THE PWI

THE JOURNAL

APRIL 2025 | VOLUME 143 | PART 2

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ENJOY YOUR RETIREMENT,
MIKE BARLOW PWI TECHNICAL MANAGER

This month, we said goodbye to Mike Barlow, who retired from his role as PWI Technical Manager.

Mike worked for London Underground for over 40 years. In that time he undertook a wide variety of roles including survey, design, renewals, construction, Parliamentary Planning, rail defects, track recording, standards and product approval. Mike retired in November 2021, and since then, worked as one of the PWI Technical Managers, assisting with the production of the Journal and organisation of seminars. Mike will be greatly missed for both his extensive industry knowledge and his sense of humour, and we wish him all the very best.

A LETTER FROM YOUR PRESIDENT

The railway industry is at an exciting crossroads. With rapid technological advancements, shifting environmental challenges, and an ever-growing commitment to inclusivity, our sector is evolving at a pace that demands both innovation and thoughtful leadership. As President of the PWI, I have had the privilege of witnessing first-hand how our community is rising to meet these challenges. In this article, I share my reflections on recent events, the progress we are making, and the vision that guides our journey into the future of railway engineering.

A TIME OF INNOVATION AND ADAPTATION

In recent months we have been busy hosting and planning a series of Seminars that not only address the technological challenges facing our industry but also showcase its immense potential. Our upcoming Seminar in April, themed around innovation and the integration of technology and data, is a prime example. This session will explore how technology is being embedded into the fabric of our daily operations—from advanced data analytics and AI-driven trend forecasting to real-time monitoring of rail infrastructure. Technology, when harnessed correctly, offers powerful tools to manage vast datasets, recognise patterns in defect detection, and support predictive maintenance. Yet it also brings challenges, particularly in terms of user engagement and the adaptation of legacy systems to modern digital environments.

The digital transformation we are undergoing is far more than the mere introduction of new software or the implementation of sophisticated algorithms; it is about transforming the way we think and operate. Many within our community have expressed both excitement and a measure of trepidation when confronted with these changes. It is essential, however, that we embrace these advancements not as a replacement for human ingenuity, but as a complement that allows us to work more intelligently and collaboratively. As professionals, we must ensure that the integration of AI and data analytics enhances our creative problem-solving, supports informed decision-making, and ultimately drives the evolution of our industry.

WATER IN THE RAILWAY: MORE THAN JUST DRAINAGE

While the April Seminar focuses on technology and data, our Water Management on the Railway Seminar addresses a subject that is equally critical to our industry's future. Traditionally, when water management was discussed, the conversation tended to point to drainage only. However, the reality is far more complex. Water affects every asset of the railway—whether it is track or earthworks stability, electro-mechanical impact, or the integrity of station infrastructure. With climate change inducing more extreme and unpredictable weather patterns, the challenges posed by water are becoming increasingly prominent.

Our upcoming Water Management Seminar is not about reiterating the basics of drainage; it is an invitation to examine the broader impact of water on our railway and its operations. We are now witnessing the consequences of both excessive water from heavy downpours and insufficient water due to prolonged droughts. These factors have significant implications for safety, performance, and the environment. The Seminar will explore approaches to water management that integrate principles of hydrology and hydraulic engineering with the realities of modern rail systems. By fostering an environment where experts from different asset groups and functions can share their insights, we aim to build a more resilient railway system—one that is better equipped to bounce back quickly from nature's extremes.

STRENGTHENING OUR COMMUNITY AND THE VALUE OF MEMBERSHIP

One of the most gratifying aspects of my role as President is the opportunity to engage with a vibrant and diverse community of professionals. Recently, at our PWI Track Renewals Conference in Birmingham, I was struck by the range of perspectives shared by colleagues from across the industry. Discussions centred on funding constraints, the need for greater efficiency in renewal projects, and the remarkable progress that has been made in reducing rail breaks. Yet, amidst these technical debates, one recurring theme emerged: the importance of being part of a professional community.

During the conference, I was particularly taken aback by the observation that the majority of attendees were not PWI Members. For those who have experienced the benefits of active participation—from access to cutting-edge training resources to invaluable networking opportunities—I would urge you to encourage your colleagues to join the PWI. Our membership is the backbone of the organisation; it fuels our initiatives, supports our research, and sustains our commitment to excellence. It is through membership that we can continue to innovate and collectively address the challenges facing our industry. I am delighted to share that we have recently celebrated a milestone by surpassing the 4,000-member mark. This achievement is a testament to the dedication of our community and the trust placed in the PWI as a leading Professional Engineering Institution. Yet, our work is far from complete; as we strive to expand our reach, it is imperative that we welcome new voices and fresh ideas into our fold, ensuring that our collective expertise remains robust and that our industry continues to thrive.

FOSTERING INCLUSIVITY AND EMBRACING NEURODIVERSITY

Inclusivity is not merely a buzzword; it is a fundamental principle that shapes our approach to professional development and community engagement. In today's world, where innovation thrives on diverse perspectives, it is essential that we create an environment where every individual feels valued and supported. At the PWI, we take pride in our efforts to embrace neurodiversity and ensure that all professionals—regardless of their learning or communication styles—have the opportunity to contribute meaningfully to our industry.

I have witnessed first-hand how a supportive workplace can transform challenges into strengths. For example, I have worked with individuals who are neurodiverse and benefited from their expertise and found them a source of unique insight. Seeing how their approach to problems offers a distinct perspective, often uncovering innovative solutions that might otherwise be overlooked. The PWI's approach is straightforward: if you have a different way of processing information, we want to harness that diversity to enrich our collective problem-solving capabilities.

THE DIGITAL TRANSFORMATION WE ARE UNDERGOING ... IS ABOUT TRANSFORMING THE WAY WE THINK AND OPERATE.

KNOWLEDGE 200 INITIATIVE: EMPOWERING THROUGH KNOWLEDGE

In our ongoing efforts to elevate professional standards and prepare for the future, the Knowledge 200 initiative stands out as a particularly ambitious project. The aim is to develop a comprehensive suite of 200 resources that will serve as a cornerstone for professional development across our industry. These resources are organised around four key areas: track, electrification, water management, and AI/data. By focusing on these disciplines, we hope to provide a balanced and in-depth perspective on the challenges and opportunities that lie ahead.

One of the most exciting aspects of this initiative is the collaborative spirit it fosters. We are actively engaging with experts from across the railway network to share their knowledge and insights. Whether through interviews, technical presentations, or collaborative research projects, the Knowledge 200 initiative is designed to empower professionals at every level. Our hope is that by making these resources widely available, we can inspire a new generation of engineers and technicians who are not only proficient in their fields but also passionate about driving progress in our industry.

This initiative also represents a wonderful opportunity to integrate external content from other PEIs and organisations invaluable material that complement our own Knowledge Hub. By linking to reputable external sources, we ensure that our members have access to the best available information, ultimately contributing to a more knowledgeable and informed railway community.

A VISION FOR THE FUTURE: REBRANDING AND REINVENTION

As we reflect on our history and look to the future, it is clear that the landscape of railway engineering has transformed dramatically since its inception in 1884. Our industry now encompasses a diverse array of technologies, asset types, and professional roles—each contributing to a dynamic and interconnected system. In recognition of this evolution, we are currently in the midst of a rebranding process that seeks to redefine our identity and align it with the realities of modern railway engineering.

The conversation surrounding a name change has been one of the most engaging topics at our recent events. It is not a decision made lightly, as it carries with it the weight of our storied past and the promise of our future. While our history remains a source of pride and a foundation for our values, we must also look forward and embrace the changes that will drive our Institution in the coming decades. Rebranding is not about discarding what came before; it is about evolving to better reflect who we are today and who we aspire to be tomorrow.

I am proud to be at the helm of this transition, even as I acknowledge that my term as President will soon come to an end. With the support of our members approving the name change, being the (possibly) last president of the PWI is a bittersweet milestone—one that symbolises both an ending and a new beginning. I am confident that the groundwork we are laying today will serve as a robust platform for future leaders to build upon. Our vision, mission, and values are being redefined not merely to keep pace with the times but to set the standard for what railway engineering can and should be.

BALANCING PROFESSIONAL AMBITION AND PERSONAL REFLECTION

While much of our focus remains on the technical and strategic aspects of our work, it is equally important to acknowledge the human element that underpins everything we do. As professionals, we often find ourselves juggling multiple roles—innovators, leaders, mentors, and, of course, family members. I have learnt that maintaining a healthy work–life balance is not only essential for personal well-being but also for professional effectiveness.

In the whirlwind of conferences, board meetings, and Technical Seminars, I have discovered the importance of carving out time for self-care and reflection. Whether it is enjoying a quiet Sunday morning with a cup of tea or taking a moment to recharge after a day of intense interactions, these pauses are crucial. They remind us that while our work is important, our well-being must always come first. I share this reflection in the hope that it encourages others in our community to find their own balance amid the demands of an ever-evolving and changing industry.

LOOKING AHEAD WITH OPTIMISM AND DETERMINATION

As we navigate this period of rapid change, I remain extremely optimistic about the future of railway engineering. Our community is resilient, innovative, and united by a shared passion for excellence. The challenges we face—be they technological, environmental, or cultural—are significant, yet they are matched by the collective ingenuity and dedication of our members. The upcoming Seminars, the Knowledge 200 initiative, and the rebranding efforts are all part of a broader strategy to position our industry for sustained growth and success. These projects are not isolated endeavours; they are interwoven threads in the fabric of our community's future. Each Seminar, each training resource, and every collaborative effort contributes to a larger narrative of continuous improvement, adaptation, and leadership.

I invite all members of the PWI—and indeed all professionals within the railway sector—to join us on this exciting journey. Your participation, insights, and enthusiasm are the lifeblood of our organisation. Together, we can overcome the obstacles of today and seize the opportunities of tomorrow. As we prepare to unveil our new identity and expand our educational initiatives, I am confident that the future of railway engineering is exceptionally bright.

THE ROLE OF CONTINUOUS PROFESSIONAL DEVELOPMENT

A key aspect of our vision for the future lies in our commitment to continuous professional development. We are developing new training programmes, workshops, and online resources that are designed not only to update our skills but also to foster an innovative mindset. These initiatives are tailored to meet the evolving needs of our industry and are accessible to professionals at every stage of their career. It is our firm belief that by investing in our own development, we can drive the transformation of the railway sector and remain at the cutting edge of engineering excellence.

IN CONCLUSION

Change is inevitable, but it is also a powerful catalyst for progress. The railway industry has always been defined by its ability to adapt—whether through the adoption of groundbreaking technologies or by reimagining traditional practices to meet contemporary challenges. As we move forward, let us embrace the innovations that will shape our future while honouring the rich legacy that has brought us this far.

I am immensely proud of what we have achieved together and excited by the road ahead. The initiatives and events we have planned are more than mere milestones; they are stepping stones towards a more connected, inclusive, and forward-thinking railway community. In this spirit, I encourage you to engage actively, share your ideas, and continue to be the driving force behind our collective success.

Thank you for your commitment and passion. Let us work together to build a railway engineering institution that not only meets the demands of the present but also paves the way for a future filled with promise, innovation, and excellence.

THINK ARTICLE

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FROM THE CEO
WELCOME TO THE APRIL JOURNAL

THINK ARTICLE

STEPHEN BARBER
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COLLABORATION AT WORK

A visit to a joint PWI-IRSE Section meeting in York gave me and others present (in-person and online) a fascinating insight into the upgrade of the Hope Valley railway route between Sheffield and the Manchester conurbation, and a reminder (if one was needed) of how critical collaboration between engineering disciplines is to the successful delivery of railway projects. Many thanks to Yorkshire Section for the friendly hospitality and for facilitating the sharing of knowledge – a fundamental purpose of our Institution. A gathering of the PWI's past Presidents the following day provided an opportunity to discuss the Institution's achievements in 2024 and the future plans outlined in my January Journal piece.

Eurostar train in Paris, France.

INTEGRATED TRANSPORT ABROAD

Travelling to Paris and Île-de-France in mid-February to celebrate a significant birthday (not mine) allowed me to enjoy a couple of Eurostar trips, both (as has become customary in my experience) on-time if not early. Paris, roughly at the centre of the Île-de-France Region[1], is a great centre from which to explore by public transport using the RATP integrated network of bus, tram, metro, and rail services (which includes SNCF Transilien Paris area services). Planned since 2016 with phased infrastructure and service enhancements, the network's new "flat fare" structure came into force on 1 January 2025. It covers the entire Île-de-France Region and allows two hours' travel on metros and trains for €2.50 (a bargain where some in-region journeys can be well over 100km long). Radial metro and rail routes are augmented inside Paris by orbital rail, metro, and tram-type services, while outside the Paris metropolitan area orbital routes are generally operated by rail or bus services (see the system map at www.ratp.fr/en/plan-rer).

ENGINEERING AT THE INTERFACES

Back to engineering roots for the annual industry Vehicle/Track System Interface Committee (V/T SIC) and Adhesion Research Challenge (ADHERE) seminar, once more in York. A selection of first-class papers described the latest developments in modelling and managing the wheel-rail interface. Lessons learnt from work in fitting the latest sanding technology to multiple unit fleets in Wessex and the North of England were shared, together with early (positive) indications of the technology's effectiveness in preventing wheel slides.

A SELECTION OF FIRST-CLASS PAPERS DESCRIBED THE LATEST DEVELOPMENTS IN MODELLING AND MANAGING THE WHEEL-RAIL INTERFACE

Whilst this was an excellent event, I noted a lack of representation from the light rail and metro sector which, though understandable given the origins of V/T SIC and ADHERE, seems like a missed opportunity for sharing knowledge, much of which is relevant to any steel wheel on steel rail system.

Delegates at the York event also learnt how artificial intelligence is being applied to video recordings from forward-facing train-mounted cameras in a pilot scheme monitoring railway infrastructure and detecting faults and conditions that could develop into faults. Notably this theme will be expanded on at the **PWI Route To Change** seminar at the University of Manchester on 10 April. (I look forward to seeing many of you there!)

[1] A land area of some 12,000 square kilometres with a population of just over 12 million broadly equivalent to the combined historic shire county areas of Kent, Sussex, Surrey, Middlesex, and Berkshire.

THINK ARTICLE

DR BRIAN COUNTER
TECHNICAL DIRECTOR
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WHAT A GREAT START TO 2025 RAILWAY TECHNICAL NETWORKING!

The PWI has already exceeded expectations and more railway people are involved in knowledge enhancements as we celebrate 200 years of railways.

I am delighted to report that the feedback from PWI Technical Courses has been excellent with many delegates not only giving credit for the expert knowledge and experience but how they appreciated the style of delivery which is "friendly, supportive and fun!".

We are pushing forward with future expansion and development into 2025, where we have secured an extensive programme of individual and corporate bookings. The PWI Education brand is becoming increasingly well recognised for quality delivery. We have bespoke plans for Network Rail Graduates and Technicians, Irish Rail and Hong Kong MTR. We were also delighted to host another delegation from Hong Kong MTR in London and discuss further training in structures and derailment investigation. Our complementary direct support for promotion of professional registration will continue with member's help as we aim to beat our best year ever in 2024. There will be more focus on an expansion of the integrated apprentice provision and experiential learning will help us achieve this ambition.

The PWI's strategic goal to "promote railways and have a voice in government" is moving to a new level with our involvement with the Royal Academy of Engineering and this now involves my membership of the Educational and Skills working group.

THE PWI
EMPOWERING RAILWAY ENGINEERING

200 Years of Train Travel Since 1825

LINKED EVENTS AND TECHNICAL ACTIVITY

On PWI courses, we are always promoting membership and corporate industrial innovation all of which leads to CPD, the backbone of our reason to exist. We have many PWI events planned for 2025 large and small, face to face and on-line, not to mention our fabulous lunch-and-learn taking place every other Tuesday. We have worked hard to find eminent and practical speakers to encourage new people to obtain more knowledge. At all these events we now have professional registration as a common theme and offer support and further help. Watch out for the PWI Water Management seminar on 7 May in London, Electrification Innovation on 2 July in Cardiff, the International Railway Engineering Conference on 9-12 June in Edinburgh and the fantastic UK RAIL LIVE exhibition and railway trade fair from 19/20 June at Stratford-upon-Avon.

I attended and presented at the UKRRIN (UK Rail Research Innovation Network) student conference at the University of Sheffield in January, where over 100 PhD students competed for prizes for doing posters and presentations. Twenty Universities participated in the event and there are an estimated 150 PhD's in progress in the UK related to railway engineering themes. I was happy to offer free student membership and guidance for registration. We are now working with RSSB to further promote research in railway system and infrastructure.

