

Track Report

The Journal of Pandrol Rail Fastenings 2008

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Front Cover: A French high-speed TGV train smashes the world record for a train on conventional rails, reaching 574.8km/h (356mph).

The record attempt, using a modified TGV trainset took place on the newly completed TGV Est, between Paris and Strasbourg, which is equipped throughout its route length, in excess of 300km, with PANDROL FASTCLIP fastenings. Photo courtesy of Alstom.

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Ground Vibration Control Using the PANDROL VANGUARD Fastening System on Beijing Subway Line 5

by Jingjian SUN Permanent Way Manager, Beijing Mass Transit Railway Construction Administration Ltd, Beijing, P.R. of China

The Chinese capital city of Beijing is the second largest in China, and has more than 17 million inhabitants. The Beijing Subway currently has 8 lines in operation, with 200km of tracks and 124 stations (including 17 interchange stations), and daily ridership of 3.82 million. The existing network consists of Line 1 (31km of tracks and 23 stations), Line 2 (23.6km of tracks and 18 stations), Batong Line (18.9km of tracks and 13 stations), Line 13 (40.9km of tracks and 16 stations), Line 5 (27.6km of tracks and 23 stations), Line 10 (25km of tracks and 22 stations) and Airport Line L1 (27.3km of tracks and 4 stations).

The existing network cannot adequately serve the city's mass transit needs and is undergoing rapid expansion beyond the 2008 Olympic Games. Existing plans call for 19 lines and 561km of tracks in operation by 201. Long-term plans envisage Beijing with 1,032km of subway by the year 2050, an impressive figure.

When building subway systems in the city, environmental protection is becoming a more and more important issue for residential, commercial, educational and hospital developments. It is often necessary to attenuate noise and vibration levels to a minimum in order to satisfy environmental

requirements. Beijing Subway Line 5 crosses the downtown district from south to the north as shown in Figure 1. Although some new track forms, for example Cologne Egg and steel spring floating slab track have been designed and used, the surface ground vibration level with the existing track form and rail fastening baseplates exceeded the limits set by environmental protection authorities. One of the 2008 Olympic Games projects in Beijing to improve environmental conditions, is to retrofit about 8km of track to reduce the ground vibration level by more than 12dB^[1]. However, with any conventional retrofitted method on the existing tunnel and track form, it would be

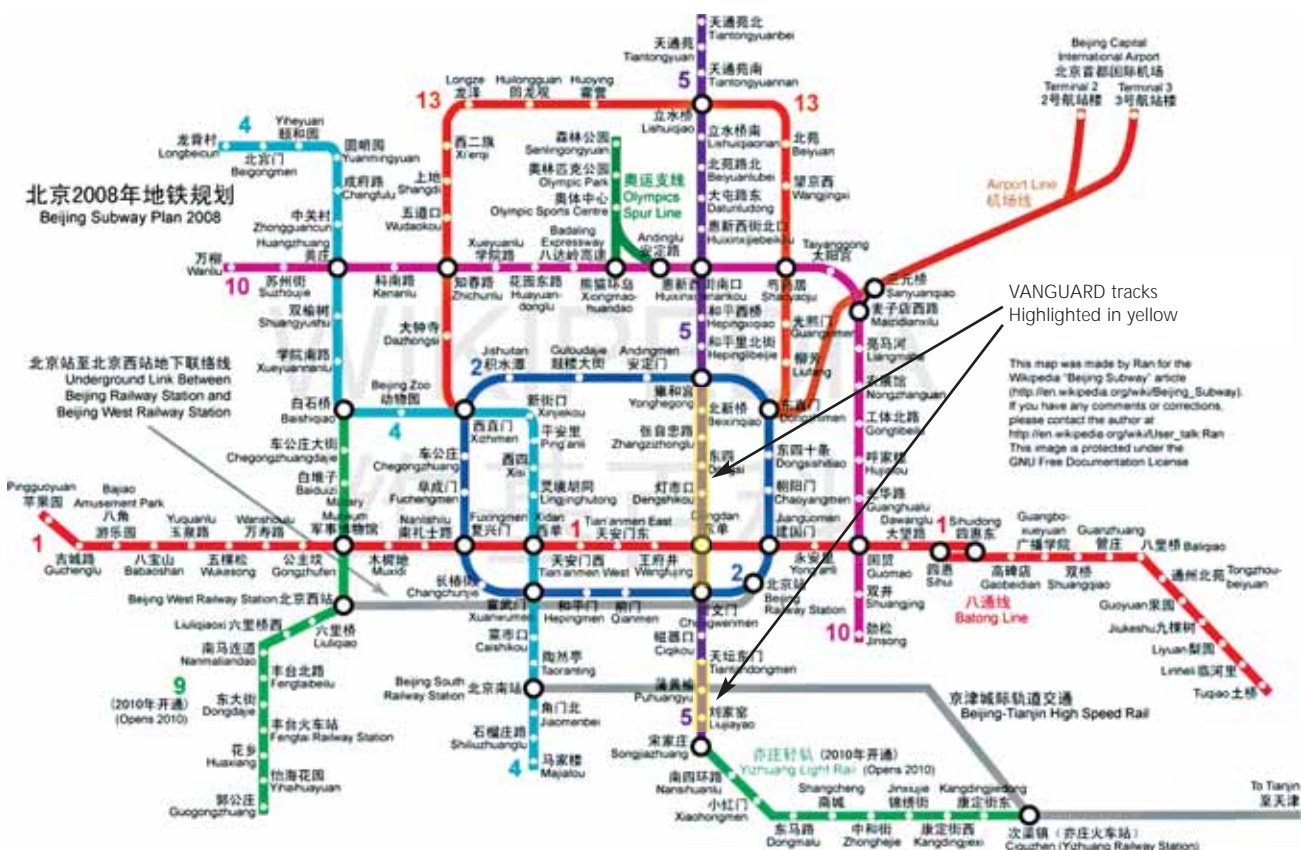


Figure 1 Beijing Subway Map

almost impossible to meet both the technical and cost targets. A high level of vibration isolation track fastening systems has to be used. The PANDROL VANGUARD system, being considered as an alternative to floating slab track, has been selected for these requirements on Line 5. As well as ground borne vibration, airborne noise in trains running in the tunnel also needs to be considered.

BEIJING SUBWAY LINE 5

Line 5 runs north-south, beginning with three stops in the far northern suburb of Tiantongyuan in Changping District, well beyond the 5th Ring Road, then crossing Line 13 at Lishuiqiao, and entering into the vast residential swaths of Chaoyang District on either side of the Yuan dynasty city wall. It skirts east of the Temple of Earth and meets Line 2 Loop at the Yonghegong, also known as the Lama Temple. Then Line 5 cuts through the old neighbourhoods of Dongcheng District and the old foreign Legation Quarter between Dongdan and Chongwenmen. Further south, Line 5 stops at the eastern entrance to the Temple of Heaven in Chongwen District and eventually reaches Songjiazhuang in Fengtai District south of the city. It takes 49 minutes to cover all the 23 stations. The Zhang Zizhong Street station, named after a general martyred in World War Two, is the only eponymous station on the Beijing Subway. The total length of the line is 27.6km of which 16.9km is underground and 10.7km on the surface and viaduct.

PANDROL VANGUARD RAIL FASTENING SYSTEM AND ITS INSTALLATIONS

PANDROL VANGUARD is a rail fastening system in which the rail is supported by elastic wedges under its head. The wedges are in turn held in place by cast iron brackets, which are fastened to a baseplate. The baseplate is rigidly fixed down to the track foundation via the existing anchor inserts as shown in Figure 2. The principal advantage of the system over more conventional rail fastenings is that it allows significantly greater vertical deflections under traffic without an unacceptable accompanying degree of rail roll and without increasing the overall rail height. A special clamping tool is used to assemble/disassemble the PANDROL VANGUARD system.



Figure 2(a) Delivery of VANGUARD components and removal of existing baseplate on Beijing Subway Line 5

A special asymmetrical PANDROL VANGUARD baseplate was designed for Beijing Subway Line 5 which allows the existing anchor system to be used. The new baseplate is just swapped from the existing type DTVI baseplate. The PANDROL VANGUARD baseplate has the same rail height level, super elevation and inclination so that no modification is required to the existing track. The track gauge and rail vertical level also have the same adjustment ability.

The static stiffness measured between 15kN and 30kN of the PANDROL VANGUARD baseplate designed for Beijing Subway is 4.7MN/m, and the dynamic stiffness under loading at 10Hz is 6.6MN/m^[2]. This very low stiffness system reduces vibration transmission to the supporting structure and hence into the ground.

Installation of the new PANDROL VANGUARD baseplates was made at night during engineering hours, with the track left at every stage in a safe condition to run trains. In order to speed up the installation, the team divided into two groups, with 4 clamping tools working on the both rails for each section at the same time. A stiffness transition design between the existing baseplate and PANDROL VANGUARD using special rail pads was also provided by PANDROL. The installation of the 26,000 PANDROL VANGUARD baseplates over 8km of track length for the project took about 4 months and finished in May 2008. Figure 2



shows the installation procedure including delivery of new baseplates, removal of the existing baseplates, installation, and clamping of PANDROL VANGUARD assemblies, inspection and finished track.

TRACK DYNAMIC DEFLECTION PERFORMANCE

In order to check track safety issues of rail dynamic deflection, a worst-case test location was selected on curved track with a 400m radius in the southbound tunnel at kilometre post of K0+890 between Liujayao and Songjiazhuang stations. A vibration performance test was also carried out at the same site. The existing track consists of a 60kg rail, type II clip, type DTV12 baseplate with a 12mm thick rail seat pad and a 16mm thick baseplate pad. The baseplates are anchored directly onto the track slab by means of 2 offset bolts. The tunnel has a round section with a single track. The traffic is 6-car trains and the

maximum traffic frequency is 12 trains per hour during peak hour operation. The track speed was about 60km/h. All recordings were made under normal service passenger traffic with an axle load of approximately 14 tonnes at peak operating hours.

Measurements with the existing baseplates were made in December 2007. The PANDROL VANGUARD baseplates were installed in January 2008 and then further track measurements were made in February 2008. Vertical deflection of the rail relative to the slab increased from about 0.31mm with the existing rail fastening to 3.11mm with the PANDROL VANGUARD system under the 14 tonnes axle load on Line 5 traffic. The maximum rail head lateral movement increased from 0.50mm to 0.69mm, both occur on the low rail under the leading axle. This combination of low vertical stiffness and rail roll restraint with the PANDROL VANGUARD fastening system offers the potential for significant reductions in vibration transmission with a mechanically acceptable system. The railhead lateral deflections indicated that the maximum dynamic track gauge widening for the existing fastening system and PANDROL VANGUARD is less than 1.0mm and less than 1.4mm

respectively. This meets the track maintenance specification issued by China Ministry of Railways in 1998, in which the dynamic track gauge change should be within the tolerance of $-6/+12$ mm for first class track under train speeds of less than 100km/h.

