

ASSET MAINTENANCE AND RENEWAL LESSONS

Engineers and experts on track and asset renewal gathered in Nottingham for the latest LRT Excellence Day - here are some of the lessons they shared.

Designed to improve the sharing of best practice and innovation between operators, infrastructure managers and the wide network of product and service providers who help us all to keep our respective systems running smoothly, the latest LRT Excellence Day was attended by around 70 delegates – all keen to learn and share their experiences.

Challenges and innovation

Craig O'Brien, the recently-appointed Engineering Manager for industry body UKTram, began with an overview of recent rail replacement projects in Sheffield.

His opening remarks summed up the sentiments of many engineers in the room: forewarned is forearmed. He then outlined five simple principles to success: understand the effect on stakeholders and employees; data capture and analysis is key; identify critical challenge areas early; preventative maintenance is a must; and finally, renewals are inevitable so they must be properly planned for.

Mr O'Brien also beseeched delegates to share their knowledge: "While we all accept that our tramways are unique, they also share fundamental similarities. So do not ignore lessons from the past, and do share information as, chances are, someone somewhere will have already experienced similar problems and may have a solution."

The importance of planning works effectively and considerately was a theme that would run through the day. No-one likes replacing assets, Mr O'Brien said, but it is important not to get 'caught out' by deferring maintenance or not communicating effectively with passengers, residents and businesses who depend on reliable tram services.

And while laboratory data can be very useful, he argued, there is no substitute for real-world experience. This is why benchmarking is vitally important: "Often we recognise the importance of analysis based on maintenance costs, but we focus on the short-term. We need to focus on the lifecycle picture and understand the requirements of both now and the future."

Referencing the practice of gauge weld restoration, he explained that while it is a very useful tool in the shorter-term, it would ultimately never prevent renewals. He further showed how effective groove grinding had prolonged rail life in Sheffield by two to three years, combatting flange running without the need for full renewals.



▲ The creation of new tramway assets for the extension of Dublin's Luas Green line, also known as the Cross-City line, involved extensive remodelling of the historic centre of the Irish capital. ■■

"We need to focus on the lifecycle picture and understand the requirements of both now and the future."

When choosing contractors and suppliers, he suggested, it can be a tricky balance as those with a proven reputation may not always focus on innovation: "Do we go with the tried and tested, which keeps the market small, or take the risk of going with a more unknown quantity?"

"Also plan as far ahead as you can as, for example, the amount of rail required may be beyond the amount held in stock by suppliers, and other components may be needed so there may be a substantial lead time on procurement. The UK is hardly flooded with embedded rail experts, so do not assume they will be available when you need them – look at what other systems may be doing to see if there are ways of working together."

Improvements and upgrades

The next case study came from Neil Cundy and Marek Szwej of Nottingham Trams, who explained their recent track renewal programmes (2016-18); Nottingham Trams Ltd is contracted as the operations and maintenance concessionaire for the tramway in the East Midlands city until 2034.

Planning was again the focus of the first section of their presentation, detailing the various challenges of five projects that posed individual challenges: tight 20m horizontal curves at Lace Market (2016), tight horizontal curves with steep inclines at Radford Road

(5.5%) and Scout Hut (8.5%) (2017); and the latest projects at Shipstone Street (three horizontal curves – 20m, 60m and 50m, inclines of 4.5-8.5%) and Gregory Boulevard/The Forest (interlaced track and both manual points and powered switches).

It was emphasised by Mr Cundy that wherever possible it is important to not only look at like-for-like renewals, but for improvements that could either remedy possible design issues with the original installation, or incorporate upgrades made possible by new technology. In Nottingham's case these included improved points drainage and track lubrication systems.

Due to differences between the original documentation and the installed specification, the team has had to learn as they go along in some cases, but this has helped inform a new set of optimum principles that should see longer life and easier maintenance. These include raising the track foundation slightly and increasing the base and side supporting structure to give a more stable base to avoid side roll.

The latest renewals have installed heat-treated grooved rails, seen very much as a 'put in and forget' solution. Improvements in materials composition include enhanced polyurethane embedding systems, where the profile and density of the material can be adjusted to provide an optimal combination of lateral support with lower vertical stiffness to improve noise and vibration mitigation.