UKRRIN 2025 STUDENT CONFERENCE @ THE UNIVERSITY OF SHEFFIELD

PROFESSIONAL REGISTRATION

Following on from a superb year in 2024, Liz, Charlotte and I are working on recruiting and processing many more people at all levels. This includes academic assessments of people's qualifications which is running at an all time high which indicates that the message about what is needed for registration is getting well known. We are still looking for the missing 5000, who should be PWI members and be professionally qualified to benefit the industry and themselves!

Shimon Shapiro PhD Rail student from Brunel University London receiving the PWI prize from Dr. Brian Counter for student membership at the UKKRIN Student Conference University of Sheffield (Photo courtesy of B.Counter).

My main target for 2025 is apprenticeships. Most apprenticeships, even those undertaken as early as 2005 provide virtually automatic registration as EngTech MPWI because the competencies assessed map straight across. Since 2018, when apprenticeships were levy-funded they match exactly with the Knowledge, Skills and Behaviours (KSB's) align to UKSPEC Engineering Council requirements. So there are hundreds of ex-apprentices at Level 3 sitting out there without EngTech – do you know any?

Anyway, there are currently 400 Network Rail Technician (Level 3) apprentices in progress,150 are free PWI members and we are working to see what support we can give them. There are also 200 Rail and Rail System degree apprentices (Level 6) who will get IEng MPWI alongside their degree, the details can be found on the PWI website or your company's HR partner.

ATTC Delegates at Progress Rail in Sandiacre near Nottingham being shown a welded vee, manufactured using submerged arc electro-slag process by Paul Kelly (Photo courtesy of B.Counter).

TECHNICAL EDUCATION AND TRAINING TO DEVELOP THE BEST RAIL PEOPLE

Going back to our "challenges" and the impact of even more PWI courses, we need to improve our conversion of the 1000+ course attendees in 2025 to PWI members and registrants. About 98% of these could be EngTech now and the majority could progress at least to Incorporated Engineer.

We will deliver over 50 courses in 2025. This is due to increased demand and the addition of Irish courses, Hong Kong MTR, Network Rail Graduates, Technician courses and further bespoke S&C Refurbishment courses. We particularly delighted Irish Rail for their Track Engineering Diploma Module 3 in Portlaoise by bringing across Mike McLoughlin over from Derby who is the world expert on derailment investigation.

Regarding new courses, the review of the electrification engineering courses is progressing well under the leadership of James Collinson to align them with the principles of safety and systems engineering, sustainability and net zero. Our ultimate idea on electrification is to have 5-6 modules which we call "pick and mix" with core 25 kv OLE, DC 3/4th Rail, DC OLE, and Trams/light rail.

The next phase of development planned for 2025 is further advanced courses in Switches and Crossings as we have perceived a great need and interestingly will also be targeted towards multi-disciplinary aspects of points including signalling.

As previously indicated, we are working to academically validate our courses to build up a portfolio which matches registration requirements to enable people to progress through the experiential route and fill any academic gaps.

We will shortly be awarding the validated Advanced Track Technician Course at HNC Level 4 (60 credit equivalent) to a cohort of 18 Network Rail technicians which will help them towards Experiential learning to IEng. An innovative element of the last ATTC Module 3 was a visit to Progress Rail at Sandiacre and Beeston, near Nottingham, with the emphasis on learning the proper and accurate ordering of replacement S&C units.

Track support loss at Grange over Sands causing passenger train derailment (Image courtesy of RAIB).

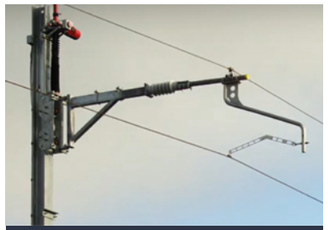
TECHNICAL AND SAFETY

Track maintenance and dealing with water is a complex engineering challenge and every incident is unique and needs to be a learning point. RAIB reported its findings into the serious derailment at Grange over Sands last year. The derailment occurred because a void had opened in the embankment on which the train was travelling, leading to the rails under the train losing support. The void had been created because water had dislodged embankment material and carried it away. The water came from a pipe partially buried beneath the railway, which had been damaged during tamping around two days before the derailment. The recommendations are internal and external. For track engineers, reduce the risk associated with temporary drainage solutions which remain in place for longer than anticipated and ensure tamper operators are aware of buried services and carry out proper surveys including marking up obstructions. Externally, liaise more with the Environment Agency and others to encourage timely decision-making in relation to the management of flood water around the railway.

AND FINALLY, LET'S GET TECHNICAL...

It's good to see a well-designed and delivered cost effective track enhancement scheme. Mark Stowell IEng (MPWI) Systra Technical Expert in track describes in this Journal (page 10) his involvement as part of S&C renewal on the Transpennine Route Upgrade east of Leeds project (TRUe). An upgraded NR60 Mark 2 curved C13 transitioned crossover, with Mark 3 in-bearer clap lock points operation was cleverly chosen to replace the existing 113A C13 transitioned timber bearer crossover, to fit in with minimal impact and changes upon other infrastructure which is excellent value for money!

On the subject of technical innovations to reduce overall system costs, Furrer+Frey GB (PWI corporate member) have developed the "Cost-Reducing Dynamic Electrification System" (CODES) which uses remotely controlled cantilevers to create a real-world twin of overhead power line designs. The company say it could revolutionise the electrification process by enabling rapid, cost-effective testing and fine-tuning of designs. Noel Dolphin, Furrer+Frey Head of UK Projects said "Our vertical-movement system could radically cut costs in the field of railway electrification. Bridge lifts for electrification can cost millions of pounds, something we can save by thoroughly testing and scrutinising designs in a way that was, until now, simply too expensive. Our kit will allow us to set up a full-scale twin of a design, bringing something from paper into real life, where it can be safely tried and tested to fine-tune designs."



Innovations in OLE systems - remotely controlled cantilevers (Photo courtesy of Furrer+Frey GB).

Mark Stowell
IEng (MPWI)
Technical Expert - Track

Mark is SYSTRA's Technical Expert – Track.

He is an Incorporated Engineer with over 28 years of rail industry experience. He specialises in permanent way design and railway engineering integration.

Mark leads SYSTRA's quality and innovation development, plus project track design delivery, including on the Transpennine Route Upgrade East of Leeds.

THE TRANSPENNINE ROUTE UPGRADE EAST OF LEEDS (TRUe) PROJECT

KNOWLEDGE 200 TRACK

INTRODUCTION

The Transpennine Route Upgrade east of Leeds (TRUe) project is enhancing the route between Leeds and York as part of the wider TRU project. The project is improving operational and asset resilience, safety, and route capacity. On the weekend of the 16/17 November 2024, the TRUe Alliance renewed 762A/B points crossover at Dringhouses, near York. The crossover is an NR60 Mark 2 curved C13 transitioned crossover, with Mark 3 in-bearer clamp lock points operation. This was chosen as a modern S&C renewal option for the renewal of the existing 113A C13 transitioned timber bearer crossover, to provide a 'like for like' footprint and minimise the impact upon other assets.

The crossover lies between the Down Leeds (CWR track) and Down/Up Holgate Goods Loop (jointed track), which required a partly welded and partly fishplate jointed layout to manage the thermal forces. Conversion of part of the Down/Up Holgate Goods Loop to CWR, to permit the full crossover layout to be installed as stressed CWR was considered. However, this was not favoured due to the adjacent buffer stop and other jointed S&C creating additional scope, etc., which may have negatively impacted the project.

The TRUe scope in this area was based around retaining the existing route alignment, to provide the optimum benefit versus cost. However, the existing track layout created several constraints. One constraint was that the through routes of the crossover would not be fully parallel, which may complicate manufacturing, installation and maintenance. This impact was minimised, as the non-parallel alignments were contained within the switches of 762B points, outside of the long bearers. Signalling clearance points lengths were also increased to the required 5.88m, with insulated rail joint repositioning and the proving of a sub-1970mm fouling point by passing clearance assessment.

Due to on-site construction access and agreed maintainability requirements, the crossover was designed as non-modular, to be lifted into position by Kirov crane. The crossover was manufactured by Vossloh Cogifer as a panelled layout to suit the transportation and construction methods.

Installation was undertaken via traxcavation and laid on an anti-pumping geotextile, reinforced with a biaxial geogrid, to provide the required track stiffness and asset life. The layout was installed and retuned to operational use on time, with no safety incidents.

ONE CONSTRAINT WAS THAT THE THROUGH ROUTES OF THE CROSSOVER WOULD NOT BE FULLY PARALLEL, WHICH MAY COMPLICATE MANUFACTURING, INSTALLATION AND MAINTENANCE.

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Belfast Grand Central Station (Part 1)
Presenter: Lisa McFadden
Date: 29 April 2025

Belfast Grand Central Station (Part 2)
Presenter: Andy Fynn
Date: 13 May 2025

The adoption of geopolymer solutions to reduce the carbon footprint of rail maintenance projects
Presenter: Sam Doe
Date: 27 May 2025

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If you would like to volunteer in chairing a session in our Autumn/Winter 2025 programme, please contact stuart.murphy@thepwi.org

Andrew McGivern
B Eng Track Engineering
Manager, Translink

Stephen Lavery
Technical Engineer,
Translink

Andrew McGivern is the Track Engineering Manager at Translink.

He is a Civil Engineer and, after a few years in that industry, he has worked in the Permanent Way Department of Northern Ireland Railways for the last 27 years. His experience covers inspection, maintenance, refurbishment and renewal of track assets undertaking roles of asset maintainer, designer, technical specialist and installer of plain line and switches and crossings throughout Northern Ireland.

His roles have always included decision making on most appropriate interventions to maximise track durability and whole life costs while working to available budgets.

Stephen Lavery has 27 years in Translink within the Permanent Way Department. Having started as a trackperson, Stephen progressed to Track Patroller, followed by P-Way Maintenance Foreman within P-Way Track Maintenance Teams. He then moved to the position of Permanent Way Trainer & Assessor before finally moving to his current position as Technical Engineer.

His core functions are based around rail health, having been involved in Ultrasonic & Eddy Current Testing and Rail Milling.

Stephen's work has involved researching and introducing new and innovative technologies, including remote monitoring devices such as Remote Rail Thermometers, Weather Stations and more recently looking after Rail Friction Management.

IMPROVEMENTS IN TRACK CONDITION ASSESSMENT TO INFORM DECISION MAKING

KNOWLEDGE 200 TRACK

Good knowledge about the condition of your assets, along with a detailed understanding of the impact of a range of interventions to correct defects, extend life and ultimately replace failing components is essential to a cost effective, high performing maintenance regime. In Northern Ireland, we have implemented a system of condition assessments to give us a better understanding of the state of our track assets so that we can optimise decisions on interventions. The ultimate aim is to develop sustainable workloads and secure adequate funding to achieve them.

We have taken a practical approach to assessing condition, using back to basics principles which can sometimes be forgotten. At each end of the condition scale, assessment is relatively easy. Recently installed track, with new components and high specification construction is very good and clear to see. At the other extreme, very poor track at the end of its life will have multiple problems such as geometry defects and wet beds with limited response to maintenance. Again, this is relatively easy to classify. However, all assets begin as new and progressively deteriorate towards poor, and the rate of deterioration is highly dependent on the effort put in to maintain them. We want to know where our assets are on the journey from very good to very poor. For an organisation planning into the future, seeking to secure the right funding and planning workloads, we have to know what we have got coming, not next year or two years' time but five, ten, fifteen years ahead.

To put this into context, the rail network in Northern Ireland covers roughly 200 route miles with 50% double track and the rest single with around 200 main line sets of points. Translink owns and operates all the infrastructure and train services. It is a passenger only service. All plain line is CWR on concrete sleepers. Track is performing well with currently no track condition speed restrictions in place and track faults account for less than 2% of all train delays. In the last few decades, we have been very fortunate in receiving funding to allow us to compete high quality renewals with formation treatment, drainage and ballast replaced in about 25% of the network. Prior to that, renewal work focused on replacement of rails and sleepers to achieve CWR with less attention on the supporting works underneath.

Our challenge is to ensure the ongoing performance of the railway and inform our decisions for the short, medium and long term so we can choose the most appropriate solutions for our network. We want to maximise the performance of what we have, minimise the whole life cost and have a clear plan for remedial measures so we can form a long-term strategy which helps us to look at financial and workload planning.

OUR CHALLENGE IS TO ENSURE THE ONGOING PERFORMANCE OF THE RAILWAY AND INFORM OUR DECISIONS FOR THE SHORT, MEDIUM AND LONG TERM SO WE CAN CHOOSE THE MOST APPROPRIATE SOLUTIONS FOR OUR NETWORK.

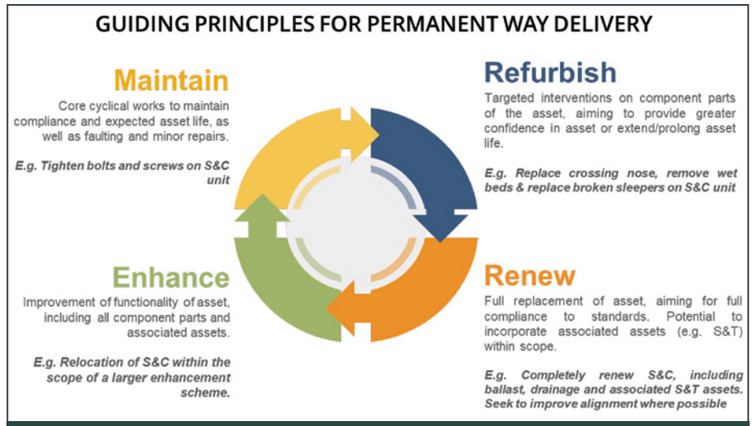

Figure 1: Permanent Way Asset Wheel.

Condition Code	Condition Description	Condition Description
C1	Very Good	Asset meets standard requirements
C2	Good	Asset meets standard requirements, but some deterioration noted
C3	Satisfactory	Asset meets core requirements, has some signs of deterioration but not presenting a current risk to performance.
C4	Poor	Asset has clear signs of deterioration, potentially likely to require short notice and/or repeat maintenance. Risk of potential failure elevated in the medium term.
C5	Very Poor	Asset extensive deterioration/defects. Does require high degree of short notice and/or repeat/reactive maintenance to maintain safety thresholds. Risk of potential failure in short term and risk of functional failure elevated in the medium term.

Figure 2: Condition codes.

- Evidence of water retention between ballast pieces
- Minor contamination/detritus, Cribs contain 25-30% fines
- Moss and small vegetation evident on top surface
- "White" areas evident as ballast degradation begins leading to tell-tale signs of minor voiding
- Failing beds potentially forming at Rail Joints, away from plain line.
- Ballast under sleepers is noticeably smaller, 11-30% fines and more rounded than ballast in cribs and shoulders

Figure 3: Guidance for satisfactory ballast.

Our approach to management of our assets can be summed up by the Asset Wheel **(Figure 1)** which is intended to maximise the service life and promote the most effective interventions. It starts with good quality maintenance, then moves through targeted component replacement and eventually to full scale renewal when most cost effective. Enhancements are over and above to achieve more capacity or higher speeds.

Coming back to condition assessment, we wanted a simple, objective, repeatable system, with an emphasis on visual assessment to harness the knowledge and experience of the Permanent Way staff on the ground, backed up by technology when we need it. Assets are given a condition code based on a five-point system from very good to very poor as per **Figure 2**.

Plain line is broken down into 1/8th of mile sections, and Switches and Crossings (S&C) are assessed individually. Elements are assessed individually starting with top and line and working down through rails, sleepers, ballast, formation and drainage. We also look at physical features that would have an impact on how well the track might perform.

Of all the elements of the track structure, ballast condition has arguably the greatest impact on track quality but is also the most variable material. Therefore, we will focus on ballast initially to describe our method of condition assessment. Guidance notes were developed to assist with the visual assessment of ballast conditions. An example for satisfactory ballast is shown in **Figure 3**. Ballast degradation is normally due to the stone breaking down into smaller fragments increasing the percentage of fines in the material which reduces the ability to absorb impacts and prevents free drainage. A small hole is dug by hand to expose the ballast under a sleeper in the middle of the track and the rating is based on what is observed.

New ballast to specification in very good condition is easy to score. It is sharp and angular, locks very well together with plenty of voids to allow free drainage. It fulfils its requirements in providing support and stability to the track absorbing impacts from sleepers and returning to its original position. It gives excellent, durable results to the maintainer after remedial work like tamping.

