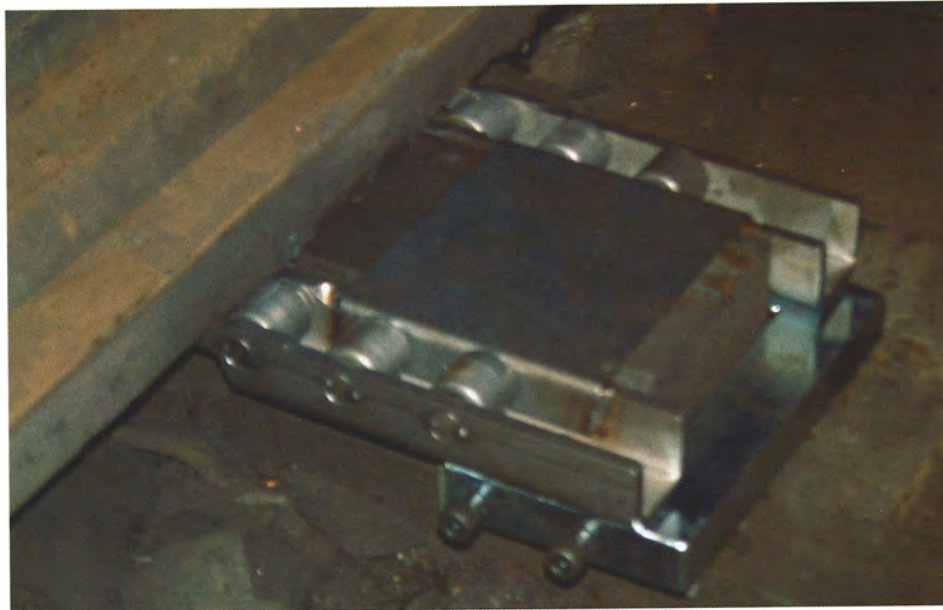


▲ Completed track.



# Rotorrail for Stockholm Metro

The Stockholm Metro uses two types of slideplate; an older design, with a raised block, that is welded to a rolled steel baseplate and a newer shallow depth slideplate with a central stock rail retaining clip under the slide surface. To complicate matters, with the old design there are two widths of block of variable tolerance. Rotorrail usually uses the fastenings that hold the slideplate to the bearer as the method of attachment but this was not possible at first for the older design as it was desired to keep the original fastenings to retain the slideplate. Several designs were prototyped, as shown in the image at the top, much ingenuity was employed but the designs compromised one of Rotorrails prime benefits of ease and speed of fitting. The final solution was to replace the fastenings with screwspikes and resort to the tried and tested standard method.