SURFACE VIBRATION PERFORMANCE OVER THE TUNNEL WITH VANGUARD

The frequency range of greatest interest for surface vibration is from 1Hz to 80Hz. The vibration assessment is based on the Chinese National Standards, GB10070-88^[3] and GB10071-88^[4], in which the vibration acceleration levels are weighted using the windows defined in ISO2631-1^[5]. Vibration in the vertical direction is represented in dBz.

The vibration level was measured in a residential property (145 Baimiaocun, Fengtai District, Beijing) on the surface above the northbound tunnel on the same curved track site as for the track test – kilometre post of KO+890m. The approximate position of the two tunnels is shown in Figure 3. Accelerometers were approximately 5.2m away from the centreline of the northbound tunnel.

Acceleration levels from trains on both the northbound and southbound tracks were recorded, and were identified and separated. Vibration measurements vary considerably from one train pass to the next, due to the effects of speed and rail-wheel condition. Trains were selected from the recordings that appeared to give a clean signal. All vibration measurements presented here have been averaged across results from these selected train passes. Similar results were obtained for all of the selected trains within each set of data.

The average background surface vibration level was about 52dBz in the vertical direction. The average vertical surface vibration level was 76.3dBz and 73.4dBz with BJM baseplates, and 64.2dBz and 58.1dBz with PANDROL VANGUARD baseplates in the northbound and southbound tunnels respectively. These indicate that the surface vibration insertion loss was 12.1dB and 15.2dB under traffic in the northbound and southbound tunnels respectively as the result of the installation of PANDROL VANGUARD system. The average insertion loss was about 13.7dB over the curved track. Vertical acceleration spectra at the surface with the existing fastening and the PANDROL VANGUARD system installed are



Figure 2(b) VANGUARD clamping



Figure 2(c) Finished VANGUARD installed on Beijing Subway Line 5

shown in Figure 4. The insertion loss spectra between the PANDROL VANGUARD and the existing systems are also shown.

Based on the Chinese National Standard GB10070-88^[3], for the residential area, the vibration level should be less than 70dBz in the day time and 67dBz at night, as shown in Table 1. The results of the surface vibration performance testing show that the track with PANDROL VANGUARD meets the requirements on surface vibration of 67dBz in the residential area, and even that of 65dBz for special residential areas. ■

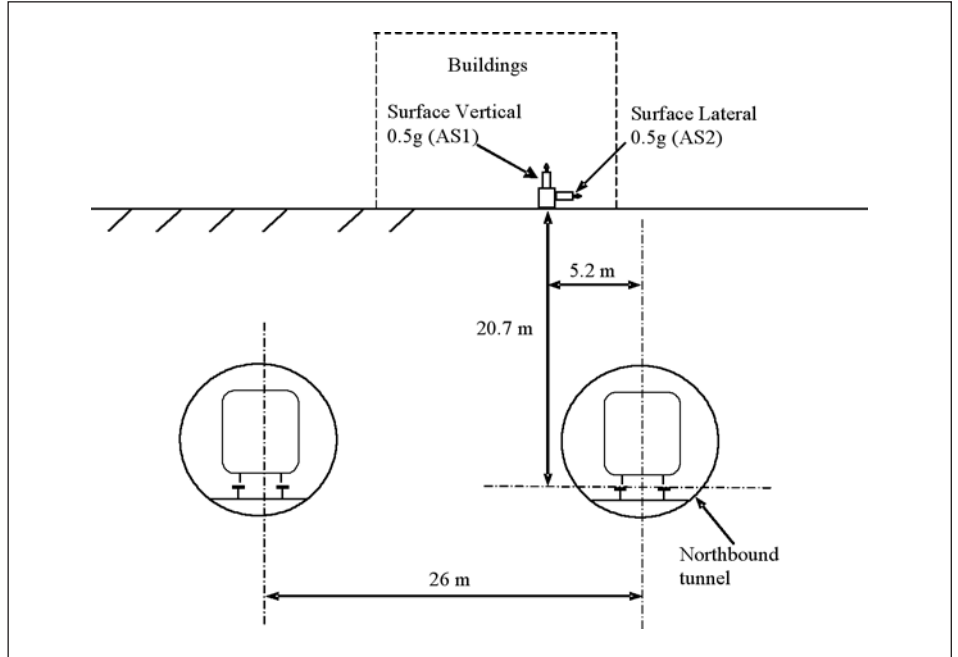


Figure 3 Cross-section through tunnels at the surface measurement positions

Place	Day	Night
Special residential	65	65
Residential. School/University	70	67
Mix, Commercial Centre	75	72
Industry	75	72
Wayside of road traffic	75	72
Wayside of railway traffic (>30m)	80	80

Table 1: BG10070-88 - Standard for vibration in urban area environment dBz

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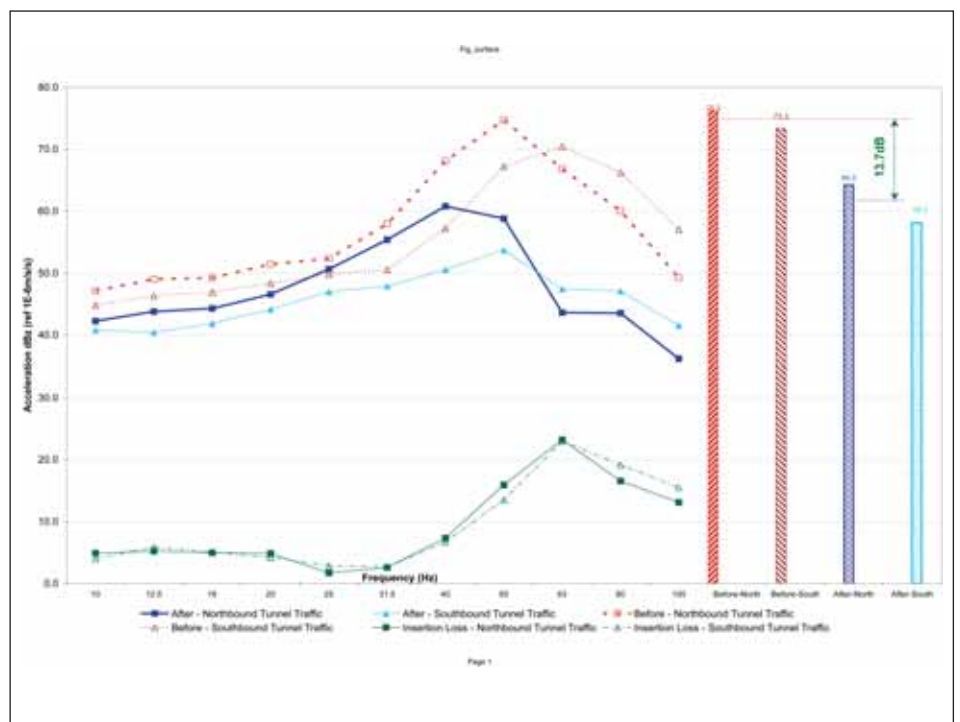


Figure 4 Surface acceleration/insertion loss spectra over a curve track

Perth to Mandurah Railway

This article has been prepared by Pandrol from information disseminated by the Public Transport Authority of Western Australia through professional papers and public presentations. Pandrol would like to acknowledge the PTA and thank Mr Peter Martinovich, who was Deputy Project Director of the New MetroRail Project and Mr James (Lock) Henderson who was New MetroRail's manager through the development and construction of the underground track works and approaches through the City of Perth.

PROJECT OVERVIEW

The Perth to Mandurah railway is a major extension to the Perth urban network, and is part of the recently completed New MetroRail Project.

The New MetroRail Project is part of a major revival in urban rail in Perth over the last

twenty years. Key to its success was the clear understanding that in a city with low density urban settlement, where the majority of potential commuters lived well beyond walking distance of a station, major modal interchange stations are required to accommodate arrivals by car and bus and to concentrate people so that trains are filled. These stations must also be a sufficient distance apart (ie: 3km) to ensure journey times on rail that are competitive with commuting by private car.

Mandurah is one of the fastest growing townships in Australia, currently with a population of around 65,000 which is forecast to double by 2021.

The A\$1.66 billion New MetroRail project – the largest public transport

infrastructure project ever undertaken in Western Australia – has effectively doubled Perth's metropolitan rail network.

The Perth Mandurah line comprises 72 route kilometres of double-track railway, 11 stations, 774m of twin bored tunnels under the Perth CBD, 18 bridges and structures, significant road and civil works, a 25kV overhead wiring system, and two electrical substations.

The project has successfully met complex engineering challenges including the design and construction of underground tunnels in soft ground under Perth's CBD. This has opened up opportunities to revitalise the main city area.

The two underground City Stations



New MetroRail project



Tracklaying in the median of the Kwinana Freeway (Photo courtesy of PTA)

provides people with better access to the Central Business District, the Swan River foreshore and a doorstep service to the Perth Convention and Exhibition Centre. It also integrates well with the two major busports in Perth.

Train speeds are up to 130 km/h giving a journey time of 48 minutes (all stops) between Perth and Mandurah.

THE ROUTE

The lack of alternative, continuous Rights of Way to link Perth directly with the south west corridor dictated that transport planners adopt the median of the Kwinana Freeway for the railway. This has disadvantages but also several major advantages including the fact that the freeway is linked by major lateral transport arteries to the catchment which can extend up to six kilometres either side of the line. Buses and free parking alongside urban stations are part of this. Land uptake and the environmental impact are lessened. Freeway alignment will usually suit rail due to the gentle curves and gradients. Additionally there is the safety aspect of freeways being fully grade separated, so by placing rail in the median strip, the risk of injury and vandalism is reduced. Additionally, placing rail on or within a freeway provides a highly visible alternative form of transport to the car.

For just over one third of its route, the Perth to Mandurah railway follows the Kwinana Freeway, which is the major part of Perth's north-south traffic link. Once the rail route leaves the freeway alignment it goes south-west towards the emerging major regional centre of Rockingham (the approximate halfway point), before returning to a southerly route direct to the City of Mandurah, some 27 kilometres south of Rockingham.

For much of its northern half, the route is bounded by private housing estates. This presented a particular challenge for reducing the environmental impact of the new railway.

About 4 kilometres south of Rockingham, there is a major transit station at Warnbro, and there are no other stations along the 23 kilometres of route to Mandurah as development has not yet reached the stage to warrant additional stations. However, there is provision for additional stations in the future.

TRACKWORK

Trackwork was split into two contract packages.

The first major contract package covered about 69 Kilometres of the route from the Narrows Bridge (which crosses the Swan River just to the south of Perth city centre) all the way to Mandurah.

This contract was handled by RailLink JV, a consortium, of John Holland, McMahon and



Automated tracklaying

Multiplex Constructions.