Ballast in good condition is similar in appearance to very good but cosmetically it may not be as clean as we see the development of small amounts of fines 4-10% beneath the sleepers It still holds profile, offers good support and stability to the track and provides good durable results from maintenance.

Satisfactory ballast is around mid-life and is slightly more difficult to assess. It's obviously not in very good or very poor condition. We see the first visual signs of degradation with moss and vegetation evident on the surface layer, water retention between the ballast pieces, signs of minor voiding, recognisable as "white areas" and with some rounding to the ballast. Increase in fines below the sleeper to approximately 11-30% and signs of detritus, contamination, and fines within the cribs to approx. 25-30%. It still provides good results to the maintainer but with some reduction in durability.

At poor condition, the ballast is well along its journey of degradation. Ballast pieces are fragmented due to the repeated loading from

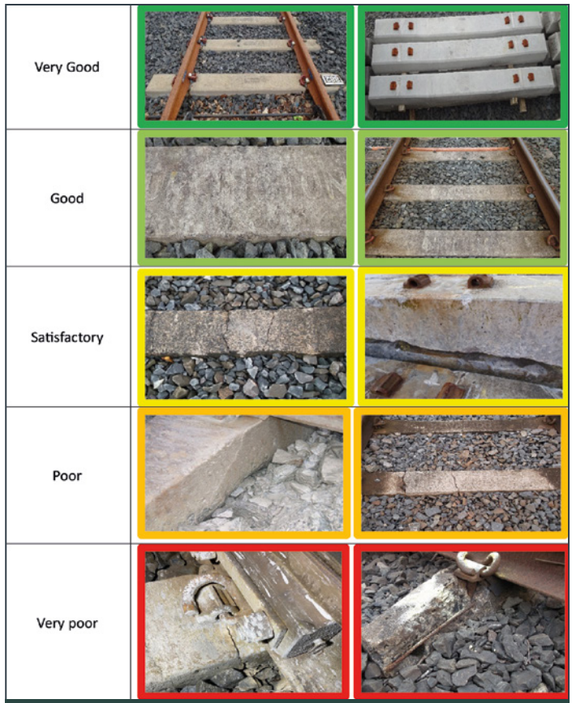

Figure 4: Examples of various grades of concrete sleepers.

rolling stock, the pumping action of the track from voiding and more frequent maintenance interventions such as tamping. By this stage the track could have been tamped several times with each tamping cycle creating 2.5-4kgs of fines per sleeper which will have a detrimental effect on ballast condition. Some ballast can be clogged with slurry which increases water retention which can lead to exponential degradation of an already poor asset. Track support and stability can be greatly diminished. We will now see an increase in fines beneath the sleepers of approximately 31-50% and approximately 50% of the content within the cribs.

Very poor is easily scored, it will look very poor. There will be more fines in each crib than useful ballast. You will see the development and propagation of wet beds. Cribs can be saturated in standing water as the clogged ballast and shoulders are no longer free draining. No durable results to be gained from any mechanical or manual maintenance activities as the ballast is no longer "free flowing". A knock-on effect of degradation is likely to negatively impact sleepers and formation. Only a full excavation and reballasting exercise are going to win favourable results.

Wet beds can be viewed as an indicator of ballast performance as it reaches the end of its life. In addition to the outlined methods of scoring ballast condition, we consider the number of wet beds per 1/8th mile of track. To build a history of the long-term condition of the ballast in a section we keep a record of the number of wet beds that have been removed locally. This data can highlight areas with a higher wet bed recurrence or where past removal has not provided the expected longevity. Recurrent, localised wet beds could be an indicator that a site is a suited for heavier intervention than ballast replacement.

In addition to the visual assessment of ballast condition, further surveys were carried out on 50 miles of track using Ground Penetrating Radar alongside Automatic Ballast Sampling and Test Holes at alternate 100m intervals. This more detailed survey produced very specific sets of data giving information on the condition and depth of existing ballast and similarly on other layers within the subgrade. Grading curve analysis at each test hole also provided data to establish the size and quantity of existing ballast and volume of fines to determine potential return rates from Ballast Cleaning. The results also provided good correlation to the condition assessed visually.

Sleepers are another vital asset within the track structure. Sleepers are a prime example that condition rules over age. Concrete sleepers can be decades old but still perform very well. Very Good & Good condition sleepers are relatively easy to score. Very Good Condition looks brand new & Good Condition simply looks a little more aged having lost the freshly made look of new concrete. As they degrade, we might expect to see some dulling of the crisp outer edges and some rounding begins in the soffit and undersides from loading and also tamping and/or Kango packing. At Satisfactory Condition, we might encounter some minor gall/abrasion in the rail seat to a max of 1mm with evidence of centre cracking to a max of 1mm width, however the sleeper still maintains gauge and supports the rail. At Poor Condition we might have cracks up to 1mm in the rail seat area and with centre cracks between 1-3mm to a maximum number of three per sleeper. At Very Poor Condition there will be larger cracks in the rail seat with possible exposure of the reinforcing tendons. There could be defective housings. The sleepers will be moving toward becoming ineffective and would already be on a plan for priority replacement **(Figure 4)**.

A further case study was undertaken to verify the condition of ballast and sleepers on a 20 mile stretch of the Coleraine to Londonderry line along the north coast of Northern Ireland. The track was relaid in the mid-1970s with jointed 50kg Flat-Bottom (FB) rail on concrete sleepers. The sleepers were installed directly onto the existing ballast which was previously used for wooden sleepers and no drainage or formation works were undertaken. In 2012, the line was rerailed and converted to CWR using to 113lb FB rail. As part of the study, trial holes were excavated at ¾ mile intervals to a depth of 200mm below the bottom of the sleepers **(Figure 5)**. Anecdotally, we consistently noted if the ballast on the surface scored as Satisfactory it was at best scoring as Poor Condition at 200mm below sleeper bottom. Frequent ballast top ups over the years provided a deceiving cosmetic top layer of ballast. Randomly selected sleepers were removed at ¾ mile intervals for off track analysis. These proved to be within tolerance with little dimensional change since their installation. The vast majority of sampled sleepers were in Good or Satisfactory condition. Even after 50 years in track under less than favourable conditions the sleepers were still performing very well.

Figure 5: Case study for ballast and sleepers - trial holes excavated 200mm below sleeper (left) and sleepers removed for analysis (right).

Moving on to rail, it can prove difficult to condition rate as there are many facets to scoring it. Non-destructive Testing provides the majority of our data to inform rail condition, mostly identifying defects such as Squats or Rolling Contact Fatigue (RCF). We broadly categorise defects as either being "actionable" or "non-actionable" with Minimum Action Codes or MAC Codes defining the severity of the defects. The frequency and severity of defects within each 1/8th mile will determine the rating for the condition of the rail within that section. To further enhance our available data on rail condition we are going to add increased Eddy Current Testing into our plans in the future.

Whilst NDT is an excellent tool, management of rail defects will always have a requirement for robust visual inspections to detect the flaws that can prove elusive to Ultrasonic Testing. Typical defects which prove difficult to detect with UT testing are associated with the foot of the rail particularly loss of section and/or corrosion. Other wear associated defects such as plastic flow, rail-end batter and sidewear/headwear might not be picked up through non-visual assessment such as Ultrasonic Testing.

Other issues that can cause potential concerns are SmW welds, an older type of aluminothermic weld with less process and quality controls at manufacture and installation than modern aluminothermic welds. These lesser controls along with Ultrasonics' inability to accurately test them (due primarily to the very exaggerated weld collar) mean they will impact upon the condition score of rail when they are recorded in any 1/8th mile. Ingot Rolled Rails also give rise to scoring down the condition of rail in a 1/8th. Ingot-Rolled Rail, unlike the current Concast rail is more liable to give rise to manufacturing defects such as Vertical Longitudinal Splitting (VLS) which can be difficult to detect ultrasonically so knowing the locations of Ingot-Rolled Rail is a key part of managing it.

WE CAN GET CARRIED AWAY WITH TRACK GEOMETRY DESIGNS, PROGRAMMES FOR REPLACING RAILS, SLEEPERS AND BALLAST AND PLAYING WITH BIG YELLOW PLANT, AND CAN NEGLECT THE PROVISION OF GOOD DRAINAGE.

Geometry is the most obvious aspect of track condition and performance under traffic. We are currently using the Iarnród Éireann Track Recording Vehicle to measure the dynamic condition of the track. Principal measurements are level, line and twist. In the first instance, track recording identifies the location and severity of geometry defects but, for condition assessment, it is the analysis of standard deviations in line and level that are the most beneficial. The track recording produces an index for line and level for each 1/8th of a mile which we classify from very good to very poor. However, the recording is only a snapshot in time and the track quality is affected by the maintenance effort put into a section, so we include tamping history to give a better indication of overall track performance.

Drainage is quoted in every textbook or track maintenance manual as the track engineer's best friend. However, I suspect we are not alone in Northern Ireland of having been guilty of failing to give it the attention it deserves. We can get carried away with track geometry designs, programmes for replacing rails, sleepers and ballast and playing with big yellow plant, and can neglect the provision of good drainage. It is unglamorous, difficult to work on and doesn't provide the immediate "hit" of new rails and sleepers. However, the people who built the railways in the 1800s knew the importance of getting the water away from the track and installed drainage systems to do it, and up until relatively recently, small armies of workers kept it working well. As stated earlier, in the last 25 years, we have undertaken high specification renewals on about 25% of our network which included good drainage in those areas. However, that leaves 75% legacy track where the drainage is less than desired. In terms of condition assessment, we take an indirect approach to prioritise the need for drainage based on how well the track is performing. Areas prone to flooding are in the very poor category followed by locations of recurring wet beds, rising in conditions rating to areas which currently do not present problems though to good areas where we know drainage is working, to very good where it has been upgraded in the recent past.

When it comes to formation, we use indirect assessment based on track quality, ballast conditions and success of maintenance works. Most of our railway is around 150 years old so the formation below the track is well consolidated. We believe most of our problems come from poor ballast and drainage, so the primary focus is on correcting these. Formation treatment can be expensive, eating up budgets, so we want to be careful that we don't over-engineer. We identify areas where we think soft ground is the problem, undertake proper site investigation to evaluate the scale of the problem and then construct solutions to correct it.

Then there are physical features that have an impact on track performance, particularly where lifting during tamping is restricted. Overbridges are an obvious feature due to structural clearances plus they are generally in cuttings which need good drainage. Level crossings are subject to additional loading from road traffic as well as extra water and dirt from the road itself. Levels need to be controlled but the road surfacing makes it more difficult to access the track for maintenance. Platforms hinder tamping while requiring tighter tolerances for stepping distances. These three areas tend to be associated with more rapid deterioration so need more frequent and higher quality interventions.

Switches and Crossings are another feature that is more challenging to maintain than plain line track. S&C condition is assessed in individual units broken down into the major components. Top and line is assessed visually before, through and after the unit to back up information from Track Geometry recording. Steelwork is assessed looking at switches, crossings, plain rails and any joints. Each bearer is given a condition rating to compile a number in each category. Ballast, formation, and drainage is assessed similar to plain line although the majority of our S&C is still in timber which is more forgiving of poorer quality ballast and all the concrete units have been installed in recent years with new ballast and high-quality formation treatment and drainage where required.

All the information gathered for the various components is recorded as "swim lanes" on spreadsheets **(Figure 6)** with columns representing 1/8th mile sections and rows representing the various condition elements with individual cells coloured to indicate the condition. Physical features affecting track quality are added to the column and highlighted. This gives a very visual representation of track quality along a section of track often providing correlation between different elements and allowing us to home in on the potential causes of problems.

ELR-Eighth	BGD15.5	BGD15.625	BGD15.75	BGD15.875	BGD16	BGD16.125	BGD16.25	BGD16.375	BGD16.5	BGD16.625	BGD16.75	BGD16.875	BGD17	BGD17.125	BGD17.25	BGD17.375	BGD17.5	BGD17.625	BGD17.75
Asset	Plain Line	Plain Line	Plain Line	S&C	Plain Line	OB	S&C	Plain Line	Plain Line	Plain Line	Plain Line	Plain Line	Plain Line	UWC	LX	Plain Line	Plain Line	Plain Line	Plain Line
TRV 2022																			
Feb TRV 2023																			
AUG TRV 2023																			
Jan TRV 2024																			
PSR UP DIRECTION				90				90				90				90			90
PSR DOWN DIRECTION				90				90				90				90			90
Ballast Visual Condtion	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Number of Wet Beds	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0
Sleeper Visual Condition	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Sleeper Count of Very Poor	0	0	0	2	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0
Condition score inc pre 76 & vilru	4	2	4	1	1	4	1	1	1	1	2	2	2	2	2	2	2	2	2
Rail condition & Rail defects	2C	3M	3B			2C													

Figure 6: Extract from "Swim Lane" for 1/8th mile section of track.

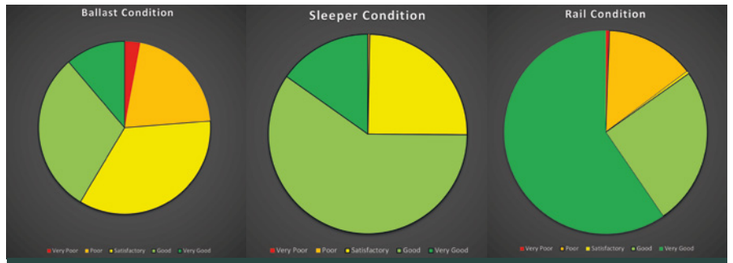

Figure 7: Condition summary for ballast, sleeper and rail.

So, what have we found from all of the condition assessment? Collecting the data and displaying it in a straightforward format makes very compelling cases for various types of interventions and is used in option selection for business cases. In addition, we have a better understanding of the overall conditions of our assets. **Figure 7** shows a summary of the condition for our ballast, sleepers and rails. For ballast, roughly 40% is in the very good / good band and with another 35% satisfactory, leaving about one quarter in the poor condition. Sleepers are doing very well despite many in less than favourable ballast conditions. Rails have got to a fairly good place, due to an intensive campaign in recent years tackling problems, with some more work to do. These statistics will direct our decision making and form a benchmark to measure the success of our interventions.

The ultimate aim of the condition assessment is to improve decision making and from it, we have identified a number of key themes that will direct our plans for the future:

- Rail milling has been introduced to remove head defects and extend rail life
- Removal of SmW Welds and ingot rolled rail
- Early replacement of Insulated Rail Joints
- Retain sleepers where possible
- Ballast cleaning is being actively pursued to cost effectively improve ballast conditions
- Target high specification renewals in problem locations to deal with root cause
- Increased emphasis on drainage
- Component replacement in S&C including introduction of Composite bearers

In conclusion, we have a much better understanding of our asset conditions, which is driving our plans for remedial work. We propose to aim for a spread of conditions in the very good to satisfactory categories with remedial works planned before it gets to poor. We want to ensure we don't over engineer so we can strike the correct balance between spend and reward, accepting that everything does not need to be perfect and taking a measured approach to risk that a small percentage of areas may need additional treatment. We wish to maximise the life or our assets and have sustainable long-term workloads. If we can get it right, we can win on sustainability, performance and cost which should be at the heart of all sound engineering.

This paper was presented at the Railways in Ireland PWI Seminar on 23 May 2024 and is available to view on the Knowledge Hub

The authors would like to give credit to Mervyn McCollam, Head of Rail Infrastructure Engineering at Translink for developing the concepts described in this paper and driving their development forward.

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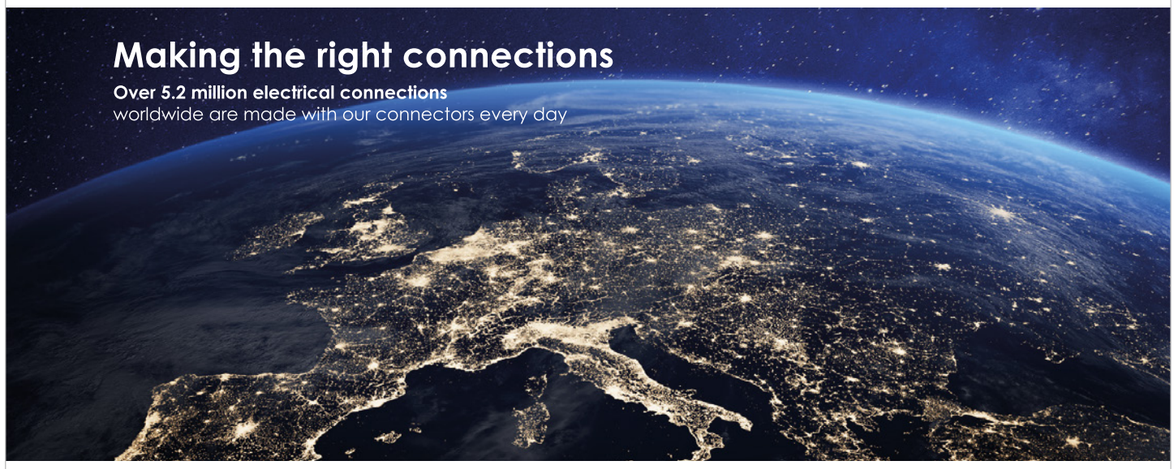

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Dr. Choon Park
Principal geophysicist,
Park Seismic LLC

Peter Sayers

Dr. Choon Park is lead author of the MASW technique published in GEOPHYSICS in 1999. He founded Park Seismic LLC in 2008, where he is currently working as the principal geophysicist.