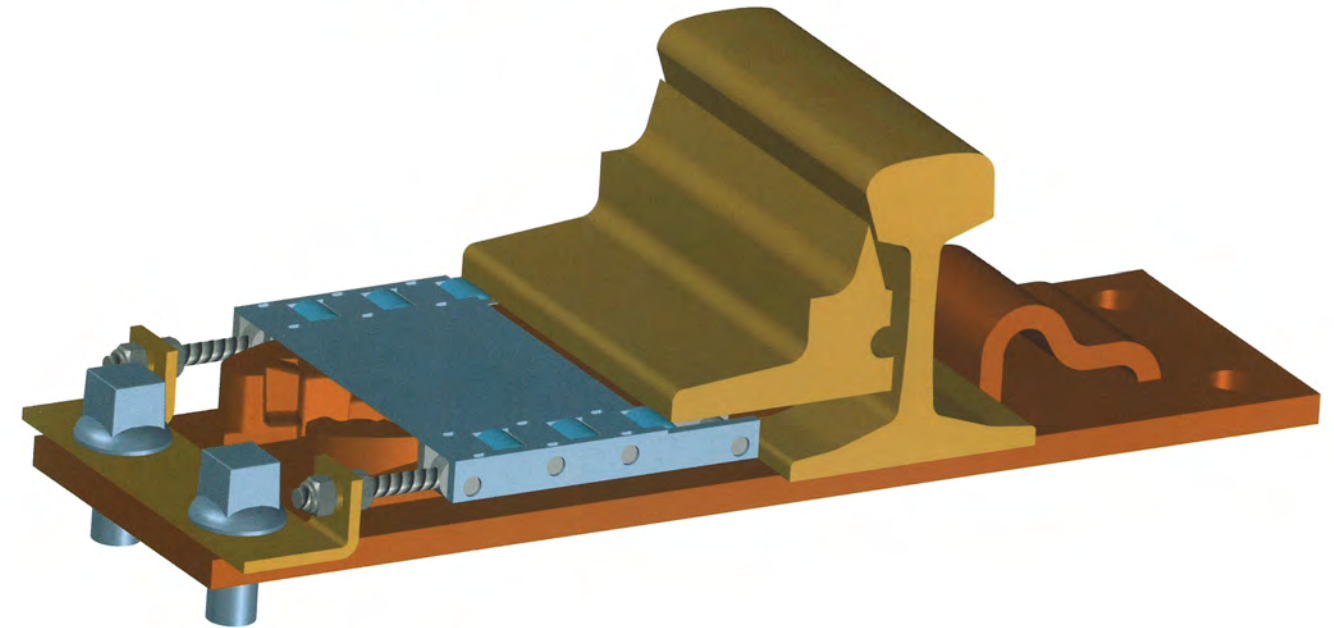
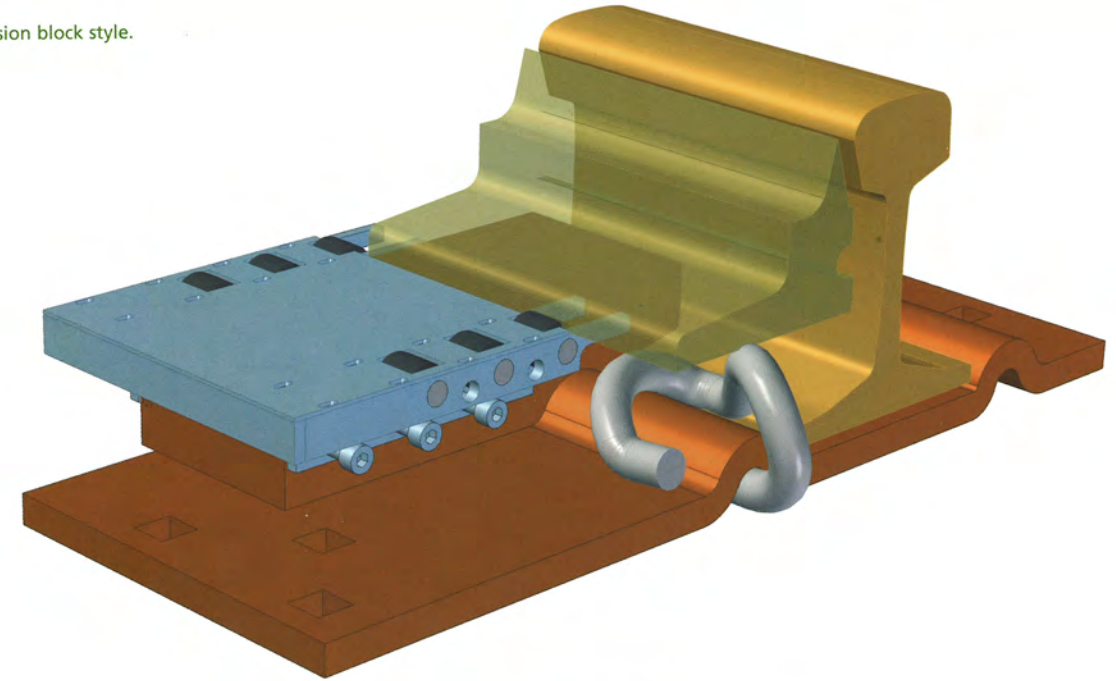


▲ Prototype block version.



▲ Shallow depth prototype.

▼ Production version block style.



▲ Production version: shallow depth version.

For the shallow depth design, the design challenge was to be sure the functions of the central clip were not affected, yet still provide location and the setting adjustment. Here the screwspikes are used as shown in the lower image.

On the original prototypes a U channel was used either side of the slide block. This channel supported three rollers each side and enabled a secure fixing method. However this exposed the channels to the risk of filling with ice and snow. Additionally expensive tooling was required to form the heavy gauge channels. The final designs overcame this problem by using a welded

construction of flat plates and a covering "guard" plate. The Rotorrail units in the trial were fitted on bearers 2 and 5 on one side and on bearers 2 and 6 on the other to show the flexibility possible on positioning at the back of the switch. No others are required on the switch as the switchblade is lifted by the rollers to clear the other slideplates. The unique design of Rotorrail and the ingenuity that Vortok bring to the implementation means that nearly all switches can be upgraded to a maintenance free and environmentally sound solution.