The majority of this alignment is at grade, predominantly on ballasted track, although there are a few areas of specialist slab track. More of this later. The basic track structure stipulated was 50 kg/m rail on concrete sleepers and stone ballast.

The second part of the trackwork was incorporated within the City Project. This comprised a route of about 2km beneath the city. It was a mixture of twin bored tunnel (774metres) and open dive/cut and cover tunnel (594 metres), with the remainder being at grade. This was basically 60 kg/m slab track.

This contract was handled by Leighton Kumagai JV (LKJV).

As the city tunnels run beneath and beside sensitive buildings much effort was focused on minimizing the impact of noise and vibration both during construction and later, during operations of the railway.

TRACK STRUCTURE

- Rail AS50 (at grade and on bridges), AS60 in tunnels
- Max speed 130km/h (45km/h in tunnels)
- Axle load 16 tonne maximum
- Minimum curve radius 138 metre (in tunnel)
- Max gradient 3.3%
- Gauge 1067mm
- Rail inclination 1:20
- Max applied superelevation 80mm in tunnels, 100mm on open track
- Traffic density 6 MGT/annum in each direction

SELECTION OF TRACK FASTENER (BALLASTED TRACK)

Approximately 69km of the total route length was built at grade, mostly in open space with conventional, concrete sleepered, ballasted track. Restricted access in the centre of the freeway median strip demanded track of high integrity and low maintenance. It also meant that a linear method of automatic and continuous track-laying would be the most economical solution. For the first time in Western Australia, PANDROL Fastclip was chosen as the preferred fastener for the concrete sleeper track.

The cost benefits for installation and savings for downstream operations and maintenance were the chief reasons for

selecting Fastclip.

Predominantly Fastclip was used with a non-resilient HDPE rail seat pad, however in some locations a studded rubber pad was used in preference.

SELECTION OF TRACK FASTENER (SLAB TRACK OUTSIDE CITY TUNNELS)

There were a number of locations outside of the CBD where slab track was laid. These included at two river crossings, one near the city across the Swan River at The Narrows, and the other some eight kilometres south at Mt Henry across the Canning River. The crossing at Mt Henry was on an existing concrete box section road bridge as was the Up Main at The Narrows. The Narrows Down Main was laid on a new steel bridge with concrete slab.

On the bridge crossings the rail was laid on a finished concrete slab and this required some packing adjustment

Additionally, there was a highway underpass near Rockingham which utilised slab track.

There was a need for a medium level of track resilience on slab, in particular on bridges where re-radiated structural noise could potentially be an issue.

In view of the need to provide a higher degree of vibration protection on bridges than on ballasted track, the decision was taken to use the Pandrol VIPA-SP baseplate. This is a two hole baseplate with

a double layer of resilient studded rubber pads to provide low vertical support stiffness.

The VIPA-SP baseplate utilises Fastclip fasteners thus ensuring continuation of the same type of fastener throughout the majority of the route.

SELECTION OF FASTENER (CITY TUNNELS)

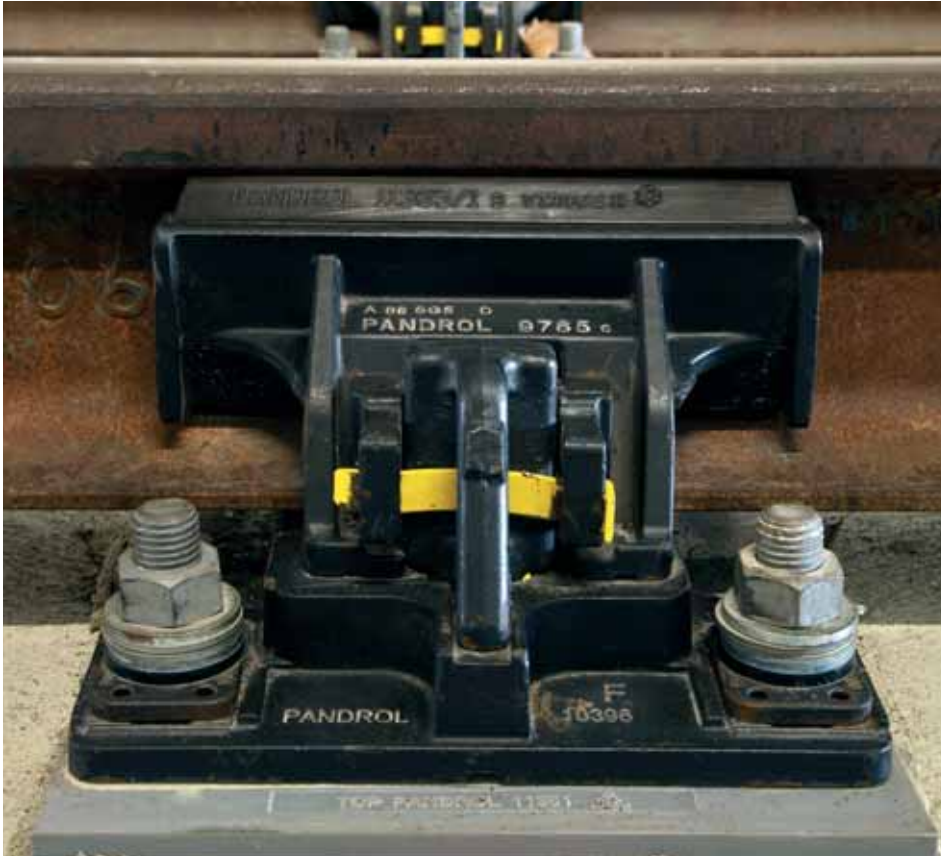
The tunnels under the city were the first ever bored railway tunnels in Western Australia. The tunnels were bored through soft soils, predominantly sand, and pass beneath and close to some very sensitive recipients in Perth's city centre. As this was a first in many ways, control of all aspects of construction was a priority. To limit operational impacts a great deal of care was taken during the design of the track and fastener. At stake was the impact of secondary noise as a result of ground borne



PANDROL VIPA Baseplates



Bored tunnel under the Perth CBD



Vanguard baseplate



Finished track



Finished track – Perth-Mandurah route

vibration transmission from the track.

The contractors, LKJV, employed GHD as Design consultants and Wilkinson Murray Pty Ltd. (WMPL) as specialist acoustic consultants.

WMPL originally identified that a significant proportion of the 2km route would require isolation by means of a high performance Floating Slab track (FST).

FST was not favoured by the contractor due to the high build cost. Additionally, FST was seen by the client as something of a maintenance liability.

Therefore, after much discussion, the contractors LKJV proposed a Performance Trial on existing track to ascertain the vibration performance of three different types of baseplate fasteners.

ROE STREET TRIAL SEPTEMBER 2005

Roe Street is a tunnel dive on slab track just to the west of Perth main railway station. It was chosen as the location to trial three different types of direct fixation fastener. The existing fastener is a medium stiffness bonded baseplate. On trial were two other types, a high performance bonded Egg baseplate and the Pandrol Vanguard system.

Track slab vibration readings were taken on

each of the three types of fastener by WMPL over the course of 3 weeks.

The WMPL report showed that the Pandrol Vanguard baseplate gave a superior level of vibration isolation to both of the other systems. In fact, when the Vanguard performance was analysed in detail it was adjudged that Vanguard could replace FST throughout the City Tunnel.

This would give several advantages

- 1) A single type of track fastener would be used throughout the city tunnel
- 2) The use of a single type of fastener would reduce the build time and improve productivity.
- 3) Build and maintenance costs would be reduced due to the use of a direct fixation baseplate as opposed to FST.

CONSTRUCTING CITY TUNNEL TRACK

Approximately 10,000 Vanguard baseplates were supplied to LKJV in 2006 when track construction began.

LKJV took a slightly different approach to build slab track, employing the 'top down' method. This is where the rail is set to line and level initially

and the supporting slab built up around it.

In this case a slab was poured first and then 4 holes were core-drilled into it that would accommodate the steel anchor studs.

Once these were in place the Vanguard baseplate is positioned using temporary support frames and final slab level achieved by pouring a high strength epoxy grout beneath the plate.

At least 60 metres per day of track was built in this way.

CONCLUSION

Construction of the Perth to Mandurah railway commenced in 2003 and the railway was opened on Sunday, 23 December 2007. The project effectively doubled Perth's commuter rail system.

Patronage surveys show that just over 12 weeks after commissioning, the railway was carrying almost 90% of the projected 50,000 trips per day. The railway is carrying the equivalent of almost four freeway lanes of traffic through South Perth to the city in the morning peak rush hour, compared to the available freeway capacity of three northbound lanes for road traffic. ■

Korean High-Speed Rail Project Phase 2 (Daegu-Busan)

The Korea High-Speed Rail (KTX) Project has been described in three previous articles in Track Report (1996, 1999 and 2002).

These articles explain the development and selection of concept and methodologies for design and installation of track components, as well as implementation of these selections in the test track, (which has been in operation since late 1999), and the experiences gained during commissioning and almost 3 years of its operation.

The current issue will cover Phase 2 of the KTX project under construction for target completion in 2010.

Phase 1 of the KTX project commenced on June 1st 1992, and major progress had been made by June 14th 1994 in adopting the TGV trains of the French Company GEC Alstom, and full-scale constructions began. It took 12 years to complete procedures required for the project such as civil works, track laying, train development and test runs. On April 1st 2004, KTX phase 1 commenced its commercial operation and has been successfully operated so far.

The KTX project was originally planned for completion in one Phase, but the economic crisis in 1997/98 forced the establishment of a phased implementation, with Phase 1 to open in 2004 and Phase 2 in 2010.

Phase 1 would mean operation of KTX trains between Seoul to Busan, but high-speed infrastructure only for Seoul to Daegu (280Km). Phase 2 consists of full high speed standard infrastructure on the remaining section between Daegu to Busan (130Km).

KTX trains consisting of 20 cars, 388m long and weighing 771.2 tons with passengers have run at the maximum operating speed of 300km/h since April 2004. Travel time from Seoul to Busan at Phase 1 is 2 hours 40 minutes. It is expected to be decreased to 2hours and 10 minutes after completion of Phase 2.