During such works, maintaining and stabling trams on the 'dark side' has also raised particular challenges. As Nottingham only has one depot, Wilkinson Street, there have been times where the network has been "cut in half". This has seen the establishment of a "flying squad" of Alstom engineers who can respond to vehicle issues anywhere on



◀ **LEFT: Engineers and suppliers from across the industry gathered for the lively day of discussion in April.** TAUT

▶ **RIGHT: The team from Robel and Plasser demonstrated a number of new products and tools for track maintenance.** TAUT

▶ **BELOW RIGHT: The PCAT test track at Long Marston; further trials are due to be conducted later this summer.** PCAT



the network, looking after a revised daily maintenance and cleaning programme, for example. During such programmes, trams are stabled overnight on the bridge at the railway station, for security purposes, and some exams are carried out early to minimise the risk of any issues when vehicles are unable to return to the depot.

New-build projects in Dublin

Later in the day, Marcello Corsi from Transport Infrastructure Ireland shared lessons from the creation of Luas' new EUR360m Cross-City route. The new 5.6km (3.5 miles) of double-track route installed through the heart of the Irish capital threw up a number of significant engineering tasks, including new and strengthened bridges and major remodelling of O'Connell Street near the landmark GPO building, he explained. The project involved six years of planning and design before the two years of construction began. It opened to passengers in December 2017.

Focusing on the embedded track sections of the project, Mr Corsi first outlined TII's extensive European benchmarking exercise and how he had found a wide range of different approaches to embedded track design and gauge control (some mechanical and some fastening based). This helped to inform the following requirements for the Cross-City track design:

- Reinforced track slab construction for track and road sections
- Using sleepers for construction support, alignment and gauge control
- Continuous encapsulation to manage stray currents and vibration control
- A preference for no filler blocks for better stability on shared-running sections
- Learning lessons of rail shoulder and road surface joint degradation.

The foundation is a continuously reinforced jointless slab track with a design life of 60 years. This was chosen as the best arrangement for the eventual surface solution of granite setts on key city centre sections, without precluding the use of asphalt elsewhere. Various trials were subsequently carried out on a section at Red Cow park-and-ride.

Learning from previous encapsulated track design issues (around 60% of shoulders

at junctions on the existing Red and Green lines had shown premature damage, Mr Corsi explained), it was decided to increase rail and road stability at the rail edge by using concrete infill laying over the structural slab, brought up to minimum distance from the top of rail.

"Getting the shoulders right is so important," he said. "As the wheel and rail wear, the wheels can run on the concrete. This is bad for stray current transmission, it's bad for the wheels and it causes cracks. Granite setts with concrete shoulders are structural, long-lasting, easy to maintain and support encapsulation. They look fantastic and last longer than concrete or tarmac, but do come at a cost."

Lessons from alternative trackforms

Amongst a number of sessions on alternative trackforms, Chris Haworth from Transport for West Midlands shared experience of the installation and maintenance of the short section of green track put in at Snow Hill as part of the Birmingham City Centre Extension in 2015.

Used widely across Europe, examples of green track are few and far between in the UK, although the choice to install 150m of grass track (using the STRAILastic_R system) at Snow Hill came partly at the request of the neighbouring property developer as a revision to the initial design. It now complements the 'living wall' and high-quality aesthetics of the Snow Hill estate and is mowed and treated at night by the developer.

As well as the aesthetic improvements and better noise and vibration attenuation, probably the most obvious benefit is the attraction for passengers, Mr Haworth added, serving as a further visual demonstration of the environmental credentials of light rail. For others looking at such systems, location is key, he explained, with maintenance, drainage, long-term durability and potential vehicle incursions being other considerations.

There have been 66 incidents of road vehicles travelling over the tram-only grass section since it opened in 2015, often causing major damage. This has seen the addition of anti-incursion methods such as a 150-170mm vertical kerb at the entrance to the section, that also incorporates drainage. This has been

finished in granite setts and is accompanied by additional 'no entry' and 'trap warning' signs.

While pleased with the overall result, Mr Haworth said that the UK's attitude to risk may make widespread adoption more tricky, but it is worth pursuing where appropriate: "It is very popular, so be prepared that if you do install it you will be asked for more!"

Two other innovative trackform approaches were presented at the LRT Excellence Day, both seeking to reduce both the cost and build time for light rail infrastructure.

The first is a design featured in TAUT before that is now making real progress as part of the UKTram Low Impact Light Rail programme. PCAT technology uses macro-synthetic polypropylene (MSF) fibre-reinforced slabs to replace steel fibres; pioneered by Greenwich University in the 1990s, synthetic fibre-reinforced concrete offers dramatic weight reductions and improved thermal properties. Five kilograms of synthetic fibre replace 30kg of steel, helping to reduce the construction depth by 25% and the carbon impact by 50%. It can also be easily recycled.