Since the late 1990s, Dr. Park has been promoting the MASW technique among relevant engineering and science communities by providing education at professional conferences. Dr. Park received his Ph.D. from the University of Kansas (KU) in 1995, and then continued his career as a scientist at the Kansas Geological Survey (KGS), a research institute based at KU. Dr. Park has published more than a hundred papers on MASW and related techniques. He is also the author of the first MASW data-processing software, SurfSeis, and co-authored the seismic reflection software, WinSeis and its predecessor Eavesdropper. He received his master's (MS) degree from Ohio University (1988) and graduated from Seoul National University (1983) in Seoul, South Korea, with a BS in Physics and Science Education.

Peter Sayers has been working in the engineering geophysics field for over ten years and has run and project managed seismic acquisition crews for the ground investigation for the Doha Metro tunnels for the FIFA world cup.

The data quality he produced under difficult conditions was regarded as the best out of the six international geophysical companies working on the project. He has processed MASW data from some of the world's iconic mega construction projects, such as the $1 trillion Line project for Neom, where he processed over 900kms of MASW data as well as the MASW data from six hundred proposed dam site locations in Saudi Arabia, for the Ministry of Electricity and Water Authority (MEWA) dams project. In 2016 Peter collaborated with Choon Park to develop an automatic dispersion curve picking algorithm that enables data to be processed many times faster than conventional means, whilst taking out human error and misinterpretation.

MULTI-CHANNEL ANALYSIS OF SURFACE WAVES (MASW) METHOD

KNOWLEDGE 200 DIGITAL & AI

With approximately 38% of the Network Rail (NR) system currently fully electrified, the Office of Rail and Road (ORR), approved an overall £43.1 billion budget for the Control Period 7 (CP7), which runs from April 2024 to March 2029. To make best use of the budget for electrification work, it is important to obtain accurate and reliable information of ground conditions at the proposed gantry foundation locations to better inform the foundation design and reduce overspend due to over engineered foundations. Mickovski, S.B. (2018) explains that investing in UK rail infrastructure, particularly Overhead Line Electrification (OLE), requires significant funding. To cut costs, ground investigation budgets have been reduced, leading to insufficient ground data and overdesigned foundations based on worst-case scenarios. Research comparing conventional design methods with the Overhead Line Equipment Master Index (OLEMI) found that conventional methods could reduce foundation depth by about 50%. Moreover, about 99.5% of the OLE foundations were shown to be overdesigned due to the fact that they were installed on firmer soil conditions and shorter foundations would have been sufficient to resist the disturbing acting moment design parameter. Therefore, using historical geological data and incorporating both intrusive and non-intrusive ground investigations can significantly reduce construction costs for OLE projects.

This article describes a proof-of-concept test, conducted at the Swanwick Junction Museum Complex, in October 2024, **(Figure 1)**, which demonstrated that a cost effective, non-intrusive method of providing stiffness variations of ground conditions along rail alignments is possible, and that this method provides engineering design parameters to better inform and improve foundation design.

The test survey proved that a very high degree of accuracy and repeatability is possible with efficient utilisation of track access due to rapid deployment of the equipment, which was not previously possible.

Figure 1: Swanwick Junction.

BACKGROUND

The Multi-Channel Analysis of Surface Waves (MASW) method (Park et al., 1999) is a seismic exploration technique that has become a cornerstone in geotechnical and geophysical investigations. This method was first introduced by Park, Miller, and Xia in 1999. The MASW method was developed to address limitations in previous surface wave techniques, providing a more robust and reliable means of evaluating subsurface conditions.

HISTORICAL BACKGROUND

The MASW method emerged from the need to improve the accuracy and efficiency of subsurface investigations. Prior to its development, surface wave methods were limited by their inability to effectively handle complex subsurface conditions and noise (Heisey et al., 1982). Park et al. (1999) revolutionised this field by introducing a multichannel approach that utilised multiple geophones to record surface waves simultaneously. This innovation allowed for better resolution and more accurate interpretation of subsurface properties (Miller et al., 1999).

SITE INVESTIGATION

Since its introduction, MASW has become one of the most commonly used methods for site investigation. Its popularity stems from its ability to provide detailed shear-wave velocity (Vs) profiles (e.g. Miller et al., 1999), which are crucial for understanding subsurface stiffness and stratigraphy. The method involves generating surface waves, typically Rayleigh waves, and analysing their dispersion characteristics to infer the Vs profile of the subsurface.

The MASW method has significantly advanced the field of geotechnical and geophysical investigations (Crice, 2005). Its ability to provide detailed and accurate subsurface profiles has made it an indispensable tool for engineers and geoscientists. From foundation design to seismic hazard assessment, MASW continues to play a crucial role in ensuring the safety and stability of various structures. As technology advances, the MASW method is likely to see further improvements, enhancing its capabilities and applications in the future.

ENGINEERING APPLICATIONS

MASW is widely used in various engineering applications due to its versatility and reliability. Some of the key uses include:

1. **Foundation Design:** MASW is instrumental in estimating foundation design parameters. By providing detailed Vs profiles, engineers can assess the stiffness and load-bearing capacity of the soil, which are critical factors for designing stable foundations. This information helps in determining the appropriate type and depth of foundations required for different structures. This is very important for gantry foundation design.

2. **Seismic Hazard Assessment (Liquefaction):** In earthquake-prone areas, MASW is used to evaluate the seismic response of the ground. The shear-wave velocity profiles obtained from MASW surveys help in assessing the potential for ground shaking and liquefaction, which are essential for designing vibration-resistant structures. This is particularly applicable to rail track systems, as the train produces a Rayleigh wave ahead of the train that may induce partial liquefaction of the materials below the ballast, resulting in track rail movement.

3. **Mapping Stiffness Variations:** MASW is particularly useful for mapping stiffness variations with depth along linear structures such as roads, pipelines, and railways. This capability is crucial for identifying weak zones and ensuring the stability and longevity of these structures. This is applicable to reliably mapping the variations in ballast due to fouling plus mapping and monitoring soft ground below the ballast.

4. **Environmental and Geotechnical Investigations:** MASW is also employed in environmental studies to detect and characterise subsurface anomalies such as voids, sinkholes, and contaminated zones. In geotechnical investigations, it helps in identifying soil layers and their properties, which are vital for construction projects.

METHODOLOGY

The MASW method involves several steps:

1. **Data Acquisition:** Surface waves are generated using a seismic source, such as a sledgehammer or a small mechanical weight drop. These waves are recorded by an array of geophones placed along a survey line.

2. **Data Processing:** The recorded waveforms are processed to extract dispersion curves, which represent the variation of phase velocity with frequency. These curves are then inverted to obtain the shear-wave velocity profile with depth of the subsurface.

3. **Interpretation:** The resulting Vs profiles are interpreted to provide insights into the subsurface conditions. This interpretation is used to inform engineering decisions and design parameters.

CHALLENGES OF CONDUCTING MASW SURVEYS ON RAIL BALLAST

Conducting Multi-Channel Analysis of Surface Waves (MASW) surveys along rail tracks, especially on ballast, presents two main unique challenges:

1. **Equipment Stability:** The uneven surface of the ballast can make it difficult to place geophones and other equipment securely. This instability badly affects the quality of the recorded data and the overall reliability of the survey.

2. **Safety and Accessibility:** Setting up equipment along active rail tracks is time consuming and poses safety risks and logistical challenges. Ensuring the safety of personnel and equipment while minimising disruption to rail operations requires careful planning and coordination. The planning and safe equipment set up, usually reduces productivity during track possession.

OTHER METHODS

Historically, many attempts have been made to reliably obtain repeatable stiffness data from rail tracks which have failed due to the challenges detailed above. Other methods have also been employed such as CSW (Continuous Surface Wave), which have proven to be inaccurate and unreliable.

Ground Penetrating Radar (GPR) is used to detect ballast fouling and map the base of the ballast, but accurate depth of ballast and fouling content is somewhat subjective and realistically, GPR only provides a broad indicator of potential defects.

NECESSITY OF MASW SURVEYS

Despite these challenges, MASW surveys are essential for several reasons:

1. **Heterogeneous Ballast Material:** The ballast, typically made up of crushed stones, creates a highly variable medium, particularly when clays and soils foul the pore space between the crushed stone. This lack of heterogeneity, irregularities and varying stiffness can be reliably detected by an innovative approach to data acquisition and specialised data processing, which is based on established algorithms.

2. **Ambient Noise:** Rail tracks are often active, leading to significant noise from passing trains and other activities. However, this ambient noise, which is an unwanted occurrence in conventional seismic surveys, such as seismic reflection and refraction, enhances the processed data at depth (Park and Miller, 2008).

3. **Minimal Footprint:** MASW surveys require relatively small equipment setups compared to conventional site investigation methods like drilling rigs and Cone Penetration Testing (CPT) machines. This makes them ideal for use in constrained environments such as rail corridors.

4. **Accessibility in Constrained Environments:** Traditional site investigation equipment can be difficult to deploy near railways due to the presence of vegetation, buildings, and other infrastructure that has built up over time. MASW surveys, with their minimal setup requirements, can be conducted in these challenging environments without extensive site preparation.

5. **Foundation Design Parameters:** MASW surveys provide valuable data on shear-wave velocity profiles, which are crucial for estimating foundation design parameters. This information helps engineers design foundations that can safely support rail infrastructure.

6. **Mapping Stiffness Variations:** These surveys are effective in mapping stiffness variations with depth along linear structures like railways. Identifying areas with varying stiffness is important for maintaining the stability and integrity of the rail tracks.

SUMMARY

While conducting MASW surveys along rail tracks on ballast presents several challenges, the method's advantages in terms of small footprint and accessibility make it a valuable tool for site investigations in these environments. The data obtained from MASW surveys is crucial for foundation design and for ensuring the long-term stability and safety of rail infrastructure.

The remainder of this article will describe an innovative acquisition and data processing method that:

1. Produces high quality data
2. Produces reliable and repeatable data directly below the rails
3. Acquires data at a far higher rate than was previously possible
4. Can map ground stiffness variations across multiple tracks
5. Can produce a variable stiffness plot of the ballast
6. Produces empirically derived moduli for gantry foundation design, including Poisson's ratio, Youngs modulus and Shear modulus.

SITE SURVEY – PROOF OF CONCEPT

Figure 2: Field equipment set up.

The seismic acquisition sensors were set up along the track, utilising twenty-four standard geophones. **(Figure 2)**. A baseplate and sledgehammer were used to input a body wave into the ground via the ballast, in between the sleepers. Over one hundred metres of track were surveyed, taking readings every five metres along the track to provide proof of the concept. Please note that the survey crossed insulated rail joints with no effect.

The geophones collect the various frequencies generated by the impact of the sledgehammer onto the ground and are recorded on to an engineering

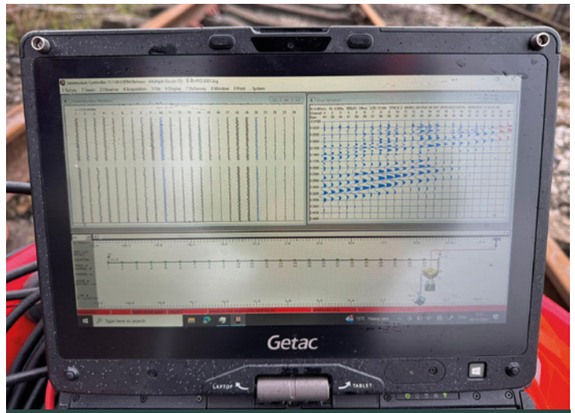


Figure 3: Raw data QA/QC.

seismograph. Conducting the surveys at each track location, it was possible to image the stiffness variation below the individual rails. This method can be used on all adjacent rail track locations to map ground variability across the area at a variety of different depths. This will greatly enhance engineering intelligence of site conditions and enable an accurate extrapolation of ground stiffness to be made at the gantry foundation locations. Each reading takes less than two seconds to acquire making it possible to rapidly acquire many hundreds of readings along the rail track in one shift.

The raw data displayed a coherent surface wave along the geophone array, indicating excellent signal to noise ratio with no interference from the irregular ballast surface, which normally negates the use of this technique. **(Figure 3)**.

DATA PROCESSING

The data was analysed and processed by Choon Park, the inventor of the MASW technique and writer of the software used by engineers and geophysicists.

The collected frequencies from the survey, were processed using a dispersion curve analysis, which shows the frequencies extracted from the raw data and its phase velocity, which is the slope between the field components. **Figure 4** shows the range of frequencies exceeding 300Hz, indicating the data should provide a high degree of resolution at very shallow depths.

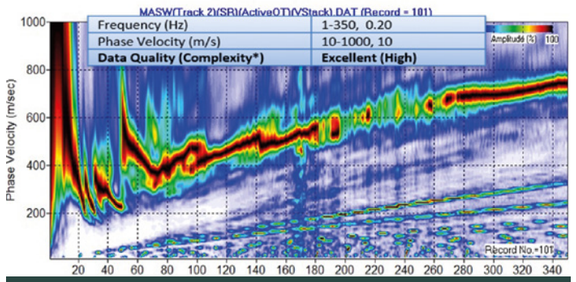


Figure 4: Dispersion curve analysis.

RELIABILITY AND REPEATABILITY

It is very important that the acquired data is of a high quality and can also be repeated from location to location, thus providing a high degree of reliability. **Figure 5** shows the extracted dispersion curves for all twenty-one readings taken along the track. There is a clear trend in the data, which highlights the repeatability of the method.

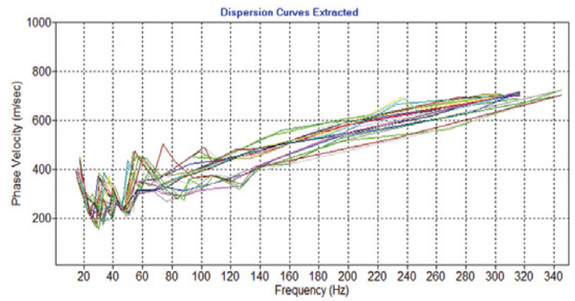


Figure 5: Extracted dispersion curves.

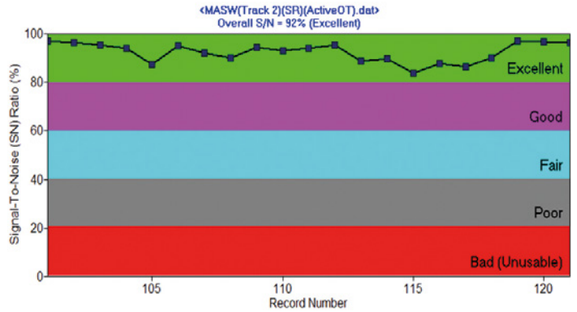


Figure 6: Data quality.

There is some variability, which is to be expected due to changing ground conditions.

The customised software analyses each data reading and performs a QA/QC check and outputs a graph of signal to noise ratio, which is also related to signal quality and reliability. **(Figure 6)**.

DATA OUTPUT – STIFFNESS VARIATION PLOT AS SHEAR VELOCITY

The data is imaged to provide depth profiles to approximately 10m below ground level, showing the variation in stiffness along its length. **(Figure 7)**.

Low stiffness (blue colour) can be seen extending to approximately 4m below ground level, with a change in material characterised by an increase in contour lines, where the stiffness is increasing rapidly. The stiffer materials can be seen in orange / red colours, with the mid-range stiffness materials in green. If borehole data were available at the location, the data could be correlated and geological cross sections output along with the stiffness values combined.