KTX project map

Classification	Application Standard	Remarks
Maximum Design Speed	350 km/hr	Maximum Operation Speed: 300km/hr
Minimum Radius	7,000 m	
Maximum Gradient	25/1000	
Effective Length of Platform	600 m	
Track Gauge	1,435 mm	
Distance between adjacent tracks	5.0 m	
Rail	UIC 60 CWR	
Electricity	AC 25KV	
Turnout	Movable-Nose Crossing	

The outline of KTX Phase 2 is as below;

* Section

Daegu City Susung-gu ~
Busan City Dongrae-gu
(130km = 281km100 ~ 409 km 860)

Section 4: Daegu ~ Ulsan

Section 5: Ulsan ~ Busan

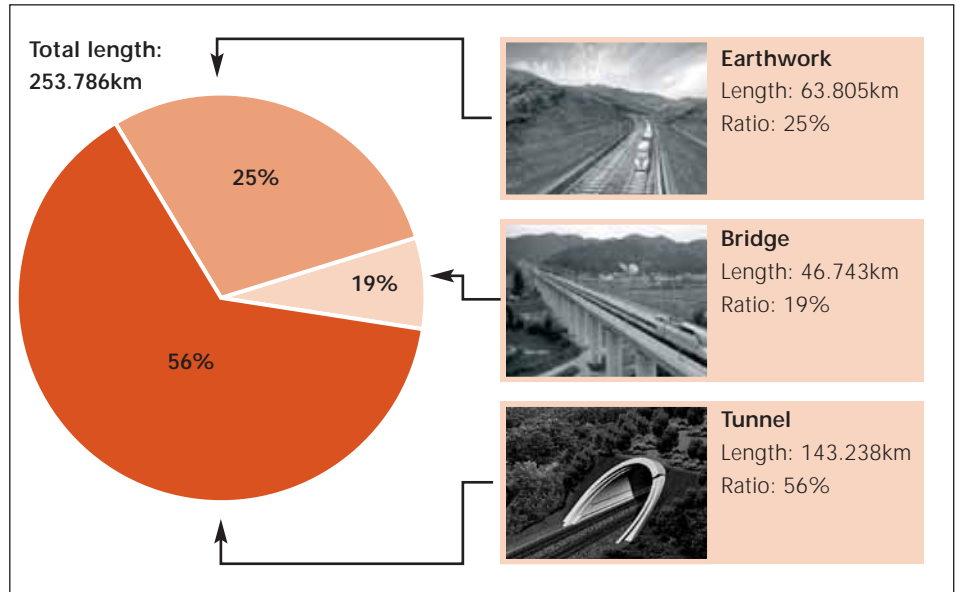
* Length of Track: 256.366 km

- Main and Sub-main Line:

253.786 km (Slab Track)

- Siding Line: 2.580 km (Ballast Track)

KTX Phase 2 was originally planned to be built with ballast, the same as Phase 1. However, it was changed to concrete slab track construction after reviewing problems from Phase 1 regarding the interface between track and the road bed, and the RHEDA 2000 system was selected for Phase 2.



RHEDA 2000 is a more recent development of the design which:

- fully took into account RHEDA design principles by Prof. Dr. J. Eisenmann
- uses a reduced height bi-block sleeper with protruding lattice truss reinforcement along the entire length of sleeper and thus provides:
 - durability due to improved bonding effect between sleeper and structural concrete

- accurate track geometry
- a high level of flexibility enabling combination with other types of rail fastening and other device fixations
- a reduced construction height
- avoids formation of longitudinal cracks in the slab concrete due to troughless construction
- facilitates and improves construction performance thanks to lighter track grid and mechanisation of assembly procedures

- system technology is consistent throughout for all track types, such as earthwork constructions, bridges and tunnels as well as turnouts, expansion joints etc.

Benefits of the system RHEDA 2000

- Minimal maintenance requirements
- Maximum long term riding comfort
- Maximum availability during operation
- Optimization of alignment criteria (smaller



Electric insulation test at KTX Phase 2 test tracks



Measurement of track geometry

- radii at same speed) higher cant deficiency
- Significant reduction of alignment constraints (reduction of civil structures or turnouts and bridges)
- Flexibility for the organization of the construction sequence
- Lower weight and reduced construction height

With the RHEDA 2000 system already selected for the project, rail fastenings compatible with the system were now reviewed.

Two rail fastening systems, the SFC system of PANDROL and Sys300 from Vossloh, were

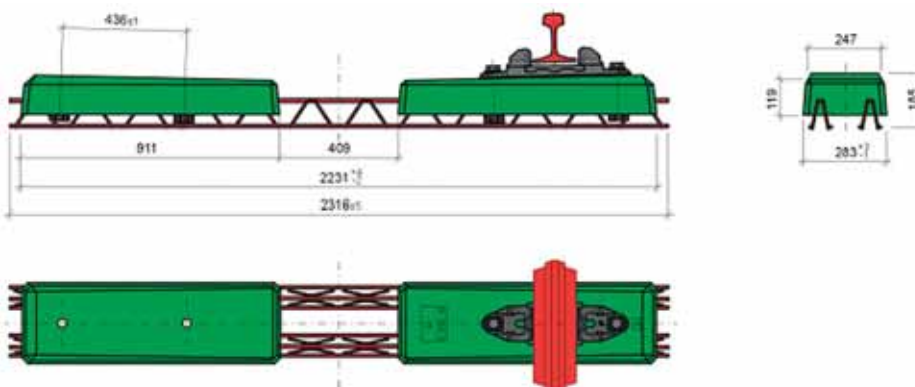
proposed for the rail fastening system of the Phase 2 project in Dec 2004. Analysis of the strengths and weaknesses of the two rail fastening systems were carefully made in order to select the rail fastenings for the project.

To verify the performance of the rail fastening systems, performance tests on both systems as per the performance specification of KHRCA (Korea High Speed Railway Construction Authority) were carried out during January to June 2005 at KIMM (KOREA INSTITUTE OF MACHINERY & MATERIALS). Both systems passed the tests.

Rail One (formerly PFLEIDERER), which

developed the RHEDA 2000 system, modified its system to be compatible with the Pandrol SFC system and issued appropriate drawings even before the result of the performance tests were known because they acknowledged the performance of the Pandrol SFC system.

For an objective review of the rail fastenings, SITAC (Special International Track Advisory Committee), an international advisory committee, was called by KR (Korea Rail Network Authority, formerly KHRCA) in July 2005. The committee concluded that both of the two fastening systems were suitable for use on Rheda 2000 track. The committee also



Pandrol SFC system on RHEDA 2000 System



Sleepers raised with spindles after iron rods assembled beneath

noted the economic benefit of the Pandrol SFC system. The SFC system was thus adopted as a standard system for the project, with the German system as back up.

Questions were raised about the use of the Pandrol SFC on the German concrete slab system, RHEDA 2000. Because of these different opinions, further local and international verifications such as local advisory meetings took place to clear these questions. Further performance tests on the Pandrol SFC system were made in a 3rd party laboratory, SNCF in France.

The advisory committees came out with the same opinions as former meetings and the performance test at SNCF confirmed the results of the test in Korea, proving compatibility of the Pandrol SFC system with Rheda 2000 track.

In fact, these verifications revealed advantages of the Pandrol SFC system. The signal system of the KTX project, which came from French TGV technology, requires high electrical insulation because the signals are transmitted via the rail, which is different from the German system which uses independent cables. In the electric insulation test made in August 2007 at test tracks made for KTX Phase 2, Pandrol SFC showed 15 ~ 20 times higher electrical resistance than the German system.



Pouring concrete



Loading manufactured concrete sleepers pre assembled with the Pandrol SFC system

This meant that the Pandrol system could be used even with the track circuit length more than 1500 metres which is required for the KTX 2 project.

In addition to better electrical insulation, the Pandrol SFC proved to have easier and simpler adjustability for track geometry which is important for concrete slab track.

After all these procedures, the contract for the supply of the Pandrol SFC systems to Sampyo, the contractor for the track construction of section 4 of the project, was

awarded in Sep 2007. Construction of the KTX Phase 2 project will be done in two sections, section 4 and section 5. The contract for section 5 is expected to be awarded in 2008. Supplies of Pandrol SFC systems to Sampyo for Section 4 started in November 2007 and have progressed smoothly so far. As of July 2008, 30% of the track construction of section 4 had been completed with exceptional speed of 500 meters per day. ■



Completed track

Replacement of the Selby Canal bridge

by Nigel Trotter of Tasque Consultancy Limited

The East Coast Main Line (ECML) is Network Rail's main route from London to NE England and Eastern Scotland.

The bridge over the Canal at Selby, also known as the Brayton Rail Bridge, was originally on the old route of the ECML prior to the Selby bypass. The old bridge had become costly to maintain and a permanent speed restriction had been imposed due to the decreasing factors of safety, as the steelwork deteriorated.

Network Rail decided the route remained important, and the bridge had to be replaced in order to restore journey times, and maintain safety on the local route for passengers and coal freight to the nearby power station at Drax.

The original bridge was a steel fabricated structure using longitudinal timber to form the track.

The bridge had to be replaced during a single 56-hours possession, and the clearance

between the bridge and canal had to be maintained all of which dictated the type of construction, and the method of replacement. The design parameters of the new bridge favoured a new steel construction, and it was decided to prefabricate the new structure alongside the track before using the largest mobile crane in the UK (1200 tonnes) to both remove the old deck and swing the new deck into position.

The track design was important because the existing alignment needed to be improved, but large radius horizontal and vertical curves had been used across the old bridge. The design sought to improve the track alignment whilst providing for adjustment after the bridge lift, and long term maintainability. The traditional use of longitudinal timbers on the old bridge needed to be reconsidered in the changing economics of timber supply. Longitudinal timbers have become increasingly

costly and difficult to procure, and decreasing quality of timber often leads to warping of the timber and difficulty in keeping the design track alignment. It was decided to use Pandrol VIPA-SP baseplates with direct fixing to the solid steel deck. This would provide both high degrees of adjustment and long term durability.

The previous VIPA-SP installation on the Leven viaduct proved a useful precedent, and the concept of using steel stools as the primary fixing point, was repeated on the Selby bridge. By altering the relative levels of the steel stools between the adjacent rails the bridge could be built in the horizontal transverse orientation, and create the required track cant between the stools, rather than by tilting the bridge deck.

Building the new bridge alongside the track allowed most of the work to be completed prior to the weekend of the track possession. However, the biggest imponderable



The Brayton bridge



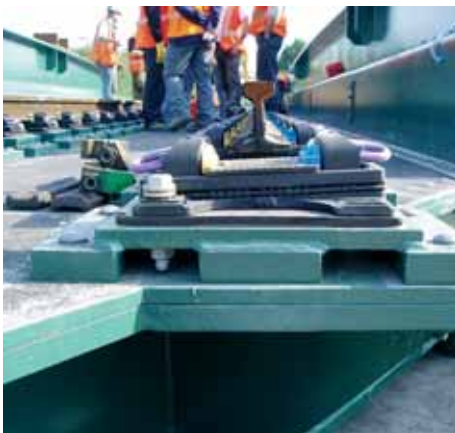
Crane prepares for bridge lift



Bridge ready for final track adjustments after craning



Inserting shims to achieve railhead design height



Bridge adjustment with first VIPA

was the achievable accuracy in the positioning of the new bridge deck by crane. The high level of adjustability (both vertical and horizontal) of the VIPA-SP baseplates proved to be useful in finalising the track design alignment.