A patented dry joint system allows precise location and curved connectors are inserted from the top of the slab and tensioned; this allows individual sections to be removed in two to three hours if required. Geopolymer resin injection fills the gap under the slabs, providing a resilient material to cushion pressure on subterranean utilities. With a predicted lifetime of 120 years, the system is made even more attractive in that any surface can be laid on top and utility ducting and manhole covers can be incorporated into the design. Laboratory testing has indicated a 300-400% whole-life saving compared to established ballasted track designs.

A 100m test track has been installed at Long Marston and it is estimated that the concept's simplified installation process would allow up to 100m to be installed in a single day in an urban carriageway, with up to 250m achievable when upgrading from ballasted track. Wireless monitors record the stresses placed upon the connectors and track movement, so action can be taken before this movement becomes so severe that it risks tram or train derailment. We await the results of the next round of trials with interest.

Much has been made of the ground-breaking lightweight vehicles being provided for the Coventry Very Light Rail (VLR) programme, but Dr Nick Mallinson from WMG outlined the initial requirements for the equally innovative trackform for the project, due to open to passengers in 2024.

In 2017, Coventry City Council commissioned WMG to lead the development of a low-cost rail-based system with the aim of achieving a “whole-system cost of around GBP7m/km”. One of the areas of focus is a new ‘ladder-form’ track design that is quiet, cyclist-friendly and can be laid in 6-8m sections, requiring minimal installation depth to reduce as far as possible the requirement to relocate utilities. Early consultation has been crucial, Dr Mallinson reported, with discussions with utility providers to date being “very constructive”.

An ‘innovation partner’ for the trackform is due to be appointed in the coming months ahead of the installation of a test track in Dudley in 2020, for full-scale testing in 2021.

New thinking on rail grade selections

In a wide-ranging exploration of rail steels, Dr Jay Jaiswal of ARR Rail Solutions – also a Visiting Professor at the University of Huddersfield’s Institute of Railway Research – described the key rail degradation mechanisms, their causes and some considerations for both flat-bottom and grooved rails that can affect the choice of grades for renewals and new-build projects.

He started by explaining that while the wear of mating components is inevitable, rail life – and consequent replacement – should be dictated by safe wear limits being reached. Any other replacement should be regarded as premature. Although acceptable wear limits vary from system to system, he added, how often are these mandated limits reviewed?

While side wear can be restored on selected steels, vertical wear cannot so grooved rail life should only be dictated by the magnitude of vertical wear. As the threshold for vertical wear is dictated primarily by the need to avoid flange running (i.e. groove depth and flange height), achieving the maximum rail



▲ ABOVE: The grass track section installed in Birmingham (UK) has become a new visual landmark as part of the stylish new Snow Hill development. TAUT

“Grass track is very popular, so be prepared that if you do install it you will be asked for more!”



▲ Gauge weld restoration in Sheffield (UK); this technique has significantly increased the life of the South Yorkshire system’s rails. C. O’Brien/Supertram

life therefore requires optimal selection of the profile and rail steel grade.

Dr Jaiswal said that “networks should not be considered as a single linear asset as different stretches will degrade differently. The rate of degradation (and life) is never uniform throughout any rail network, so choosing a single rail grade is unrealistic.” Instead, he argued, tailored solutions for sub-sections should be based upon knowledge of influencing factors such as curve radius, cant deficiency, gradient, and vehicle type and loading.

A methodology for segmentation and determining susceptibility to degradation has been established at the University of Huddersfield, but this needs to be extended for all UK networks in the creation of an industry database of rail grades, lessons from their maintenance and where they are used to allow accurate comparators. Only once we have a comparative study can we develop guides for optimisation of maintenance and design of future networks and the selection of rail steel grades, he argued.

R260 (shallow curves or tangential track) and R340 HB (curves susceptible to side wear) account for 99% of European rail assets, Dr Jaiswal said, and hardened and heat-treated rails are increasingly becoming the ‘standard’.

Summing up, a total rethink is required when considering rail grade selection, he suggested. For tangent track, authorities and operators should consider the use of the most wear-resistant grade – no weld restoration will be required and the harder grade reduces corrugation growth. For shallow curves (i.e. >250m radius), choices need to be based upon avoidance of keeper wear before the vertical wear limit is reached; for tighter curves, he suggested opting for the most wear-resistant grade that can also be weld restored. Experiences in Sheffield have shown that this can significantly increase the life before replacement is needed. TAUT

› The latest LRT Excellence Day was organised by Mainspring in partnership with UKTram and took place on 30 April in Nottingham – www.mainspring.co.uk/lrt-excellence-days/

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LRT Excellence Days are designed to enhance understanding and co-operation between the teams responsible for the day-to-day operation and maintenance of light and urban rail systems, those with procurement responsibility, and the supply chain. Complimentary places are available for local authorities and rail operators.

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