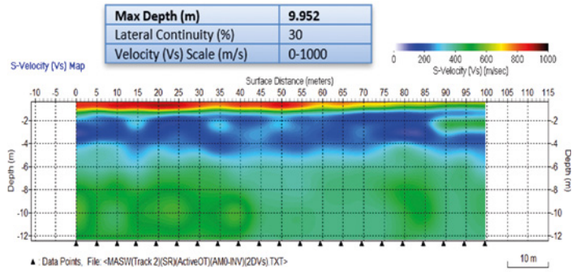
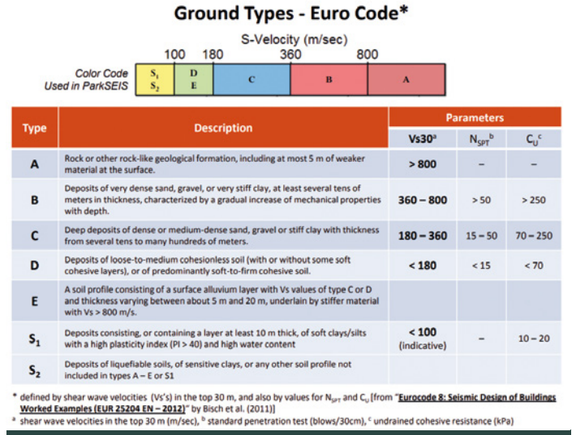


Figure 7: Stiffness variation profile.



Type	Description	Parameters		
		Vs30[a]	N_{SPT}[b]	C_U[c]
A	Rock or other rock-like geological formation, including at most 5 m of weaker material at the surface.	> 800	–	–
B	Deposits of very dense sand, gravel, or very stiff clay, at least several tens of meters in thickness, characterized by a gradual increase of mechanical properties with depth.	360 – 800	> 50	> 250
C	Deep deposits of dense or medium-dense sand, gravel or stiff clay with thickness from several tens to many hundreds of meters.	180 – 360	15 – 50	70 – 250
D	Deposits of loose-to-medium cohesionless soil (with or without some soft cohesive layers), or of predominantly soft-to-firm cohesive soil.	< 180	< 15	< 70
E	A soil profile consisting of a surface alluvium layer with Vs values of type C or D and thickness varying between about 5 m and 20 m, underlain by stiffer material with Vs > 800 m/s.			
S_1	Deposits consisting, or containing a layer at least 10 m thick, of soft clays/silts with a high plasticity index (PI > 40) and high water content	< 100 (indicative)	–	10 – 20
S_2	Deposits of liquefiable soils, of sensitive clays, or any other soil profile not included in types A – E or S1			

* defined by shear wave velocities (Vs's) in the top 30 m, and also by values for N_{SPT} and C_u (from "Eurocode 8: Seismic Design of Buildings Worked Examples (EUR 25204 EN – 2012)" by Bisch et al. (2011))
[a] shear wave velocities in the top 30 m (m/sec), [b] standard penetration test (blows/30cm), [c] undrained cohesive resistance (kPa)

Figure 8: Eurocode 8.

FOUNDATION DESIGN PARAMETERS

The shear velocity (Vs) values obtained from the data, can be used to empirically derive a number of engineering design parameters, which include;

- Poisson's ratio
- Youngs modulus
- Shear modulus
- Bulk modulus

The data can also be referenced to Eurocode 8. The extracted table above, shows ground type against the expected shear velocity. **(Figure 8)**.

By creating a colour transformation code as per the Eurocode ground type ranges, it is possible to produce a cross section of ground that is referenced to the Eurocode and indicates the type of foundation required for that material class or velocity range. **(Figure 9)**.

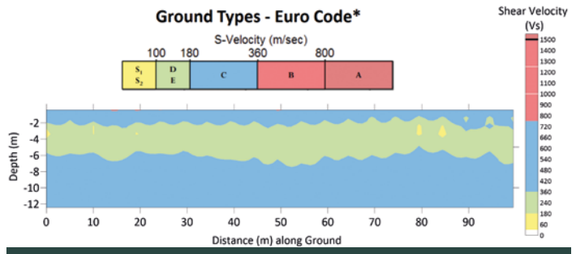


Figure 9: Profile references to Eurocode.

Shear wave velocity (Vs) is a critical parameter in geotechnical engineering, especially for foundation design, as it provides valuable information about the stiffness and dynamic properties of soil and rock layers. Here's how Vs is used in the context of Eurocode 8 (EC8) and Eurocode 7 (EC7):

EUROCODE 8 (EC8)

EC8 focuses on the seismic design of buildings and structures. Shear wave velocity is used to classify the seismic site conditions, which is essential for determining the seismic design parameters. The average shear wave velocity in the top 30 metres of soil (Vs30) is commonly used for this classification. The site classification influences the design ground acceleration and other seismic response parameters, which

are crucial for designing earthquake-resistant structures, but also in assessing the impact of Rayleigh waves induced by moving trains on soft (less stiff) materials below the ballast that might induce track movement.

EUROCODE 7 (EC7)

EC7 deals with geotechnical design and covers the design of foundations, earthworks, and retaining structures. Shear wave velocity is used to determine the dynamic properties of soil, such as stiffness and damping. These properties are important for assessing the soil's behaviour under dynamic loading conditions, such as earthquakes. By incorporating Vs into the design process, engineers can better predict and mitigate the effects of seismic forces on foundations and other geotechnical structures.

In summary, shear wave velocity is a key parameter in both EC8 and EC7 for assessing the seismic and dynamic properties of soil and rock layers, which are essential for designing safe and resilient structures.

SUMMARY AND CONCLUSION

The MASW method is an industry wide accepted method for providing ground condition information, notably, ground stiffness, which is a geotechnical parameter used for foundation design. MASW has now been successfully proven to work on rail tracks due to its novel coupling. This rapid and reliable method can be used across individual and multiple tracks that are adjacent to each other, providing stiffness variation maps over large areas and lengths of track. It is now possible to better inform the design of the gantry foundations, providing a substantial cost benefit to NR (and other infrastructure managers), in both design and build costs. The high frequency data can also be used to map and monitor variability of the stiffness within the ballast layer, providing reliable information on which to base maintenance programs.

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Mr Chris Tindall MEng, BEng, BSc, CEng, MIMechE

Rob Carroll has been working as Technical Principal - Materials and tram-train lead within the Urban Transit and Mobility practice at Mott MacDonald since 2018. He is currently working for various client organisations to develop and deliver tramway and tram-train projects.

Following a PhD in Sheffield studying the effect of surface metallurgy on rolling contact fatigue of rails in 2006, his first job on graduating was with Corus Rail (now British Steel) working on various research and development projects including HPRail. From 2010 until 2018 he worked for Stagecoach Supertram as IT and Major Projects Manager where he was responsible for the successful delivery of the tramway, vehicle and operator workstreams of the UK's first Tram-Train project including the integration of the Citylink vehicle with the tramway and railway infrastructure.

Chris Tindall currently works as Technical Principal in light rail rolling stock for Mott MacDonald and is based in Altrincham. He is currently working on a number of tram, light rail and tram-train procurement projects across the globe, where he is acting as technical advisor on rolling stock to the client.

Following academic achievements in Sheffield, Manchester and Birmingham, Chris has worked on light rail and tramway projects with Mott MacDonald for the past 19 years and has worked as technical advisor for the procurement of rolling stock for a number of UK tram and light rail projects, along with multiple tram and light rail rolling stock procurement projects worldwide.

TRAMWAY VEHICLE/ INFRASTRUCTURE INTERFACES

KNOWLEDGE 200 TRACK

KNOWLEDGE 200 ELECTRIFICATION & PLANT

INTRODUCTION

Tramways have a unique operating environment, the most obvious aspect being the operation of a light rail vehicle in a street environment in close proximity to pedestrians, cyclists and road vehicles. As such they have many specific challenges for the interface between vehicles and infrastructure. Examples of the different interfaces are shown in Figure 1.

In Germany, tramways are required by legislation and national standards to follow detailed technical requirements to aid consistency and compatibility. By comparison in the UK, until recently, the only legislation and guidance has been high level, providing functional requirements. Tramways have therefore developed separately with limited commonality providing a wide range of different vehicle/infrastructure interaction characteristics. This paper provides an introduction to some of the most important vehicle/infrastructure interfaces but is limited to general themes that are applicable to all systems although the specific details will be different.

WHEEL/RAIL

Tramways typically consist of both segregated and on-street sections of track. Segregated track, which is not open to other road users, typically use conventional ballast track forms with Vignole rails (which can be lighter in section than those used on railways) but often also use direct fix/slab track. It is also possible to use grass track, where the area around the rails is covered with grass or other plants, although the rail fastening typically are similar to the other track forms. Where tramways differ from other rail systems is the use of embedded grooved rail for on street sections, **(Figure 2)**. Grooved rails used in the UK include BS EN14811 [1] 54G1, 55G1, 55G2 and 59R1, with groove depths of 46-47mm and widths of 36-42mm.

Tram wheels that need to be compatible with grooved rails are typically narrower and shallower than railway wheels. Many tram systems, and all those in the UK, use standard gauge therefore the distance between wheels on an axle, the back-to-back spacing, has to be greater than for trains. The flange way clearances at check rails also needs to be narrower to ensure compatibility with the wheel profile. Flange running is also often used to reduce noise and vibration through switches and crossings, therefore a square tipped flange can be used [2]. A typical tramway wheel profile in a grooved rail is shown in **Figure 3**.

Figure 1: Tramway Vehicle/Infrastructure Interfaces.

Figure 2: Example of embedded grooved rail.

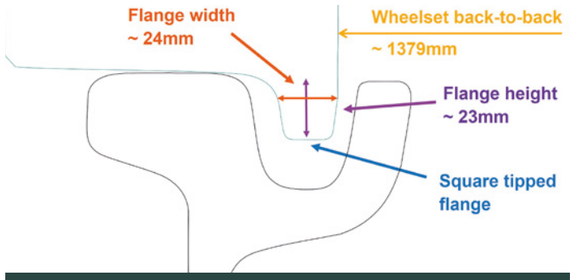

Figure 3: Typical tram wheel profile and grooved rail.

Installing grooved rails in street introduces risks for other road users as the rail surface and surrounding encapsulation/sealants has much lower friction than the adjacent road surface, especially when wet, and the groove can present a trip hazard. Major risks to cyclists with the use of grooved rail include skidding on the rail head or trapping of the tyre in the rail groove. These risks need to be mitigated through the use of acute crossing angles (as near as perpendicular as possible with a minimum of 60º) and where possible providing alternative routes for cyclists.

GAUGING AND PLATFORM INTERFACES

Like all rail vehicles, clearance is required between the vehicle and the infrastructure. As well as fixed infrastructure and other trams, this also needs to consider road markings, other road users and pedestrians on pavements. Careful consideration is required to avoid trapping hazards for members of the public and for evacuation routes in emergencies. Clearances to equipment, both that belonging to the tramway and assets belonging to others, also need to consider access for staff to maintain it. The requirements for clearances in the UK are provided in Light Rail Safety and Standards Board (LRSSB) LRG 1.0 Tramway Principles and Guidance [3].

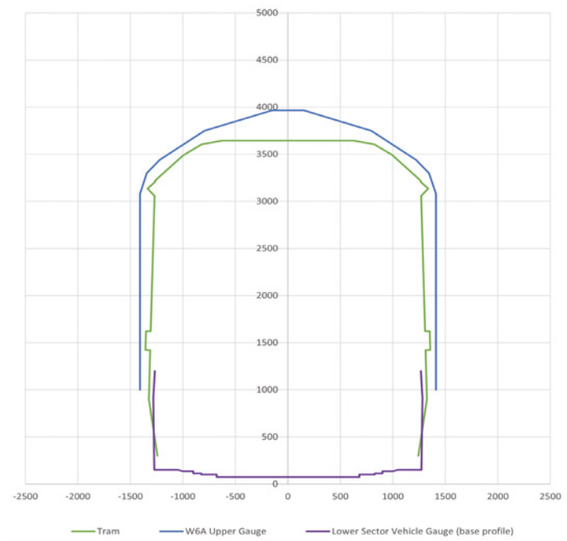

Figure 4: Comparison of the static vehicle profiles of a generic tram and trains (W6A and lower sector) (with thanks to Keith Holt, Mott MacDonald).

A comparison between the static profile of a typical tram and train is shown in **Figure 4**. In general a tram is narrower than a train above 1m from the top of rail, but they can be slightly wider below this height.

Gauging also needs to consider vehicle movements with clearance assessed to the swept envelope of the vehicle in normal and degraded modes for all applicable line speeds. Important factors in the swept envelope of trams is the use of articulation between sections and independent rotating wheels (wheels with no fixed axle between them) as these behave differently to conventional vehicles. The tight curves (as low as 18m radius in the UK) magnify vehicle movements therefore any software used for assessing tramway clearances needs to ensure that it can model these factors and unique behaviours correctly.

In contrast to most parts of the infrastructure where greater clearances are better; at tram stops the platforms need to be located close to the vehicle. All modern tram systems in the UK provide unassisted level access between vehicle and the platform and are required to have a horizontal clearance of less than 75mm with a vertical step of no greater than +/-50mm at door locations in accordance with the Rail Vehicle Accessibility (Non-Interoperable Rail System) Regulations (RVAR) 2010 [4]. The conventional approach is to have the platforms designed to match the dimensions of the vehicle and the required static clearances, with speed limits used to reduce dynamic movements and ensure dynamic clearances for vehicles moving through the platform area **(Figure 5)**. However, this can require major alterations when new rolling stock is brought into use, therefore new platforms should be designed to allow future adjustment of the platform edge positioning, such that their design is future proofed and can allow for use of alternative rolling stock. On one system in the UK modifications to platforms was undertaken for the introduction of new vehicles, the costs of which were circa £1m but this was believed to have saved over £6m on the procurement of the new vehicles as it allowed open competition rather than requiring bespoke trams.

Ensuring that the stepping remains compliant with RVAR 2010 as part of the ongoing maintenance and operation is vital. Embedded track provides a high track fixity to ensure that there is limited movement and clearances remain in tolerance. Ballasted track is more of a challenge, with additional long sleepers butted up to the face of the platform to reduce lateral movements being a common solution, with ongoing monitoring and adjustments required to ensure compliance [5]. Although not currently used on a UK tram system it is likely that sliding steps, similar to those on Mersey Rail (class 777) and Tyne and Wear Metro's (class 555) new trains, will be fitted to future tram vehicles. This is the approach being used on the South Wales Metro with the introduction of class 398 tram-train vehicles that will stop at heavy rail stations with plans for a future tramway extension in progress.

Figure 5: Level boarding and clearances for trams at stops.

TRACTION POWER

The traction power for trams is typically 750V DC supplied via overhead line equipment (OLE) but this brings challenges for urban integration. In city centres the visual intrusion of the OLE can be a

Figure 6: Conventional tramway OLE.

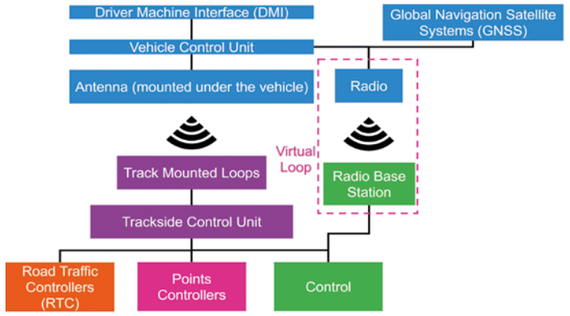

Figure 8: Schematic of vehicle/infrastructure communication system.

challenge for the introduction of tramways, building fixings can reduce the number of poles required but there is still a need for equipment to support the contact wire. The tight radius curves on tramways require more support, **(Figure 6)**, to enable the wire to be correctly positioned above the track within the limits of stagger. To ensure compatibility on curves, tramway pantograph heads are typically wider than those used on heavy rail vehicles.

It is also important to ensure safety for other road users so tramway OLE is typically mounted over 6m and up to 7m above the road but can be as low as 3.8m to go through structures on segregated sections. The pantograph needs to be able to operate over this full range and accommodate the relatively quick changes in contact wire height and the associated steep gradients to ensure it does not lose contact with the wire.

To overcome some of the challenges with fitting OLE in city centres, especially those with a historical character, other traction power sources have been used around the world [6]. Currently the most popular is the use of super-capacitor or battery based onboard energy storage system (OESS) as used by West Midland Metro, **(Figure 7)**, and also planned to be used in South Wales. These types of OESS can provide off-wire ranges capable of operating for several miles between charging inputs, however their ultimate range is typically a function of the demands of the alignment (e.g. track gradient, speed profile, shared/segregated running), the operational requirements of the route and the required lifespan of the OESS battery cells. Detailed traction and charging simulations must be undertaken to ensure that an OESS solution is suitable for the demands being placed upon it by the infrastructure, alignment and operation.