The bridge deck is skewed relative to the canal by 35 degrees, making the bridge deck much longer than the width of the canal. It also created a challenge of how to design the ends of the bridge at the parapets.

The transition ends of the bridge were divided into two areas. Firstly a concrete apron (slab track) was created to correct the skew on the track and terminate the slab under adjacent rail seats on the track. Secondly was an area of the resilience transition to normal ballast track, and it was decided to use traditional ballast ramps at the ends of the concrete slab track. There was considerable debate about the need for the ballast ramps, because the VIPA-SP is actually more resilient (softer) than the ballast track, so the assumptions regarding customary ballast ramps were inaccurate. Network Rail decided the continued use of ballast ramps for this project to curtail the debate and use the existing technology. It was recognised that potentially significant savings had been foregone in the use of ballast ramps.

During prefabrication of the new bridge deck, the track was formed using serviceable rails. It was decided to position the baseplates

as if for straight track and adjust to the new alignment after the bridge lift and after the final position of the deck was established. Lateral adjustment was accommodated using the slotted holes in the baseplates (+/- 20-mm) and reversing the dissimilar insulators provided further adjustment. Vertical adjustment was achieved using a range of different thickness shims up to 50-mm, inserted beneath the baseplates.

The high resilience and vibration mitigation of the VIPA-SP was not a principal design consideration, despite the neighbouring housing estate, but it was a useful aspect of the baseplate to know that Network Rail could not be criticised for noisy track by the local residents. The replacement bridge has achieved all the track alignment requirements and kept the neighbouring area as quite as practical.

The Selby Canal bridge is now fully operational with restored line speed, a significant improvement in safety factors, lengthened design life and easier to maintain. A project completed and handed back on time to very high standards.

The team included alongside Network Rail was; Alfred McAlpine the managing contractor, (since acquired by Carillion), Donaldson Associates as structural engineers, Cleveland Bridge for steelwork fabrication, Tasque Consultancy for track design, and Clough Smith Rail built the track. ■



Completed track at Selby

DLR To Woolwich Arsenal

by Dr Mike Bent Novelist and Transport Historian

Over the past two decades the Docklands Light Railway (DLR) network has expanded considerably, mainly in a down stream direction through the heart of what was once the Port of London, now known as Docklands, and what is now a vast, vibrant and expanding redevelopment district. The line which serves London City Airport and currently terminates at King George V (named after one of the docks) is now being extended under the river just downstream of the Woolwich Ferry and pedestrian tunnel, to a new terminus at Woolwich Arsenal. A start on this 177 million GBP project was made in June 2005, boring of the tunnel was completed on 23 July 2007, and inauguration is scheduled for 28 February 2009.

The history of Woolwich Arsenal, on the right bank of the Thames estuary, dates back to 1671 when an ordnance storage depot was established there. An ammunition laboratory and a gun foundry followed, and in 1805 King George III suggested that the establishment, close to Woolwich Dockyard and the Royal Military Academy, should be known as the Royal Arsenal. Among the notable engineers employed there during the mid-nineteenth century were Samuel Bentham, Marc Isambard Brunel and Henry Maudslay. A football team was formed in 1886 (today's Arsenal Football

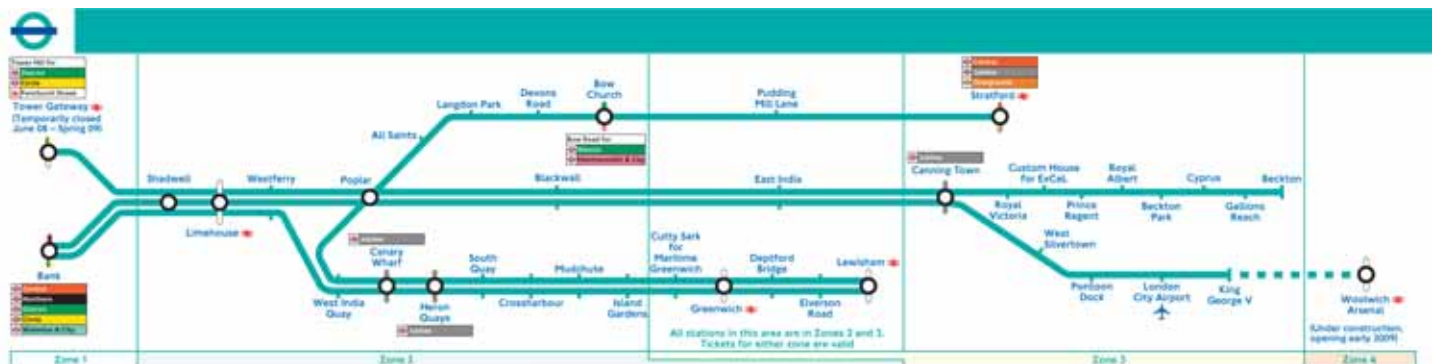
Club, based since 1913 in North London), and when manufacturing for the armed forces was at a low ebb following the end of the First World War, steam locomotives were built there; the complex had its own extensive 1,435 mm gauge rail network with a link to the Southern Railway near Plumstead station.

In the late 1940s, during another brief lull in armaments production the Arsenal built railway wagons for export. Although the Royal Ordnance Factory closed in 1967, and part of the complex was sold off for redevelopment as the new town of Thamesmead, certain military functions continued there until 1994. Many historic buildings have fortunately been conserved, and the site is now part of the Thames Gateway redevelopment area, with housing estates and tower blocks dominating the landscape. The past is remembered in a museum and heritage centre.

At Woolwich the Thames is about 400 m wide, and since the fourteenth century there has been a ferry service linking Woolwich on the right bank with North Woolwich on the left one. From 23 March 1889 the service has been provided free of charge to users, and is currently operated by three motorships, John Burns, Ernest Bevin and James Newman, built in 1963 by the Caledon Shipbuilding & Engineering Company of Dundee and featuring Voith-Schneider propellers for enhanced



Woolwich ferry



DLR network

manoeuvrability. Since the ferry links the North Circular and South Circular ring roads, it is also an important route for truckers, and each vessel can carry road vehicles, including HGVs, up to a maximum payload of 200 tonnes, as well as up to 500 passengers. On weekdays the service operates from 06.10 to 20.00 with sailings every ten minutes; less frequently at weekends.

The ferry is not the only way across the Thames at this point. Designed by Sir Maurice Fitzmaurice and bored by Walter Scott & Middleton for London County Council, the Woolwich pedestrian tunnel, 504 m in length, was opened to the public in 1912. Its design is very similar to that of the Greenwich pedestrian tunnel, further upstream, with circular, brick-built, glassdomed entrance buildings on each bank, whence descend lifts and spiral staircases. The tunnel itself is lined with white glazed tiles. Somewhat coincidentally, when the first sections of the Docklands Light Railway (DLR) were inaugurated on 31 August 1987, the main line ran from Tower Gateway, a stone's throw from the City of London, to Island Gardens, on the north bank of the Thames, and adjacent to the northern entrance to the pedestrian tunnel to Greenwich.

The Woolwich extension of the DLR is not exactly a new idea. It was broached at the time the London City Airport prolongation was proposed in 1997, and was costed over the two years that followed. At that time the Government Office for London, Transport for London and the DLR were already undertaking a series of studies under the umbrella title of the East London Integrated Transport Strategy, focusing on the area now known as the Thames Gateway. Both heavy rail and light rail alternatives were considered, together with the possibility of DLR trains using part of the Network Rail branch from Stratford to Canning Town to North Woolwich, which would be extended under the river. In May 2000 it was concluded that the best option was light rail - faster, easier and cheaper to build, and also more appropriate for a rail-based transport system designed to foster patronage at a very local level.

It was evident that the short extension under the river would bring benefits quite disproportionate to its modest length. Travel time between Woolwich and the left bank communities of North Woolwich and Silvertown would be reduced tremendously, access from towns in North Kent to the London City Airport, the new trade fair centre, the



DLR with Canary Wharf in the background

office complexes at Canary Wharf, and the evolving public transport hub at Stratford would be vastly improved. In the reverse direction, the Woolwich extension would make it far easier for those living north of the Thames to enjoy a day out by train in Kent. The eastern end of London's Docklands is still very much a run-down area compared with the western end, developed in the late 1980s and 1990s, and the new line was envisaged as a catalyst for redevelopment and revival.

Four possible routes were evaluated, the main differences between them lying in the approach to the Network Rail station in Woolwich. The DLR announced its preference in November 2001, and the scheme received the green light from government in early 2004. WARE (Woolwich Arsenal Rail Enterprises) is the concessionaire. An unincorporated joint venture between COLAS RAIL (formerly AMEC SPIE) and AMEC Group Ltd (using MORGAN EST) are the building contractor, awarded the design and build contract.

Work on the 2.5 km extension started in the summer of 2005. To the east of King George V station, where the track is already 1.7m below ground level the line starts descending, first into a concrete-walled cutting to the northern portal of the tunnel under the river. After an 85 m double-track cut and cover

section, the two lines separate into twin bores, each 1,800m in length with an external diameter of 6m (5.3m after lining). Both were excavated by a 540-tonne Lovat TBM nicknamed "Carla", which during its two subterranean years removed 104,000 m³ of spoil.

The line falls through 31.1m on a maximum gradient of 5.5%, and at its lowest point the track is 15.6m below the bed of the Thames. Then comes the ascent, through 30.6m and on a maximum gradient of 5%, to another short cut-and-cover section, the route now swinging west then northwest through close on 180 degrees on a curve of 300m radius to approach the Network Rail line from London to Greenwich, Woolwich, Erith, Dartford and the Medway Towns. The final section is again in a concrete-walled cutting, and the terminus, at Greens End and 7.5m below ground level, is on the north side of Network Rail's Woolwich Arsenal station, and at an angle to the latter.

One exit from the DLR terminus accesses Woolwich town centre, the other the former Royal Arsenal. The station, which is built on two subterranean levels though with the concourse at street level, is equipped with lifts, escalators and CCTV, and unlike most other DLR stations will be staffed during operating

hours. A footbridge provides access to London and Kent-bound trains on the Network Rail line. The Network Rail facilities have been modernised as part of the redevelopment programme for the site.

Boring was not an easy process. On the north bank the tunnel descends through alluvium and river terrace deposits to the Upper Chalk stratum, while on the south bank it rises into the Thanet Sands. Early surveys suggested that the chalk was closely jointed, but the reality was somewhat different.

There was a tremendous amount of groundwater, which was saline underneath the river bed and entering the bore at pressures of between 3.0 and 3.5 bar, making for very difficult working conditions.

Once tunnel boring and lining had been completed, the tracklaying could start. This presented some unusual challenges of its own. At one point the line runs beneath an area sensitive to vibrations. For this section of line it was decided to employ Pandrol Vanguard on Stanton Bonna twin-block sleepers, which are linked by double steel tie-bars. To speed up the tracklaying process, these were partly assembled at the sleeper factory, then moved into the tunnels.