Two sets of the shallow depth Rotorrail design were installed in Stockholm in July 2003

and have performed flawlessly. The final iteration of the older block design will be fitted shortly and as this has reverted to the standard method of fastening no problems are envisaged. Once these units have proven their worth a fitment programme will be undertaken to install Rotorrail on the other switches in the network. This will be the end to greasing and all the manual and environmental problems that it brings. ■



# e-PLUS in the UK

The Pandrol e-PLUS system was originally conceived as a retrofit system for older 'e' clip sleepers installed in locations with very high lateral forces. These were locations where 'e' clip insulator life was being limited by high axle loads, sharp curves, heavy traffic, or more usually a combination of all three.

In the past Heavy Duty Insulators had been used with 'e' clip systems to extend insulator life as far as possible. However, these were expensive and in the very worst heavy haul curves they had a lifespan that was measured in months rather than years.

The FASTCLIP development programme of the early 1990's had already demonstrated that major improvements in insulator life could be achieved by the use of a two part insulator.

The e-PLUS development programme was

carried out in the mid 1990's and showed that major improvements in the durability of 'e' clip insulators could also be achieved by having a separate Toe and Sidepost Insulator.

## EARLY INSTALLATIONS

e-PLUS was originally installed where existing 'e' clip plastic components were giving an unacceptably short life due to the arduous operating conditions.

One location was on the Narita Airport Express Railway Link in Tokyo. This site was at a 300m curve subjected to very high annual tonnages owing to the intensive service pattern and high lateral forces as long wheelbase rolling stock are used.

Another site was on a 290m radius curve owned by the American heavy haul freight



▲ Exploded view of the e-PLUS system showing the separated Toe and Sidepost Insulator.



▲ A Heavy Duty HD8 Insulator for 30T axles (black) shown against a Standard 4452 Insulator for 25T axles (blue).

company CSX which carries 32T axle loads.

In both cases component life has been extended significantly by the use of e-PLUS components.

## NEW TRACK INSTALLATIONS

Although originally conceived as a retrofit application, in recent years e-PLUS has been used in new track installation.

One application has been in the UK on new RT60 Switch and Crossing layouts. The new layouts are designed for 30T axle loads so for maximum component durability the e-PLUS system was selected.

Another application has been for the new EG49/EG50 sleepers for areas of the UK electrified with the British Third Rail System.

## THE NEW EG49/EG50 SLEEPERS

When the railway network was first developed in the UK each line was built, owned and operated by individual private companies.

For example the lines between London and Brighton were operated by the London, Brighton and South Coast Railway Company in the early part of the 20th century.

In 1922 all the private operators were grouped into four large companies. In the area of Southern England, the 'Southern Railway' was formed.

The new Southern Railway decided to discontinue with overhead electrification in favour of the cheaper 3rd rail system.

By the 1930's most of the UK network south of the River Thames was electrified by the 3rd rail system and the system remains in operation to this day.

The 3rd rail delivers 750v D.C. to the traction stock with return current being passed through the running rails.

The 3rd rail is very close to the running rail and so it is important that the fastening system and its tools will operate with the 3rd rail in place.

This important requirement has led to the adoption of the e-PLUS system on the third rail network south of the Thames. The enhanced durability of the e-PLUS components will reduce the need for component maintenance even under the 30 tonne axle loads planned for parts of the network.

The new system has been used for the first time on the Shortlands Junction Project in London. Here an old at grade junction has been replaced by a new grade separated junction to improve the path of Eurostar trains to and from Waterloo Station.

The junction has been built with a number of the new RT60 Switch and Crossing layouts. ■



▲ e-PLUS system at Shortlands Junction.



▲ e-PLUS Crossover at Shortlands Junction.