Figure 7: West Midland Metro tram operating on batteries.

VEHICLE/INFRASTRUCTURE COMMUNICATION

Tramways operate on line-of-sight principles, where the driver is required to operate at a speed where they are able to stop before an obstruction [3]. This is facilitated by the high braking capability of trams relative to heavy rail rolling stock, largely due to the fitment of magnetic track brakes. The signalling and control of route setting on tramways is locally controlled using programmable logic controllers (PLCs) which operate automatically based on information provided by the tram. These local controllers need to be integrated with the urban traffic controllers to ensure priority for trams through road junctions. Unlike heavy rail networks there is no person controlling the signalling from a central control although there is an operational control centre (OCC) that ensure services are operating correctly. There is therefore a need for a system to be able to relay information from the vehicle to the track side equipment, the key functions of this are to report location and to request routes through road junctions and points, **(Figure 8)**.

The driver can request the route through points using a route code (start to end of the journey) or by requesting a direction (left or right) on approach to the points, this information is relayed to the points controller through the interfacing system. This typically has an onboard antenna mounted under the vehicle that uses a coded radio frequency signal to a track mounted loop, **(Figure 9)**. It is also possible to use a radio system to relay information to a central control point, although this is typically limited to location reporting. Drivers also have a tram ready to start (TRTS) button on their desks e.g. for requesting a route away from a tram stop when ready so as not to delay other road traffic.

Track loops need to be positioned at the correct locations to ensure good reception from the vehicle in terms of lateral position (allowance for curvature and movement of the vehicle antenna away from the centreline is required) and height. Loops also need to be positioned in relation to junctions so that they can request a route with sufficient time for the tram assuming normal operation conditions to be able to continue without slowing but not too far away that other road users have to wait for the tram to arrive.

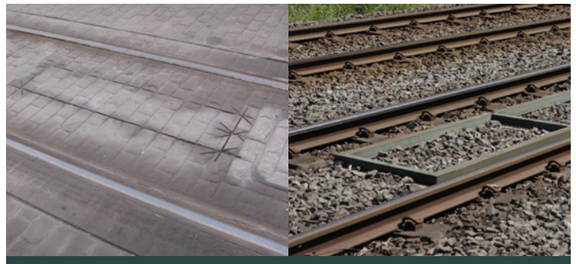

Figure 9: Track mounted loops in street (left), on ballast (right).

PEDESTRIAN PROTECTION

Unlike railways and metros where the infrastructure is largely segregated from other road users; by their nature trams operate in close proximity to pedestrians, cars and other road users. There are therefore several ways that this risk is mitigated.

With line of sight operation visibility is vital. This is both visibility for the driver of the infrastructure and people/vehicles around the tram. Equally important is visibility of the tram by other road users. The vehicle needs to be designed for good all round visibility for the driver which is why trams have large windscreens and side windows in the cab. Visibility is also required to ensure the driver is able to read signals and signs at the required distance. The driver also requires visibility along the sides of the vehicle, using either wing mirrors or a CCTV system, for operation on street and for checking doors at stops, **(Figure 10)**. Trams are required [3] to be conspicuous for other road users with front, rear and side marker lighting, **(Figure 11)**, along with headlights, central 'cyclops' headlight (or sufficiently bright LED destination display), taillights and brake lights. Like other road vehicles they also need to be fitted with an audible warning. A short range warning is required for on street operation to ensure that pedestrians are aware that a tram is moving e.g. when pulling away from a stop or approaching pedestrian crossings. With a louder medium range warning for use off street and in emergencies.

Figure 10: Typical tram demonstrating its design for on street operation.

Figure 11: Visibility of a tram at night.

The infrastructure needs to be designed to provide good visibility, where it is not possible to remove obstructions to visibility, then the operational speeds need to ensure that the vehicle is able to stop should any obstructions occur. The impact of third party developments alongside the tramway on visibility needs to be understood and where possible factored into the designs through the planning consents processes. Vegetation management is required to ensure that trees and shrubs do not block visibility, this is not always within the tramways control and liaison with the local authority and neighbours/residents is required.

However, visibility will not always prevent accidents therefore the vehicle needs to be designed to cause minimal damage if it is in contact with a road vehicle, cyclist or pedestrian. Trams are designed to be fully skirted around their lower extremities, with no exposed running gear and clearance below the vehicle constrained by an obstacle deflector or life guard, (**Figures 10 and 11**). The articulation between sections should be fitted with a set of bellows to ensure that there is no risk of trapping.

A high deceleration rate brake is required (up to 2.8m/s2) to facilitate line-of-sight operation, with electromagnetic track brakes mounted between the wheels on each bogie. When the driver applies the Emergency 3 Hazard Brake, by moving the traction/brake controller to its most rearward position, the electromagnetic track brakes drop on to the rail and slow the vehicle through magnetic attraction and friction.

Figure 12: Obstacle deflector mounted in front of the bogie.

Figure 13: Track mounted underrun protection on ballasted track.

The last line of defence for a tram if a pedestrian is hit and goes underneath the vehicle is the underrun protection. An obstacle deflector or lifeguard is mounted at the front of the vehicle, typically 100-200mm above the rail head. This is designed to either prevent a person being drawn underneath the tram, **(Figure 10)**, or to push a person along in front of the wheel, **(Figure 12)**.

Typically, obstacle deflectors are only effective on embedded track, where there is a solid infill between the rails. On ballasted or direct fix track at non-motorised user crossings an infill, often called underrun protection, is required to be fitted, **(Figure 13)** [7].

SUMMARY

Although the vehicle/infrastructure interfaces for tramways are similar as those for heavy rail, the special characteristics of tramways mean that they have some aspects which are unique and these need to be understood and managed if vehicles and infrastructure are to be compatible. The obvious area of difference is the proximity of tramways to members of the public and other road users and therefore understanding and managing these interfaces is key to safe integration into a urban publicly accessible environment.

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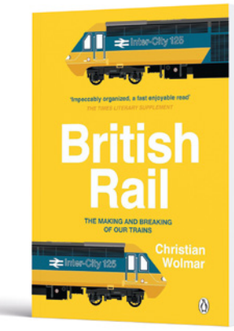
BOOKS FOR OUR TIME...

RAILWAYS IN BRITAIN - HOW IT WAS, WHAT WE LEARNT, AND WHAT THE FUTURE MIGHT BRING?

With UK Government consultation on its Railways Bill in full swing and the establishment of Great British Railways (GBR) on the horizon, I thought it could be helpful to point readers towards three relatively recent books focussed on our railway transport industry. Taken together, the books provide an explanation of how the UK's national railway network arrived at its current state. The books pull out important lessons learnt during that journey (and from other parts of the world), and look at how those lessons might be applied with vision to enable railways to play a central role in future integrated transport systems, facilitating human mobility in a way that is complementary to the health of our environment (and planet) rather than at odds with it.



The first book ***British Rail – The Making and Breaking of our Trains***[1] is authored by well-known transport journalist Christian Wolmar. Written in large part during one of the Covid-pandemic lockdowns, it was published in 2022, just as passengers in the UK started to return to rail transport in force. The book presents a lively account of the development of British Railways (BR) from the late 1940s to the organisation's disaggregation and privatisation, concluded in 1997. At 394 pages the book doesn't claim to be an exhaustive account (for that readers might try Terry Gourvish's two-volume, 1033-page official history with its accompanying 453 pages of appendices, notes and indexes[2,3]) but it does cover the major structural changes in BR's organisation and in the political and legal framework within which BR was obliged to manage the national railway system.

One of this book's major strengths is its use of senior railway managers' and politicians contemporary accounts of the many financial, social, and managerial challenges faced by BR to illustrate the sheer difficulty of running a huge and complex organisation, against a backdrop of massive rapid social change. The author explains how the construction of motorways, growth in car ownership, and the transfer of freight transport from rail to road created a growing financial crisis within the railway transport industry - itself still recovering from a dearth of investment during and immediately following the Second World War. In today's world of near universal car use and online shopping deliveries it is perhaps difficult to appreciate the degree to which railways still touched the lives of the majority of the UK's population in the early 1960s. At that time railways still played a major role in moving general freight, parcels, domestic coal, and in rural passenger transport. In the subsequent ten years to 1970 that situation would change dramatically.

Christian provides a fascinating insight into how the politicians and civil servants of the time responded to the railway's financial woes, initially at least from a basic position that regarded the railway as a business that should cover its costs or be closed down. Government frustration was to a degree understandable as it attempted to deal with railway organisations that were commercially immature, to say the least, and still engaged in internal managerial battles that were a legacy of pre-nationalisation inter-company rivalries and hostility. With hindsight, a strategic review of the industry and its purposes was inevitable, and the author gives a good account of the Beeching review and report, and of its not-uncontroversial political context.

The book's tone becomes increasingly positive as Christian recounts how in the later 1960s the social value of the railway system appeared finally to be understood by *some* politicians - not least the then Minister of Transport, Barbara Castle - and the requirement for some level of government subsidy to reflect that value was acknowledged. In parallel, he describes how the railway organisation became increasingly commercially aware, albeit still dogged by organisation structures and processes that shed little light on why and where costs were incurred or the degree to which, at any disaggregated level, costs and revenues were related.

The latter section of the book describes how, under the successive Chairmanships of Peter Parker and Robert Reid, BR underwent something of a renaissance both in terms of how it interacted with its markets and with politicians and civil servants, and how – over a ten year period - it

CHRISTIAN PROVIDES A FASCINATING INSIGHT INTO HOW THE POLITICIANS AND CIVIL SERVANTS OF THE TIME RESPONDED TO THE RAILWAY'S FINANCIAL WOES, INITIALLY AT LEAST FROM A BASIC POSITION THAT REGARDED THE RAILWAY AS A BUSINESS THAT SHOULD COVER ITS COSTS OR BE CLOSED DOWN.

restructured itself into six market-focussed Sectors with roundly 25 subsidiary Profit Centres giving middle-managers clear accountability for operations and their related costs and revenues. Whilst not ignoring BR's occasional failures in this period (notably, the Advanced Passenger Train project), he gives credit for technical innovations, including developing a proper scientific understanding of how the wheel-rail interface operates; prototyping the tilting train concept; pioneering computer-chip-based signal interlockings and equipment; and producing the iconic High Speed Train (the HST). (One point he doesn't note is that in the late 1980s BR's management accounting system was both very advanced and reputedly the largest database in the world outside NASA and the Pentagon!) On a financial theme he does conclude that in its late years BR was almost a role model for how to run a state-owned railway on a shoestring.

[1] Published in paperback by Penguin Random House UK ISBN 978-1-405-94627-8
[2] Vol. 1, 1948-73 Published by Cambridge University Press- ISBN 0-521-26480-4
[3] Vol. 2, 1974-97 Published by Oxford University Press- ISBN 0-19-925005-7

In a short epilogue the book looks again at BR's relative financial efficiency compared to that of other European railway systems in the mid-1990s, and compares BR's performance to that of the successor fragmented industry structure. The latter comparison draws heavily on the 2021 Government White Paper, *Great British Railways*, in describing weaknesses which any new industry structure should seek to address.

My second book ***Changing Times Changing Trains – Memoirs and insights on running railways***[4] was published last year and is written by Richard Brown CBE, a hugely experienced railway manager who started his railway career in 1977 and worked in increasingly senior roles, firstly in the nationalised British Railways, then leading private sector franchised passenger train operations. A subsequent move saw Richard take on the Chief Executive role at Eurostar Group - a common services company owned jointly by the three national railway companies who worked together to operate the initial Eurostar London-Paris/Brussels train service through the Channel Tunnel. Having taken a central role in leading what might be termed the Eurostar operating alliance, in 2010 Richard went on to become the Non-Executive Chair of Eurostar International when it was finally reconstituted as a single integrated train operating company with shares owned by French Railways (SNCF), Belgian Railways (SNCB), and the UK Government[5].

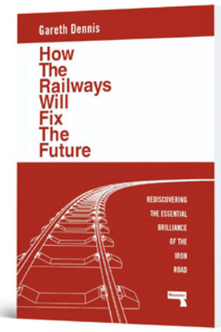
GIVEN HIS WIDE CAREER EXPERIENCE IN BOTH THE PUBLIC AND PRIVATE SECTORS, IT WOULD BE SURPRISING IF RICHARD DIDN'T HAVE MUCH OF INTEREST TO SAY ABOUT THE RAILWAY TRANSPORT INDUSTRY, AND INDEED HIS BOOK DOESN'T DISAPPOINT.

Richard stepped down from the Eurostar Chair role in 2013, subsequently taking on several non-executive director roles, including at HS2, at the Department for Transport, and at Network Rail. Given his wide career experience in both the public and private sectors, it would be surprising if Richard didn't have much of interest to say about the railway transport industry, and indeed his book doesn't disappoint.

The first two thirds of Richard's book give an engaging account of his career, illustrating by anecdote and explanation many of the hard-learnt lessons which informed and influenced his future attitudes and actions. From the importance of well-constructed management accounts at Freightliner to the empowering effect of understanding the drivers of costs and revenues at InterCity (and having the devolved authority to take actions to influence both), Richard's enthusiasm for hands-on business management is clearly apparent. Richard's narrative supports his obvious conviction that the best way to optimise the performance of a railway system is to manage it in an integrated way where the interplay between costs and revenues can be clearly seen by all involved, where all costs and revenues have a managing owner, and where mobile assets are deployed where they can deliver most value. Interestingly, he illustrates optimisation using examples at both national and local level with obvious implications for layered business structures.

Those looking for guidance on how (and how not) to manage organisational change in both public and private sectors will find Richard's book full of helpful hints and tips as much of his career has been dominated by such change. Similarly anyone looking for an example of how to manage a serious operational crisis and its aftermath should look no further than Richard's account of the Christmas 2009 "meltdown" of Eurostar train services through the Channel Tunnel when a combination of weather conditions in Northern France, higher temperatures inside the tunnel, and rolling stock design features led to five near sequential train failures and the suspension of train services for three days.

The final third of the book pulls out and expands on some of the important themes which arise in the earlier narrative sections. The importance of building relationships and teams is underscored, and the broad characteristics of public and private sector organisations are discussed at some length. A helpful chapter (complementing Christian's book, discussed above) charts the evolution of BR's management structure as it moved iteratively from Regions, Divisions and Areas, to Business Sectors and Profit Centres, looking at the motivations, incentives, complexities, and decision-making qualities at each iteration. The importance of considering railways as a total system rather than a set of quasi-independent assets is illustrated, including by contrasting descriptions of the implementation of the Thameslink 2000 project (between 2018 and 2020) and of implementing Eurostar services on the full HS1 route in 2007. Above all the latter part of the book stresses the critical role in planning and operating a railway system played by collaboration – a sentiment I endorse wholeheartedly.



The third book I'd like to introduce, published late last year, is ***How the Railways Will Fix The Future***[6], written by PWI Member Gareth Dennis. As its title suggests, this book's main focus is what railways can and should do for future transport provision. Set firmly within a social, political, and governmental context and unashamedly pro-rail in outlook, Gareth kicks off his book with an overview, from a global perspective, of the physical and social pressures impacting mobility for people and for freight. Unsurprisingly Climate Change and carbon emissions figure prominently, but so does the role that railway transport (and integrated public transport more generally) can play in increasing equity both within and between societies.

After a very brief introduction to railway history from both an economic and physical perspective, Gareth looks at the characteristics of what he describes as the world's "Top 20" railway systems, exploring their relative performance through a range of economic and physical performance measures. As might be anticipated Switzerland and Austria come close to "top of the table", but there are other perhaps more surprising conclusions. India, China, and Japan come in equal second place but for rather different reasons. Germany and France sit at 10th and 11th place while the UK at 18th is just below Belgium, Netherlands and the USA. The latter's position being due to the still hugely important role that railways play in North American freight transport.

Having reviewed the current status of railway transport across a large swathe of the globe, Gareth considers most of the alternatives to railway transport for providing passenger and freight transport at volume. From maintaining (and expanding) the use of cars, through rubber-tyred "tram"

[4] Published in paperback by New Generation Publishing ISBN 978-1-83563-362-5
[5] UK Government sold its 40% shareholding in Eurostar in 2015.
[6] Published in paperback by Repeater Books ISBN 978-1-91567-250-6

technology, low speed loops carrying autonomous cars, air-travel, and recently vaunted "hyperloops" these are found to have serious disadvantages from technological, environmental, and social perspectives.