The rails were mounted (three - two running rails and the third, for the 750 V DC power supply) and the whole assembly was embedded in mass concrete, to form the slab track using a top-down construction technique.

Elsewhere on the extension Pandrol VIPA-SP was mounted on Stanton Bonna twin-block sleepers, and delivered to site ready for installation. VIPA-SP is designed to reduce the transmission of vibration caused by passing trains in sensitive areas, such as near the foundations of buildings, or on bridges. It comprises a modular baseplate, which sandwiches two layers of studded rubber pads in series, everything being held in place using Pandrol Fastclips. The system permits the rail position to be adjusted transversally by 20 mm on either side of the centre-line. Shims can be used to adjust the vertical alignment. VIPA has a static stiffness of 19.57-kN/mm, and a dynamic stiffness of 19.48-kN/mm.

SelTrac, the moving-block signalling system on the DLR, was developed by Alcatel in 1994, and was bought up by Thales, which now provides updates and installations for the entire DLR. The driverless trains are operated via an on-board computer which is in communication with the network's control centre at Poplar.

The extension is designed to accommodate trains running at four-minute headways at peak periods, with journey times from Woolwich Arsenal of 5 minutes to London City Airport, 20 minutes to CanaryWharf, and 27 minutes to Bank, in the City. Once work on the former Network Rail North London Line between Canning Town and Stratford is finished in 2010, the latter will be just 20 minutes from

Woolwich as well. This will facilitate the movement of spectators during the 2012 Olympics, since the shooting events will be held at the Royal Artillery Barracks, while the Olympic park and village, accommodating participants, will be situated at Stratford. ■

This article was previously published in the Railvolution Journal Issue R4 2008.



Pandrol Vanguard photo by R Cosstick



Woolwich – Arsenal tunnel breakthrough



Pandrol Vipa photo by R Cosstick

Retrofit of Elastic Rail Clip sleepers in Bangladesh with Pandrol's Anti Theft ERC Retrofit (TR1899) system

by Engr. Abul Quasam, Chief Engineer/East and Engr. Mohammed Amzad Hossain, Additional Chief Engineer Bangladesh Railways

During the 1990's, Bangladesh Railways (BR) embarked upon a programme to replace timber sleepers with pre-stressed concrete sleepers on the Dhaka to Chittagong and Akhaura to Sylhet lines.

Concrete sleepers were manufactured in Bangladesh and incorporated the Indian Elastic Rail Clip (ERC) Mk II rail fastening system. BR imported these rail fastenings from India including ERC Mk II clips, 6 mm grooved rubber

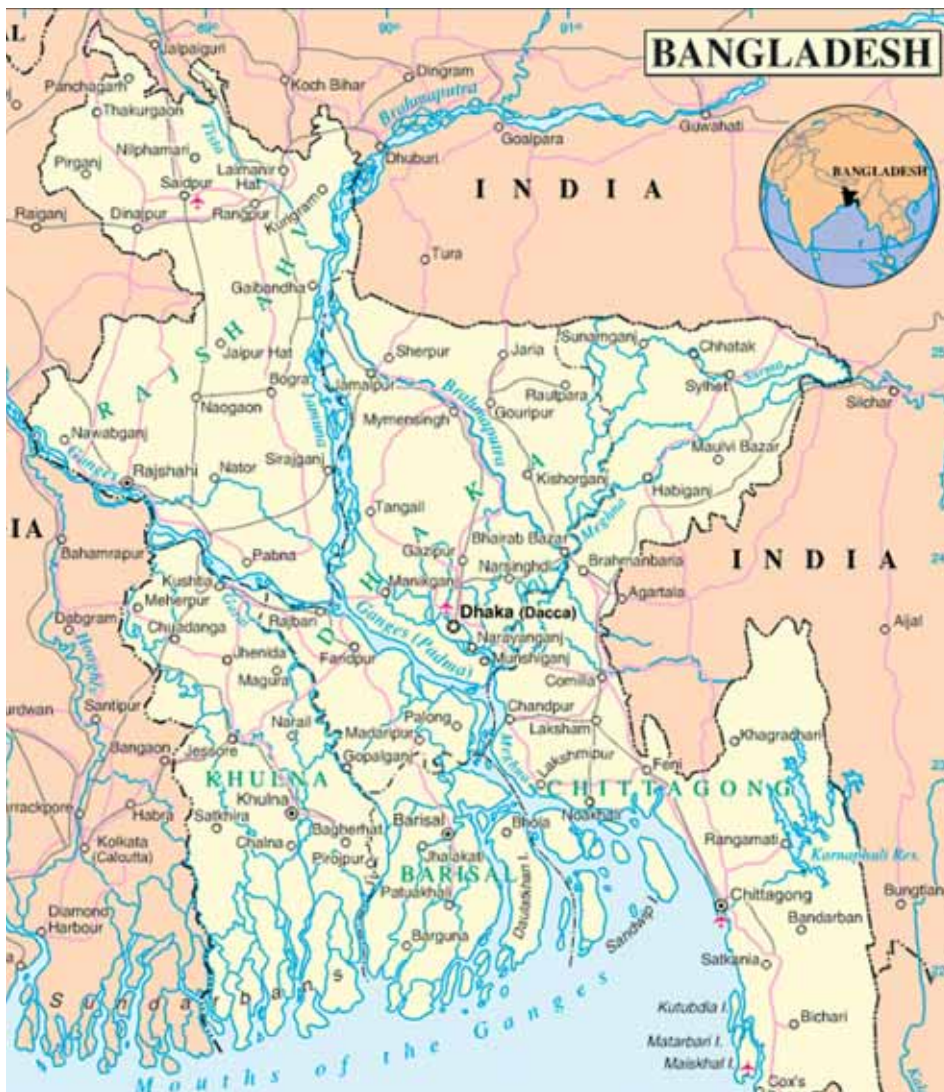
(GR) rail pads, and glass reinforced nylon (GRN) insulators.

BR operates maximum axles of 12.8 tonnes on metre gauge tracks, sleeper spacing for straight track is 674 mm and the design ballast depth is 200 mm, although ballast depths in practice may be less.

Despite a maximum speed of only 80 km/hr, the combination of rail corrugation on the BS75A rail, wheel condition and ballast

condition, contributed to higher track loadings that might otherwise be predicted.

This track condition was compounded by theft of the ERC clips. It became necessary to introduce a policy of welding the clips to the cast shoulders. Whilst this was effective in preventing theft, it was onerous to undertake, and created difficulties in maintaining the tracks since the clips could not be removed without grinding off the weld. In many cases



Bangladesh



Typical site condition



Pandrol TR1899 system



Removal by special hand tool

the weld failed.

Within a few years the rail fastening system quickly became ineffective and multiple problems developed. Pads failed in just a few years, ERC clips lost significant clamping force, and insulators came out or were broken.

Pandrol was invited to survey the track condition between Dhaka and Chittagong and were asked to consider what solutions might be possible.

The solution Pandrol provided was designed to strengthen the overall track structure and provide high quality materials that would give a long life cycle in track and reduce theft, maintenance and overall

Summary of Improved performance.	
Existing ERC Rail Fastening System	Pandrol TR 1899 System
Theft of Clips	No Theft to date
Loss of Toe Load	Toe load maintained
Poor pad life (approx 2 years)	Pad life expectancy > 10 years
Loss / failure of insulators.	No loss or breakage
Consequential Impact on Track Structure	
Loosening of cast shoulders	No loosening of shoulders
Damage to concrete sleeper	No damage to concrete sleepers
High cost of maintenance	Low cost of maintenance

life cost. It was agreed with Pandrol that electrical insulation of the assembly was not required for the sections between Stations, allowing a more cost effective system to be adopted.

The system comprised an 18mm Pandrol e-clip, generating between 800 and 1,000 kgf toe load, a 10mm thick studded natural rubber rail pad for attenuating the sleeper strains and a cast spacer incorporating the anti theft device.

Installation was undertaken using a standard Panpuller and extraction only by means of a special hand tool.

Pandrol supplied 50,000 sleeper sets of the system in 2007 which were installed into track

in the 4th Quarter 2007.

Due to the priority being placed on strengthening the track, the system has been initially installed on 1 in 4 sleepers. This has allowed BR to maximise the length of track that could be strengthened.

BR hopes to continue the rehabilitation work and eventually provide the retrofit system in each sleeper.

Site visits so far demonstrate that no fastenings have been removed from the track and that the system performs well.

With the introduction of TR 1899 system, BR is taking the right steps to maximise safety and reliability and benefit from whole life cost savings from the rail fastening system. ■



Pandrol TR 1899 Retrofit system installed every 1 in 4 sleepers

Union Pacific's Commitment to Concrete Ties

by Bill Van Trump, Sr. AVP Engineering, Union Pacific Railroad

CONCRETE TIE PRODUCTION FACILITIES

A long term contract to supply concrete ties was finalized between UP and their current supplier, CXT, which required eighteen million dollars of upgrades or new construction. The new contract involved a new tie production facility in Tucson, Arizona, which produces concrete ties for track renewal operations and new track construction. Tucson was chosen as the site for the new plant after careful logistical analysis of access to raw materials and geographical need for concrete ties by UP. It is centrally located in UP's Sunset corridor, where the construction of a second main line is under way. It will serve the western half of the UP system while the eastern half will be served by the CXT's plant at Grand Island, Nebraska.

The concrete tie production facility at Grand Island continues to make changes to enhance their quality and capabilities. The latest technology in concrete tie production was installed in Grand Island and Tucson over the past couple years. This new production

system is provided by Grimbergen, a Dutch company with extensive experience in constructing concrete tie casting equipment and systems.

Grimbergen designed the entire process for these new facilities. Everything from forms and abutments to sawing to clip installation is an integrated system. By treating each step in the process as an integral part of the production line, efficiency and reliability are maximized. This technology creates a better quality tie by incorporating new forms that retain specified dimensions, more exact wire patterns, the ability to easily change wire patterns, precise shoulder placement, and demoulding the ties prior to transferring prestress to the concrete. The long line process also ensures minimal variation of prestressing. Form reliability will be increased since they are not subjected to fatigue caused by the large prestress forces associated with the old technology that utilizes self-stressing forms. The Grimbergen technology will eliminate some of the most common quality defects, including wire pattern placement, gauging and cracks.

The new plant is highly automated, with robotic delivery of concrete and tie stacking. Fastener installation is also built into the process, enabling efficient installation of fastening components and less tie damage due to less handling.

The latest addition to the system is a process that treats the rail seats of the concrete ties with an epoxy coating that strengthens the concrete against rail seat abrasion.