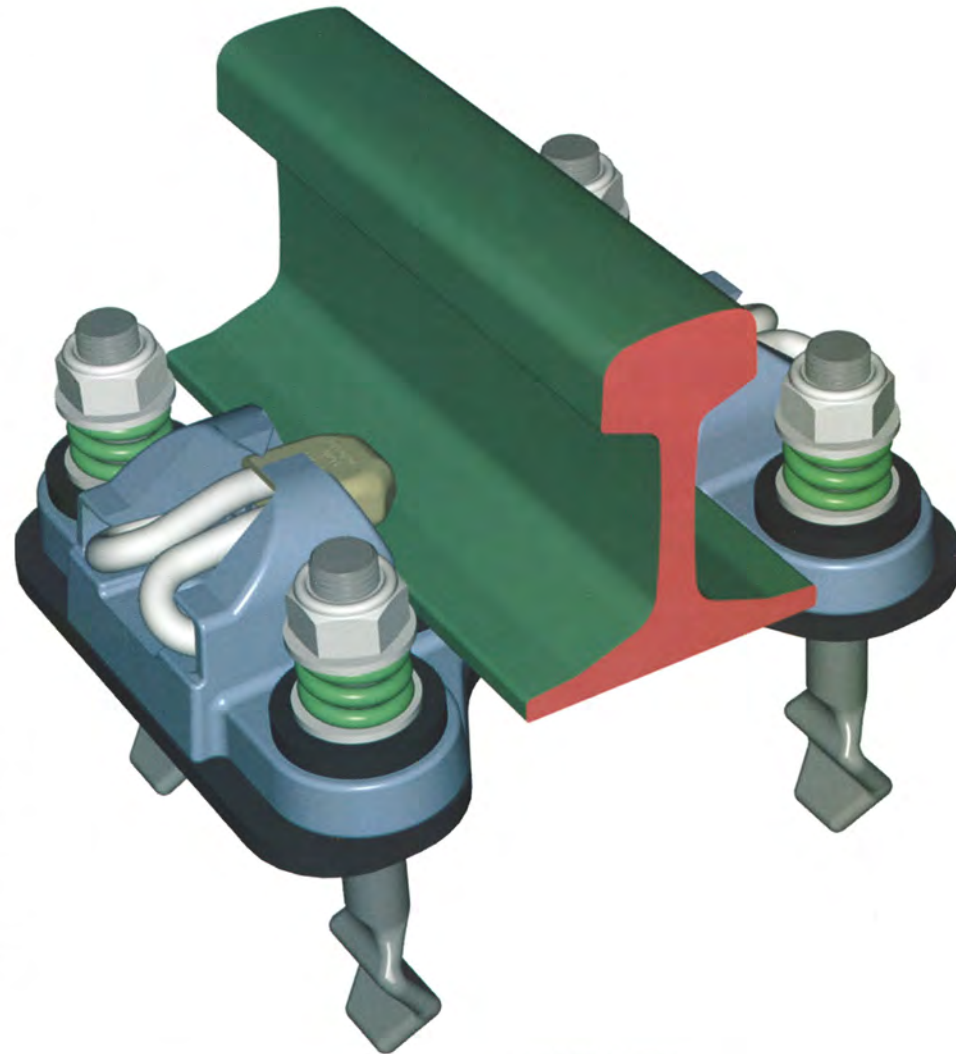


# VIPA-BD Development

Concerns over vibration from trains are becoming an increasingly important issue. These are now given significant emphasis in the construction of many new railways as well as in controlling vibrations on existing track. Vibrations of the rail can be attenuated through the fastening system. Fastenings with lower stiffness generally perform better in controlling vibration than those with higher stiffness. Different solutions are required, depending on the particular circumstances of the project. Important factors affecting the correct choice of fastening include the degree of vibration control required, the method that will be employed to construct or reconfigure the track, the degree of subsequent adjustment required, and, of course, the costs of components and of construction.

Over the past few years Pandrol has developed a range of products that offer solutions to track vibration problems across a broad range. For example, the Pandrol VANGUARD baseplate is a unique design that offers a very high level of performance. The Pandrol VIPA-SP baseplate delivers a lower vibration attenuation level – but one that is nevertheless sufficient in many circumstances. Other attractions of the VIPA-SP baseplate are that it features Pandrol FASTCLIP and is a fully captive system - with all of the fastening components pre-attached to the baseplate - that can be easily delivered to site and installed either in new track or as a retrofit. Where control of vibration is an issue of lesser importance, the Pandrol SFC baseplate fitted with a resilient rail seat pad will provide sufficient attenuation. This too is a fully captive baseplate solution, and can be installed in track using the same techniques as VIPA-SP.

Pandrol has recently developed another new product to expand and compliment the existing range. This is the Pandrol VIPA-BD baseplate assembly. It will provide a similar level of vibration performance to VIPA-SP, but with a lower installed cost and a lower assembly build height. It is expected to prove attractive to customers



▲ VIPA-BD Assembly.

whose circumstances are such that the overriding factor in their common aim of a finished track construction is lowest overall cost.

The assembly comprises a baseplate, stiff rail pad, soft baseplate pad, and through bolts that anchor it to the track base. The main resilience in the assembly is provided by the baseplate pad, and electrical insulation is provided at the interface between the baseplate and the bolts. Springs under each of the nuts ensure that the baseplate pad remains compressed at all times as loads traverse the track. The assembly is designed

such that it can be used with four anchor bolts where these are required on curved track, but with only two bolts on tangent track. The FC1509 clips and shoulders contribute to a small overall plan view size as the FC1509 is narrower than the FC1501 design. The assembly will produce a nominal rail clamping force of 23 kN, and the target stiffness is between 18 and 20 kN/mm. ■

Pendolino Tilting Train running on PANDROL FASTCLIP track, Network Rail, U.K.