Most of the second half of the book looks in some detail at what would be required to move our transport systems to a position that is both environmentally and socially sustainable. Notably, most of the challenges on this development path are identified as political, economic, and social rather than technological. It turns out that, as currently demonstrated by several of the "Top 20" countries, we already possess all the technologies required to create first class sustainable integrated public transport networks: what appears to be in shorter supply is vision and political will.

In the final part of the book, Gareth sets out a vision for 2050 and beyond and a development path from today, that would deliver the mobility that human societies demand (and require) in a way that doesn't undermine the viability of the planet itself. The challenges inherent in such a path are discussed in some detail in the context of the UK and from a wider international perspective. Those challenges are daunting – but arguably less so than those inherent in continuing as we are.

CONCLUSION

The three books described above are written in very different styles but all are highly readable. Each has something very significant to say about railways' place in transportation and about railway operation. In the space of 70 years the way freight transport and personal mobility are provided in the UK has changed out of all recognition and the books illustrate important lessons from that period that can (and hopefully will) be applied over the next 70.

The first two books describe and discuss at length how railways can be organised in a way that incentivises both efficient operation and the provision of services that people need and want. For me, the only notable omission from both is a clear recognition of the need for the "holding company arrangements" that regulated how, firstly BR's Regions and latterly its Business Sectors dealt (or traded) with each other. As we look to the creation of GBR, a description of those arrangements would be instructive.

One of the geniuses of BR's Sector organisation was the comprehensive framework of internal rules which determined how costs and revenues were allocated between Sectors (and between Profit Centres), how those businesses were expected to trade with each other - and the mechanisms put in place to monitor Sectors' performance and control their behaviour. Those rules evolved iteratively but, in their final form, played a very significant role in empowering devolved management teams, aligning objectives and incentives, and avoiding the effects of perverse incentives and behaviours.

In many ways the second two books seek to answer the questions, raised in the first, that appear to have haunted UK Governments from the 1950s to today. - What do we, as a society, want our railways to do? And what are the purposes we want (or need) railways to fulfil? Having decided over 50 years ago that railways do provide wider social value, it is perhaps disappointing that we have yet to find a way of comprehensively defining and quantifying what that social value is, particularly as its consideration should be central to decisions on how future mobility in the UK is to be delivered.

THINK ARTICLE

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Network Rail are not alone in the challenge to deliver track renewals at an affordable cost. Other railway administrations around the world face similar challenges.

In this Seminar we will hear about Network Rail's recently formed "Track Community of Practice"; a group of relevant stakeholders who have come together to understand their cost drivers and what can be done to achieve efficiency in delivery. Workstreams from within this community will share details of their action plans and intent.

Transport for London will present on the work they have undertaken in recent years to deliver their track renewals portfolio as efficiently as possible and there will also be contributions from other railway administrations.

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He is a committed believer in continuous innovation and in the operational benefits smaller, more agile companies can offer the rail supply chain. John has over 25 years' experience at Director level working within the SME rail industry providing both Civil and Track related products and services, with a focus on added value solutions.

Chris Parasram is Development Engineer at Excalibur and has 42 years' experience in mechanical and precision engineering, having also run his own engineering company for 25 years.

Chris excels in finding solutions to problems from design to manufacture and especially when prototyping one-offs and small batch products. Chris has worked across many sectors including electro-glass, oil and gas, power generation, food and transport.

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As an innovative British SME, Excalibur Screwbolts revolutionised the construction fixings industry and has won two Queens Awards for Enterprise Innovation. Their products have been used extensively to reliably fix numerous applications on rail infrastructure and have various Network Rail (NR), London Underground and Crossrail product approvals.

For some time now Excalibur Screwbolts have been working collaboratively with the rail industry (Network Rail and Transport for London) to provide a purpose designed fastening for baseplates on timber and composite sleepers which has been demonstrated to be easier to install and more reliable than conventional rail screw fixings.

Loose and missing rail baseplate screwspikes in timber sleepers are a commonly acknowledged problem on all rail networks, worldwide. This issue along with the significant torque (circa 2,000Nm) and large heavy machinery needed to install the traditional tapered rail AS screwspikes was the driving force behind this collaboration process.

To identify whole life cost and performance benefits a comparison assessment of the Excalibur timber sleeper bolt and AS Screwspike was commissioned by Excalibur Screwbolts with assistance from NR. The tests conducted included ergonomics, speed/ease of installation and individual product performance tests and were undertaken at Southampton University's Research Institute for Industry (RIFI), supported by NR engineers and ergonomics specialists.

Initial NR ergonomics tests confirmed Excalibur timber sleeper bolts (NR Cat No: 057/150419) were quicker and easier to install than the traditional AS screwspike. These tests also confirmed that the increased speed of installation is likely to lead to potential productivity and reliability gains, lower levels of operator fatigue and potential gains including reduced hand arm vibration syndrome (HAVS), reduced manual labour, COSHH and environmental impact.

Further laboratory testing at Southampton University's RIFI and subsequent on-track installations have all proved positive and reaffirmed these initial findings.

The question we ask is have you ever wondered why timbers split and screwspikes become loose?

This article explains in more detail the tests that were conducted at Southampton University's RIFI and explains the design differences between the two types of fixings and how they react and interface with the sleepers.

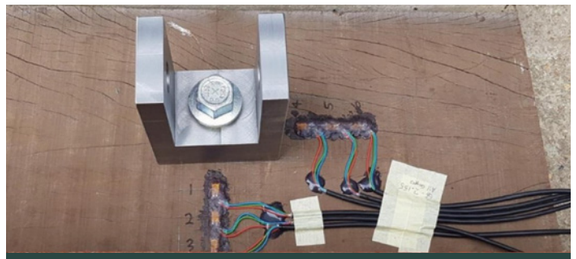

Figure 1: Configuration of strain gauge sensors.

STRAIN GAUGE TESTS ON FITTING OF AS SCREWSPIKES AND EXCALIBUR 20X163 RAIL CHAIR BOLTS

This test was performed by the use of strain gauge sensors attached to the face of the timber in an 'L' formation. (See **Figure 1**). Six sensors were used for each test, attached with three of them running across the grain and the other three running along the grain of the timber. Strain gauge 1 was closest to the drilled hole and was one of the three running across the grain. Data was recorded at a frequency of ~ 100 Hz using a Vishay Strainsmart system. All holes drilled were of the same diameter and depth; all components used for testing were new.

Figure 2 has been taken from the testing. This graph shows the strain imposed on the timber surrounding the drilled hole when the screwspikes or Excalibur bolts are inserted.

There are five of each type of bolt/spike, blue bars represent the AS screwspike and orange bars represent the Excalibur Screwbolts tested to be used as a comparison. This graph shows along the top each specimen and its identification; to the left of the graph is the strain measurement, (the higher the number, the more strain that is being imposed on the surrounding timber).

From this graph it is possible to make the observation that the traditional no. 3 AS screwspike (blue bars) has imposed a high amount of strain at nearly 1500 με (micron strain, linear), and no.5 AS screwspike the least at 400 με. The average mean for the AS screwspikes is 1068 με.

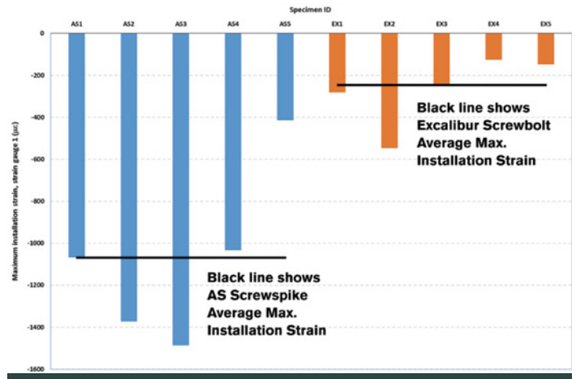

Figure 2: Strain imposed on the timber surrounding the drilled hole.

For the Excalibur chair bolt EX 2 (orange bars) shows 580 με as the highest strain, and EX 4 showing 150 με as lowest strain that is being imposed. The average mean for the Excalibur is 247 με.

The black horizontal lines on the graph shows the average mean for the AS screwspike and the average mean for the Excalibur chair bolt. This then equates to a factor of 4.32 greater strain that is being imposed by the traditional AS screwspike compared to the Excalibur chair bolt. The findings of this graph now start to give an understanding of why the AS screwspike requires such a high rotational torque to install it.

Figure 3 and **4** are plotted from the data collated from the testing; the left-hand graph is for no. 1 AS screwspike.

Figure 3 has been selected as it represents the average mean in strain for the AS screwspikes. **Figure 4** is for Excalibur chair bolt Ex 3, this graph also represents the average mean for the Excalibur chair bolt, as seen in the previous bar chart/graph.

Both **Figures 3** and **4** have at the top a scale of time measured in seconds, and to the left strain imposed measured in με (both graphs have the same scaling). When viewed in conjunction with the graph it shows strain gauges 1-3 are running across the grain, with gauge 1 being the closest to the drilled hole. The red lines on the graphs represent this. Strain gauges 4-6 are running with the grain, with gauge 4 being closest to the drilled hole. The yellow lines are representative of this.

Observation of what can be seen in these graphs.

Figure 3 is for test sample AS1, the traditional screw spike.

1. It can be seen that the fitting time for this sample is 34 seconds, this can be deduced by the point at which the coloured lines flatten out to a straighter line.
2. As this test subject is being screwed in, it is causing more and more strain to be imposed into the surrounding timber, this is evident by the lines running down the graph to the point where strain gauge 1 has recorded 1068 με, this being the average mean for the AS screwspike.
3. Consideration needs to be given to what has happened after the fitting is completed, which is shown by the strain gauge lines where they flatten out and become straighter. It will be noted that from 34 seconds to the end of the recording time (40 seconds) that the lines stay fairly static and do not head back up the graph significantly.

By seeing this it can be deduced that the strain in the surrounding timber remains, the only way these plotted strain gauge lines will move back up the graph towards zero, is when the timber splits and relieves the strain imposed in it.

Figure 4 is for test sample Ex3 the Excalibur rail chair bolt.

1. It can be seen that the fitting time for this sample is 6 seconds, this can be deduced by the point at which the coloured lines flatten out to a straighter line.
2. As this test subject is being screwed in, it can be seen that the amount of strain that is being imposed on the surrounding timber is very low. Again, this is evident by the lines running down the graph to the point where strain gauge 1 has recorded 247 με, this being the average mean for the Excalibur rail chair bolt.
3. The strain factor equates to 4.32 times less stress caused by the Excalibur rail chair screw bolt.
4. Again, consideration needs to be given to what has happened after the fitting is completed, which is shown again by the plotted strain gauge lines where they flatten out and become straighter.

It will be noted that from 6 seconds to the end of the recording time (10 seconds) that the coloured plotted lines are a constant and that any strain remaining is less than 50 με in total, as seen by how close the coloured plotted lines are to '0' at the top of the graph.

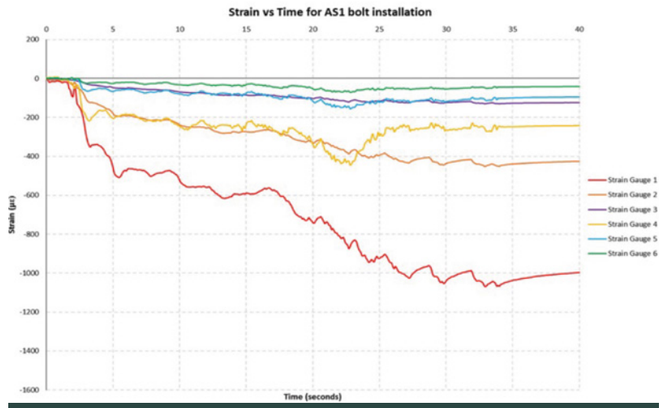

Figure 3: Strain vs. time plot for installation of AS screwspike.

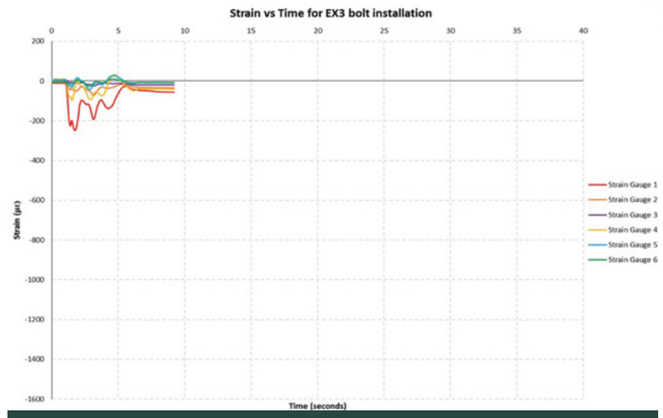

Figure 4: Strain vs. time plot for installation of Excalibur screwbolt.

From this it is possible to deduce that the chance of the timber splitting is negligible as there is next to no strain left in the surrounding timber. In both tests the AS screwspikes and the Excalibur rail chair bolts are tightened to give a clamping force, which is representative of fitting practice used by NR. The strain sensors are located 50mm from the edge of the hole, across the grain (sensor 1), and (sensor 4) is 70mm from the edge of the hole, with the grain of the timber. The other sensors are set at 25mm intervals thereafter.

Figures 5 and **6** are the test representation of axle/wheel contact loadings with the assembly of components as would be found out on track, i.e. Pan 11~ 3 bolt fixing chair/ferrules/pads/e-clips, all fitted to a 600mm long hardwood sleeper with a piece of rail 250mm long. The assembly is then loaded onto the test machine (Instron Schenck servo-hydraulic + 630KN load cell). Data collection is by the use of LVDT's (linear variable differential transducer) and recorded by using an Instron test machine controller and Wave Matrix software. The tests in each of the bar graphs below are run at a frequency of 4 Hz. Test duration is for three million cycles, to be able to recreate the dynamic type of wheel-rail loading which occurs in real-life. A vertical loading and a lateral loading of a varying force is applied, as prescribed in the BS standard.

The **Figure 5** and **6** graphs are marked to the left-hand side in microns for the movement of the spikes / bolts, and along the bottom of the graphs are marked with cycles completed and loading applied. Zero on the left-hand side of the graphs is the set point to which the screw spike and the Excalibur rail chair bolt are tightened down to for the start of the test.

Figure 5 graph shows the results for a test to the prescribed BS standard, starting with a low load for the purpose of bedding down/ running-in. At 0.6 M cycles it can be seen that there is a blue bar (AS screwspike) heading up the graph to 45 microns, at this point in the cyclic loading there is no orange bar showing (Excalibur rail chair bolt), which means it has not started to come undone. As the test progresses the lateral load force is increased from 0 to 30KN and the vertical force from 105KN to a maximum loading of 150KN. At 1.2 million cycles it can be seen that there is a small amount of movement on the Excalibur (orange bar). As the cyclic testing continues to 3.0 million cycles and ends it can be seen that the AS screwspike (blue bar) continues to rise up the chart to 107.5 microns, meaning it is unscrewing, in comparison the Excalibur rail chair bolt (orange bar) which has unscrewed slightly to 16.5 microns at the end of the test. From this it is possible to deduce a factor of 6.25 greater movement (unscrewing), of the traditional AS screwspike against the Excalibur rail chair bolt, which in turn could mean longer intervals between inspection/re-tightening. If this is the case, the sleeper longevity could also be increased by using the Excalibur rail chair bolt, because the loss of clamping force/ component stiffness with the AS screwspike increases the shear load which can then elongate the hole and require remedial repair work.

Figure 6 has been run as an over-load to try to induce failure. In this cyclic load test, there is a small bedding down/running in period of 0.9 million cycles, after this point full load is applied until the end of the test at 3.0 million cycles is reached.

In this graph it can be seen that the (orange bar) Excalibur rail chair bolt has moved up the chart to 55 microns and there is no blue bar showing, meaning no movement. At 1.2 million cycles, (now on full load), the Excalibur (orange bar) is not showing, this means that the bolt has tightened back to its '0' set point.

There is though a small (blue bar) AS screwspike which has moved up the graph to 20 microns as it starts to come undone.

At 1.8 million cycles, (still at full load), there is a small (orange bar) 5 microns uplift of the Excalibur compared to 38 microns, (blue bar) of the AS screwspike.

At 3.0 million cycles still on full load at the end of the test, the (blue bar) AS screwspike, has moved up the graph to 114 microns as it continues to come undone.