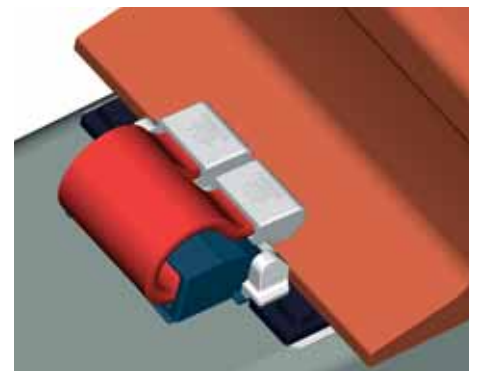
NEW TRACK RENEWAL MACHINE

Union Pacific also took possession of a new track renewal machine in 2005, replacing the old P8-11. The new machine, dubbed the TRT-909 is owned and operated by Harsco Track Technologies and leased to the Union Pacific.

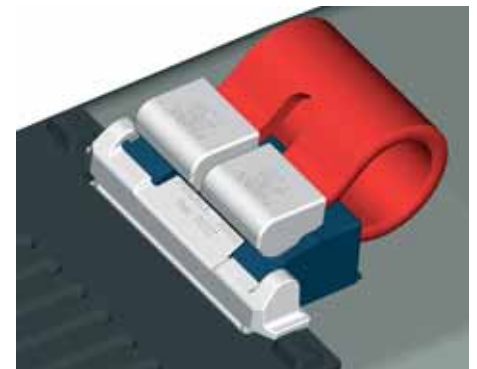
This new machine incorporates several technological improvements over previous



Union Pacific's TRT-909 track renewal machine



Installed position



Pre-installed position

track renewal operations. The TRT-909 is designed to be able to stay in work mode while trains are passing on adjacent tracks, and is designed to install up to six thousand ties per day. It features new spike pullers that are capable of pulling multiple spikes on each side of the rail with each pulling strokes.

The most significant enhancement to the TRT-909 is the addition of an electric induction rail heating system. Electric induction is superior to conventional open flame heaters due to the accuracy of temperature control. Electricity that is produced by the TRT-909 power car is used to propel the TRT-909 consist to and from the job site. When the machine reaches the job site, this electricity is switched over to power the rail heating system. In addition to providing better controlled rail heat, electric induction is safer than open flame heating. Heating rail to the correct neutral temperature, installing into the rail seat, and clipping in place are all automated. This eliminates the process of having to run a rail heater behind the track renewal machine, followed by a clip car to clip up the rail, that was used by the P8-11; saving the cost of the clip car and labor to operate.

NEW ELASTIC FASTENING SYSTEM

To take advantage of this new technology, UP had to change the elastic fastening system that was being used. UP had standardized on the Safelok 1 elastic fastener for the past several years. While a satisfactory clip, this system was not designed to be assembled on the concrete ties at the plant, but had to be assembled in the field, utilizing a clip car. The clip car had work stations to install insulators, others to install the clips and others to press the clips onto the rail. A system was needed that could be pre-assembled so the heated rail could immediately be clipped behind the track renewal train while the rail was still at optimum neutral temperature. UP worked for several years with Pandrol to develop the Safelok III system. This system features a clip that has the insulators fit onto the toes and can be pre-installed in the castings in a "park" position. An additional long term benefit to this fastening system is that the clips can be notched back to the "park" position, the rail removed, new rail installed, and the clip squeezed back onto the rail base without having to handle the clips at all. This results in

a significant labor saving for future rail replacement operations.

The Union Pacific plans to continue installing around 500,000 concrete ties each year with the TRT-909, in addition to the ties used for new track construction. With plans to

install concrete ties the entire length of the UP central corridor between Salt Lake City and Chicago over the next few years, these advances in technology are producing valuable returns. ■



Safelok III system

Saudi Arabia Rail Network Expansion Projects

Saudi Arabia compares favourably in size to the whole of Western Europe, and sits amongst the 25 largest economies in the world, yet their rail network is relatively modest.

A 556km track between Riyadh and Hofuf via Haradh was built in the 1950's and is now used only for freight service.

A second track of 449km running between Riyadh and Damman via Hofuf was constructed in the 1980's and this is used by passenger trains.

In 2003 the total container traffic handled in the Middle East / Gulf Ports was estimated to have risen by 124% since 1995. This growth is a function of both national activity and transshipment traffic, and this has resulted in the UAE benefiting from regional growth twice as much as other countries.

Container transport is the core business of the Saudi Railways Organisation (SRO).

- 50% of containers arriving at Dammam Port have a final destination of Riyadh
- 85% of these containers are transported by Rail
- 65% of SRO's revenue comes from container transport.

In 2002, the Kingdom of Saudi Arabia announced its intention to upgrade and expand its existing railway. Three new railway lines will be constructed:

- Saudi Landbridge
- Makkah Madinah Rail Link
- North-South Railway

The supreme Economic Council of Saudi Arabia approved implementation of the Saudi Landbridge and Makkah Madina Rail Link through the private sector on a build-operate-transfer basis.

THE SAUDI LANDBRIDGE (SL)

The Saudi Landbridge project will see construction of 950km (590 miles) of new line between Riyadh and Jeddah, and 115km (71 miles) of new line



Sleeper factory – Saudi Arabia

between Dammam and Jubail. There will also be upgrades to 450 km (280 miles) of existing tracks between Dammam and Riyadh

It will be primarily a freight / container line, although passenger traffic is also expected. Interoperability with the North-South line is also a requirement.

Track construction will be single track, with the option to expand to double track in the future. It will be designed for speeds up to 180km/hr (112mph) for both freight and passenger trains, and for a 25 tonne axle load

although 32.4 tonne axle loads may also be considered.

STATIONS

3 freight stations will be built in Jeddah, and 2 passenger stations, 1 at the Airport and 1 in the City Centre.

MAKKAH MADINAH RAIL LINK

The Makkah Madinah Rail Link will be a high speed line consisting of approximately



444km (277 miles) of new double track linking the western port of Jeddah to the holy cities of Makkah, Madinah and potentially onwards to Yanbu.

It will provide passenger traffic between Makkah-Jeddah-Madinah, and both passenger and freight traffic between Jeddah and Yanbu, and will be designed for high speed traffic.

There will be 2 stations in Jeddah, 2 in Makkah and 1 in Madinah

NORTH – SOUTH RAILWAY

The Saudi Arabia North/South Project (K.S.A, NSR) is a new railway track 2400kms in length linking the phosphate mines of Al Jalamid to Riyadh with branch lines from Al Haditha and Al Basata. There is also an East-West axis from the bauxite mine at Al Hadaitha to a processing plant at Ra's Az Zawr with a further connection to the deep-sea port at Jubail. The line between the junction for the bauxite mine and Riyadh will be mixed traffic, the rest pure heavy haul.

In addition to freight stations, passenger stations will be constructed in cities such as Hail, Qaseem, Zabeerha and Hazm al-Jalamid.

The project is being funded by the Saudi government, and is being overseen by the public investment fund which is part of the Ministry of Finance. The implementation and

project management consultancy is in the joint hands of Louis Berger, Systra, Canarail and the Saudi Consolidated Co. who have written a track specification to require a world class standard for heavy haul railway construction. The track will be capable of carrying 32.4 tonne axle loads using CEN 60E1 rail and locally produced concrete sleepers which will be laid at 1800/km spacing. The structures will be built to accommodate double track but the initial construction will be single track with 11 passing loops each of 3.5kms length.

Twelve consortia bid for the track construction work. The project is divided into 4 district contracts, three of which have already been awarded. The fourth is yet to be awarded. The PANDROL FASTCLIP elastic fastening designed for Heavy Haul track has been chosen for the project.

The project will require the supply of approximately 4 million sleepers over a maximum period of four years with a peak annual demand of 1.25 million sleepers. Deliveries of the Pandrol fastenings commenced in early 2008 and sleeper deliveries will continue until the end of 2010. ■



Dubai Metro

Pandrol UK Limited has been awarded a major contract to supply 361,500 resilient baseplate assemblies for a major new metro system in Dubai. The contract was won against stiff international competition.

Groundworks for the new Dubai Metro, the first railway system of its kind to be built in the Arabian Peninsula, commenced in February 2006.

A growing trend of international business relocations, increased tourism and rapidly growing population have all combined

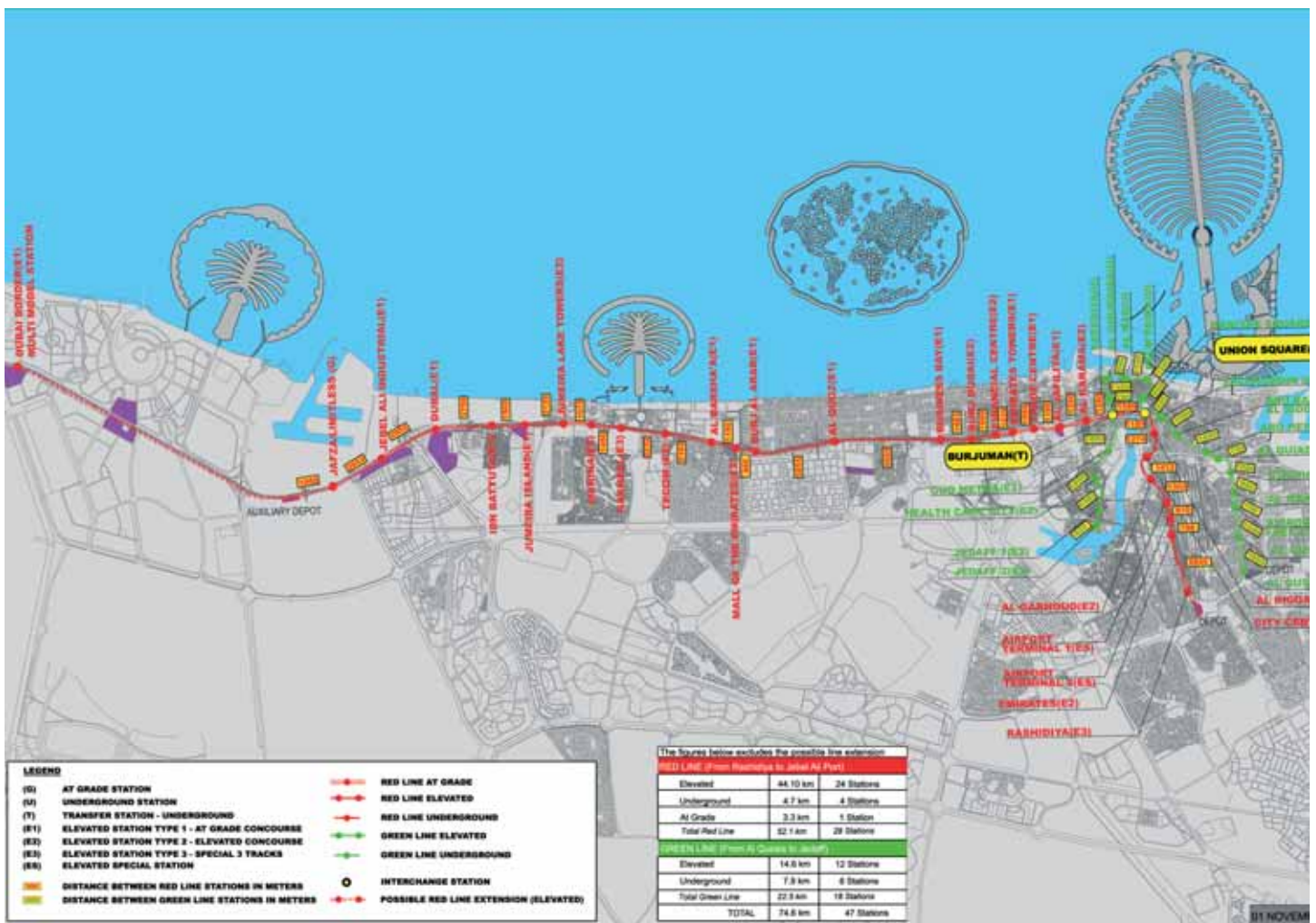
to provide growing pressure on the city's road network.

The Government of Dubai created the Roads and Transport Authority (RTA) to address the issue of transportation systems in Dubai, the flagship project being the Dubai Metro.

Initially, Dubai Metro will consist of three lines. The 52.1 km Red Line will run from Rashidiya to Jebel Ali. The majority of the line will be elevated, except between Port Saeed and Burjuman, where it will be constructed underground. There will be 23

elevated stations, one at-grade station and 4 underground stations.

The 17.6km Green Line will run from Al Ittihad Square to Rashidiya bus station, through Deira City Centre and Dubai Airport Terminals 1, 2, and 3. It will be progressively extended to serve the Deira and Bur Dubai central areas and Souks up to Burjuman and Wafi shopping centres. Again, the route is primarily constructed as elevated tracks, comprising 8 stations. The underground section of the line comprises 5 stations, excluding Union Square



Dubai metro network

and Burjuman, which are interchanges with the Red line.

The 47km proposed purple line will link Dubai International Airport with the new Airport at Jebel Ali, serving communities along the Emirates Road, and is expected to become operational in 2011.

Rolling stock will consist of 99, fully air-conditioned, five-car trainsets. Each train will be approximately 75 metres long, seating around 400 passengers, with standing room for many more. The trains will be driverless, fully automated, and will run as often as every 90 seconds.

As mentioned, apart from the city centre, where both lines will travel underground, the two lines will run elevated, on specially designed viaducts, and the proximity to existing buildings meant that noise and vibration attenuation was an important factor when designing the trackwork.

Initial invitations to tender were issued by Mitsubishi Heavy Industries (the contractor appointed by RTA) specifying a preference for the well-proven Pandrol 'e' clip system. The specification was soon opened to allow Vossloh to participate and, for many months, its design was strongly favoured. However, Pandrol's engineers developed an adaptation of a baseplate design previously used in Singapore, which provided a good track reference, and this, coupled with a competitive price, led to the award.

The Pandrol design for the main line track is a Single Plate double resilience system, a single 'e' clip baseplate assembly incorporating two pads, one above and one below the baseplate, providing a level of noise and vibration attenuation which meets fully the MHI tender requirements both in technical and cost terms.

For the contract Pandrol will supply 306,500 baseplate sets for the main line and 55,000 baseplate sets for the depot.

Track construction in both the depot and mainline areas has been using a top-down methodology, allowing a modern and efficient method of track-laying. The Jebel Ali depot trackwork is now complete and Rashidiya is very close behind. The mainline construction has been hindered by delays in civil works, but all personnel are still working to a 09/09/09 opening date. ■



The Feasibility of the Vortok Pandrol e clip Stressing Rollers on a Network Rail High Output Ballast Cleaning Site

by Ian Saul, Project Engineer, Network Rail, High Output Renewals, MP&I

Vortok stressing rollers have been developed for both Pandrol FASTCLIP and 'e' Clip fastenings, and are now in widespread use around the world. The following report details Network Rail's experience with the 'e' Clip version.



Trial site at Corby Glen

Network Rail has recently approved the new Vortok Stressing Roller (eVSR) designed for use with the Pandrol e Clip fastening system. A feasibility study was carried out for use on the High Output Ballast Cleaning project to assess the possible benefits the rollers could offer in key areas of the HOBC process and in particular, based around four points.

- Technical improvement
- Safety
- Speed
- Cost (when compared to manpower saved against initial outlay of funds)

Two methods were used to conduct the study.

- Desktop study (using the Vortok paperwork and data provided by Network Rail)
- On site trial

DESKTOP STUDY

As a technical improvement the rollers are designed to reduce the friction between sleeper and rail by a high factor (the Vortok eVSR has a friction factor of 0.0012 reduced from a factor of 0.12 with the traditional methods). This reduced friction allows for a far better distribution of stress throughout the rail that has been pulled. This improved distribution of stress also allows for much greater length of track being possible to stress (up to 1200m) or even greater, as against the current UK limit of 900m.

As a safety issue, the eVSR holds the rail up without the use of jacks, with the rollers supporting the rail under the head of the rail, and holds the track in a way that the rail will not fall while it is raised (the rollers go past the centre point of the lift with the downward force of the rail locking the rollers in place – the

actual roller therefore would have to completely fail for the rail to drop). This means that the possibility of operators getting their fingers trapped under the rail is virtually eliminated.

Due to the reduction in processes such as no jacking of rail, no use of side rollers and reduced manpower requirements coupled with faster operation compared to the traditional methods, there are potentially large cost savings to be envisaged.

TRIAL DETAILS

The trial was carried out as part of an 800m stress on both legs of the Up main at Corby Glen on the East Coast Main Line (ECML) near Grantham in Lincolnshire. The forty four Vortok eVSR rollers were used over 190m of the six foot rail/leg.

The site consisted of a curved area of track which favours the speed of the Vortok eVSR as the traditional method requires extra work than on straight track (traditional side rollers would normally have to be used on the inside radius of curved track). The trial also focused on the speed of use of the eVSR rollers and the staffing savings with the method compared with the traditional rollers used elsewhere on the same site.

TRIAL METHOD

The Vortok eVSR's were supplied in plastic crates holding eight rollers (each crate is laid out on track every 44 sleepers). The quantity in each crate is to allow a maximum weight of 25kg per box – this allows each crate to be carried safely by one man.

The rollers were then laid out every 11 sleepers which was the suggested distance between the sleepers on the radius curve at the trial site. On this site, 11 sleepers equates to approximately 7 metres. Vortok does not state in any documentation the correct spacing's of the rollers, as this should be determined by the local technician working to the agreed

specification for the network.

After the rail was cut, it was unclipped away from the pull point. Installation of the eVSR's was delayed until unclipping had reached at least thirty metres from the pull point. This was important because raising the rail with the eVSR closer than this to a secured clip makes it more difficult to operate the stressing rollers. The Vortok rollers were then installed and spaced at intervals of every eleven sleepers and then raised. This operation process was timed and compared to the times taken on the other rail which was being stressed using the traditional methods and equipment. As soon as all rollers of both types had been installed, the rail was stressed. As soon as the stressing was completed the rollers were lowered and removed and clipping up of the rail commenced. Again, times were taken of both methods of operation.

TRIAL SPEED RESULTS

Vortok eVSR.

- i. Installation by two men using Vortok eVSR's took 10mins and 4 seconds to put up

190m of rail on one leg. This time included the time waiting for the rail to be unclipped after the roller team caught up with the unclipping team. This means that 800m of rail could be up on Vortok rollers in 42mins and 23 seconds.

- ii. Removal using two men the Vortok eVSR's took 6mins and 41 seconds to lower and remove 190m of rail on one leg. This means that 800m of rail could be taken down using Vortok rollers in 28mins and 9 seconds.

Traditional Side/Under Rollers

- iii. Installation by four men using the traditional rollers (with side rollers) took 24mins and 15 seconds to put up 190m of rail on one leg. This means that 800m of rail could be raised up on traditional rollers in 102mins and 6 seconds.

- iv. Removal by four men using the traditional rollers (with side rollers) took 17mins and 21 seconds to lower and remove 190m of rail on one leg. This means that 800m of rail could be taken down using traditional rollers in 73mins and 3 seconds.



eVSR at Croby Glen in raised position

Method	Time Taken To Set Up 190m	Time Taken To Remove 190m	Time Taken To Set Up 800m	Time Taken To Remove 800m
Vortok eVSR	10mins and 4 seconds (2 Men)	6mins and 41 seconds (2 Men)	42mins 23 seconds (2 Men)	28mins and 9 seconds (2 Men)
Traditional	24mins and 15 seconds (4 Men)	17mins and 21 seconds (4 Men)	102mins 6 seconds (4 Men)	73mins and 3 seconds (4 Men)
Time Saved Using Vortok eVSR	14mins and 11 seconds	10mins 40 seconds	59mins 43 seconds	44mins 54 seconds
Manpower Saved Using Vortok eVSR	2 Men	2 Men	2 Men	2 Men

EFFECT ON COST

When considering all of the gathered data the calculated effect on cost is based on the savings in man power that can be achieved by using the Vortok eVSR's. The team to set up the rollers on one leg/rail would consist of two men therefore the two teams that would be needed to simultaneously set up two legs would consist of a total of four men. With traditional methods we would use a team of four men on one leg/rail and therefore we would use eight men for two legs/rails we would therefore save four men on site using the Vortok eVSR.

As with all new technology or equipment, methods of use and management must be considered. The management of these rollers needs extra control due to the higher level of investment but this is mitigated by the handling and storage system provided by Vortok in the form of stackable lightweight plastic crates. The business benefits already identified from the experience on the Western Territory with the Fastclip version (fVSR) gives us confidence that the eVSR will give similar benefits in other locations.

CONCLUSIONS OF THE FEASIBILITY STUDY

There is strong evidence of a technical improvement by using the Vortok eVSR in the form of the potential increase in the length of rail that can be stressed in one length and the fact that the desired stress is more evenly distributed along the full length of the rail.

Use of the eVSR (and fVSR) rollers provides a much safer operation method with a huge reduction in the risk of operators trapping their fingers between the rail and

sleeper. The data in this study also highlights the significant time saving that the eVSR introduces into the stressing process. Installation is 41% faster than the traditional methods and 38% quicker in the removal process. Less ancillary equipment is required as well.

The cost benefits over a period of time are very high and will obviously vary from job to job, track to track and country to country, always depending on local conditions. It must also be remembered that the VSRs do need to be managed more carefully as more rollers are required on each site when compared to the traditional methods but the overall improvement in productivity and safety substantially outweighs this small extra aspect. ■



Blue tote box



fVSR's on 450m curve showing at blue storage crates