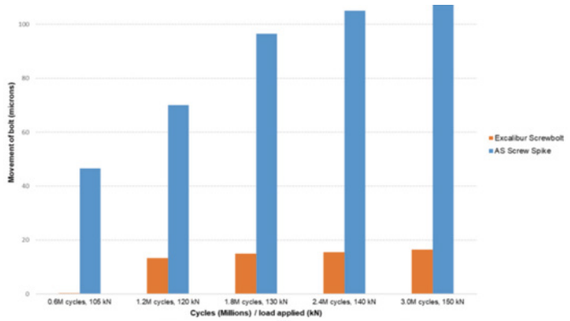

Figure 5: Comparison of movements under load cycles.

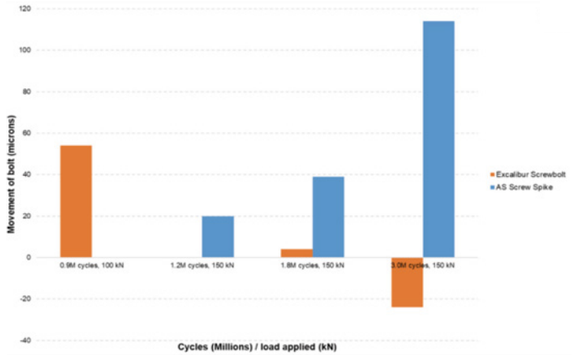

Figure 6: Comparison of movement following overload.

The Excalibur rail chair bolt (orange bar) now is plotted on the opposite side of the '0' zero line, which is the point that all test subjects were originally tightened to, this is showing a -24 micron tightening beyond the original set point for the test.

An observation from this graph, could the Excalibur rail chair bolt under harsh operating conditions be a fit and forget fixing for rail chairs?

CASE STUDY 1.

A one-year trial to improve productivity, reliability, and workforce welfare by replacing AS screws in timber sleepers for NR – Wales & Western.

Result Summary:

Reduction of each screw installation by approximately 4 seconds.

A saving of 3 hours possession time.

User-friendly operation through use of battery powered tool.

Reduced manual labour.

Reduced HAVS risk.

Reduced COSHH requirements.

Reduced environmental impact.

In an effort to find an innovative way to reduce 'boots on ballast', NR / Wales & Western undertook replacement of a large number of AS screwspikes with Excalibur bolts at its Ninian Park **(Figure 7)**, and Carmarthen stations **(Figures 8** & **9)**.

Wales & Western's James Devine is Supervisor for Works Delivery / Wales South, and was given the project to manage. In this case study, he provides insight into the work which ran from Aug 2021 to Aug 2022.

Figure 7: Ninian Park installation with Excalibur Screwbolts.

Figure 8: Carmarthen installation with Excalibur Screwbolts.

Figure 9: Carmarthen installation with Excalibur Screwbolts.

Figure 10: Chair lifting is present with AS screwspikes, and it was noted cracks appearing around holes which are failing to maintain a hold on the AS screwspikes.

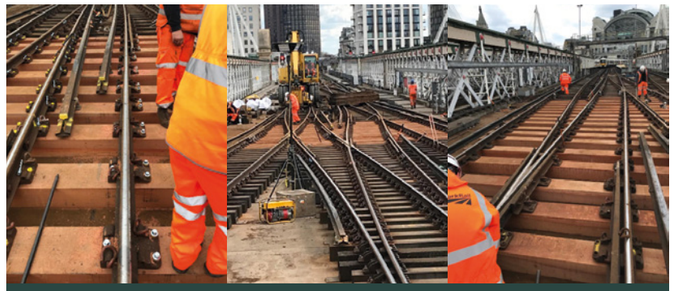

Figure 11: Charing Cross 648pts installation by Swanley Works Delivery.

"This has been an excellent trial. I was initially sceptical about using the battery technology with chair bolts, but the operatives are happy to use Excalibur sleeper bolts because of the decrease in manual effort – they go into hardwood so easily. Our operatives work 6-hour and 12-hour shifts, normally using heavy petrol-powered impact drivers, which is not ideal. We work in a high-stress environment and the less time spent on installing screws means less physical fatigue on the operatives, which has to be a good thing."

Specifications:

Ninian Park: Approximately 300 AS screwspikes were changed to Excalibur Screwbolts, utilising a battery-operated impact wrench with a high amp hour battery. The job involved renewal of 17 hardwood bearers for 9331b points throughout the switch and crossing, re-gauging of the switch and re-ballasting of the cribs. The time to screw an Excalibur bolt was an average of 7 seconds into a new timber – this compared to 11 seconds with an AS screwspike. Excalibur Screwbolts achieved an average of 80 screws per battery, with little time loss.

Carmarthen: Approximately 2000 AS screwspikes were changed to Excalibur Screwbolts on 74 points, 78 points, 72 a&b points and 71 points.

CASE STUDY 2.

NR's Swanley Works Delivery team installation at Charing Cross.

Result Summary:

No signs of star cracking around bolt holes.

No signs of baseplate lifting and Excalibur Screwbolts firmly seated.

Installation time saved.

Reduced HAVS risk.

Reduced manual labour.

Reduced COSHH and environmental impact.

Plus no lubricant needed to aid installation (additional time / money savings).

Charing Cross bridge 648pts uses extra-depth timbers, over 10 metres in length, which are stressed by high vibration with no ballast to absorb the loads. Coupled with water ingress they had degraded, so NR's Swanley Works Delivery team were tasked with installing new chair bolts at the Charing Cross location. This site was particularly noted for failures brought on by the timbers frequently expanding and contracting over and above standard tolerances **(Figure 10)**.

Commencing in April 2022 approximately 500 Excalibur Screwbolts were supplied for installation in 18 no. 10m+ timbers and 3 no. 2.6m timbers **(Figure 11)**. The timbers were drilled out using 19mm drill bits using sleeper drills and Excalibur Screwbolts driven in with 30mm hex head attachments using Bance petrol powered impact drivers. No lubricants were used to aid the installation. Typically, sites using hardwood sleepers and AS screwspikes have had to lubricate the screwspikes to stop them overheating from the force of the screw being driven in which causes heavy friction and slows down the installation, and can cause splits in the timbers (see **Figure 12)**. In June 2023 Swanley Works Delivery reported on the site, with the following results, despite evidence of water ingress and hot weather effects on the timbers:

- No signs of star cracking around bolt holes
- No signs of baseplate lifting
- Excalibur Screwbolts are firmly seated
- Installation time saved
- Reduced HAVS risk
- Reduced Manual Labour

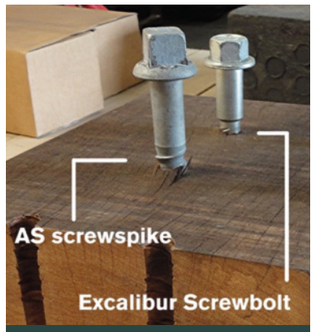

Figure 12: Increased fitting damage caused by traditional rail AS screw spikes to timber sleepers, (similar damage would be caused in plastic sleepers).

Figure 13: Excalibur Screwbolts firmly seated.

In addition, the report noted; Using 19mm drill bits as per standard for timbers, the Excalibur Screwbolts could be initially inserted into the drilled holes very easily. When driven into the timber rather than applying outward pressure at the top of the hole to hold the baseplate like standard AS screwspikes the Excalibur Sleeper Bolts cut their own thread into the timber. As a result, the Excalibur bolts work with the impact wrench to drive bolts into the hole, making installation quicker on each bolt and resulting in time savings that allows an increase in the volume of job scope within a given time. Unlike traditional rail screwspikes there was no lubricant required to aid driving the Excalibur bolts in, and reductions in manual handling and HAVS risk, site tidiness and time saved were recorded. The report concluded that Excalibur Screwbolts would aid in a quicker transition to battery powered tools given how easily they can be inserted, which would have an even greater impact on workforce welfare, HAVS risk, COSHH and environmental impact **(Figure 13)**.

CONCLUSION

The results of the RIFI tests and track installations confirm that Excalibur Sleeper Bolts require substantially less torque to install than traditional rail screw spikes and are therefore quicker and easier to fix.

Lower whole life cost benefits and efficiency gains can be achieved along with reduced sleeper damage leading to extended asset life and reduced maintenance costs.

The vibration resistant Excalibur twin helix thread design imposes minimal stress to the timber sleeper and does not require the use of heavy petrol-powered impact wrenches for installation.

On track installations of Excalibur Sleeper Bolts support the use of battery powered equipment in real life application.

Health & Safety benefits include reduced HAVS risk, Manual Handling, COSHH & Operator Fatigue.

Excalibur Sleeper Bolt key benefits are:

1. Quick & Easy to Install = Time savings, improved productivity & workforce welfare benefits including reduced HAVS risk, manual handling, COSHH & operator fatigue.
2. Reduced fixing installation damage = Improved safety & reliability.
3. Twin helix thread profile imposes minimal stress to sleeper on installation = Extended sleeper life & repair cost savings.

Further reading on technical data is available on request from Excalibur.

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Stefan Vonbun

IVES SLAB TRACK SYSTEM

KNOWLEDGE 200 TRACK

Stefan Vonbun has been working in different roles in infrastructure and railway infrastructure since 2015.

Since 2024 he is globally responsible for product management, R&D and sales of Rhomberg Sersa's superstructure products. He holds a Master's degree from the Technical University of Vienna, Austria. He is an active member of ÖVG (Austrian Society for Transport Science) and VDEI (Association of German Railway Engineers).

THE FUTURE OF SLAB TRACK SYSTEMS IS MODULAR AND EXCHANGEABLE

Modern railway tracks have high requirements when it comes to availability, reduction of maintenance and lifetime. Slab track has proven to be an efficient way to build – not only high-speed – but also urban and heavy haul railway lines. Current trends demand additional features of future-proof track systems: namely modularity and ease of dismantling, as thinking from cradle-to-cradle is more and more important than decades ago. This article explores the requirements and presents a novel system, the IVES slab track system, that tackles some of these issues. The last part deals with experiences from real tracks, where IVES has been successfully in use.

REQUIREMENTS FOR SLAB TRACK

Slab track, ballastless or high fixity systems, as these track systems are called in different regions of the world have literally solidified their presence in the railway superstructure in the past decades.

Being used in tracks across the globe, in various operating environments, they have moved far from being niche. Still, on a global scale ballasted track is the far more widely used version of infrastructure. One particular upside of ballasted track is the relative ease of making post-installation adjustments by tamping the track. The construction is also highly modular, making replacements – even of singular sleepers – a possibility.

There are different approaches to slab track construction, many of which end up in a monolithic body of concrete, that includes some elastic elements to counteract the rigidity of the reinforced concrete slab and add some resilience to the superstructure.

Slab track systems started to gain popularity in the sixties of the past century, so some of the oldest systems are already reaching the end of their design life span. Contrary to ballasted track, where it is rather easy to cut the rails and remove complete track panels, a lot of the demolishing work when dismantling a slab track is much trickier to execute. Also, in the case of accidents, the simple replacement of track components cannot always be realised. Especially in an age of resource scarcity and the need for a more circular economy, systems that are modular and enable the exchange of components can be advantageous. Other challenges that the track construction industry is facing, similar to other industries, is the shortages of skilled workforce: fewer and fewer people are willing and able to work night shifts and weekend possessions. There is a certain pressure on contractors to not only automate in order to gain efficiency and stay relevant, but also to make up for the lack of workers.

THE "LEGO WAY" OF CONSTRUCTING SLAB TRACK

About 14 years ago Rhomberg Sersa set out to funnel its decade long experience in slab track construction, having built all the major European slab track systems (PORR STA, LVT, Rheda, Getrac amongst others) in different projects, into the development of a new slab track system. Besides construction, the company also gained experience with refurbishing and repairing different track systems. The synthesis was a combined approach between bottom-up and top-down construction approaches. The IVES slab track system was developed with both modularity, high construction quality and automation potential in mind. The process starts with the construction of an asphalt base layer, harnessing the advantages of this quick to build construction material, that is fast-curing, can be worked with even in temperatures where concreting is a hazard and proves to be long-lasting. In curves the asphalt layer is executed in a wedge shape (laterally), to create superelevation (cant). The next step is the installation of pre-fabricated concrete blocks, that can be manufactured with pre-stressed and non-stressed reinforcement. These building blocks can be thought of as supersized LEGO bricks: whether they are used on a straight track or in curves, even in areas of high superelevation, the block design remains the same. Due to their slim dimensions (2400 mm width, 610 mm length, 255 mm height) they can be laid in curves as tight as 40m radius. The blocks were designed to have a flat surface with one thing in mind: minimising difficult logistics, especially in tunnels. The design of the blocks allows rubber-tyred vehicles, even heavy lorries, to drive over the blocks during construction. In very tight conditions one tyre could even be running over the centre of the block, with the other tyre running on the safety walkway next to the track. Longitudinal and lateral forces are transferred from the block to the asphalt layer mainly by friction, as an extra measure of safety a shear dowel is installed according to routing parameters: e.g. in tight curves every block uses a dowel, in straight track fewer dowels are used. After core drilling into the asphalt to be able to insert the stainless-steel dowels, the bottom-up portion of the installation is done, (for build-up and main components of IVES slab track system see **Figure 1**).

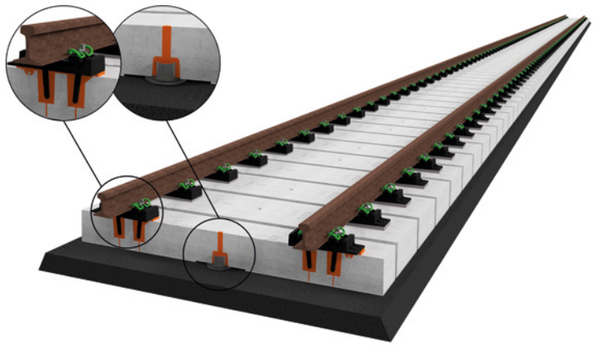

Figure 1: IVES slab track system – details show direct fastener type Vossloh DFF 300 RS and the stainless-steel dowel embedded in the asphalt layer providing additional longitudinal and lateral fixation, both held in place by a fast-setting grout, depicted in orange. (Copyright RSRG).

Figure 2: Vossloh DFF 300 RS before assembly of track panel; also visible are the grouting pockets on top of the IVES blocks.

Figure 3: Track adjustment system RhoFAS supporting the track panel, placed on IVES blocks. Formwork installed around the fastening system. (Copyright RSRG).

FIRST: BOTTOM-UP, SECOND: TOP-DOWN

The next step is where the methodology switches to top-down: an especially developed direct fastening system (DFF 300 RS, see **Figure 2**), that is based on one of the most successful slab track fasteners, the system 300 fastener, is used to construct track panels depending on the length of the rails used. The panels are very accurately positioned with a track adjustment system (see **Figure 3**), enabling high accuracy. While resting on the adjustment system spindles, the track can be used for logistics by construction vehicles up to a certain tonnage. Once the final position is confirmed by surveyors, the direct fasteners (type Vossloh DFF 300 RS, refer to **Figure 4**) are permanently bonded to the blocks with fast-curing cementitious or epoxy grouts. The direct fastener combined with the prefabricated block is a lesser-known approach that allows for bigger construction tolerances in the asphalt base layer and the block itself. At the time of grouting, all previously accumulated construction tolerances can be set to zero again. Track gauge widening in tight curves can be executed just by positioning the direct fasteners at a wider position, without needing special angled guide plates. This leads to higher reserves for post-installation adjustments during the lifetime of the track. The same is true for the vertical adjustments inside the fastening system, should track settlements occur.

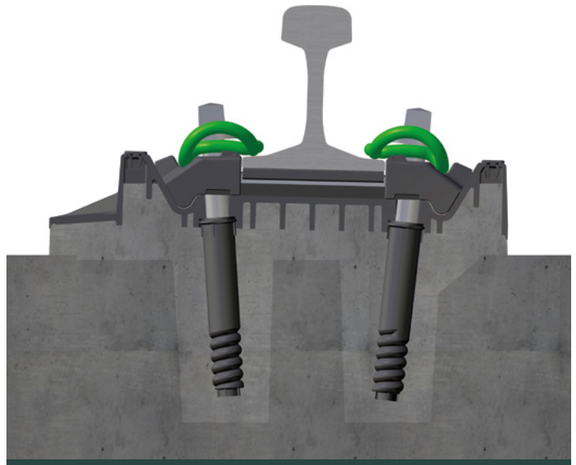

Figure 4: Direct Fixation Fastening System Vossloh DFF 300 RS: shown as installed on an IVES block with fast-setting grout permanently bonding the DFF to the slab track blocks. (Copyright Vossloh Fastening Systems).

Figure 5: Standard version of the IVES system as installed in Asfordby tunnel in 2014.

Figure 6: Longitudinal version of the IVES system as installed on viaduct at New Bailey Street, Manchester.

PRACTICAL EXPERIENCE WITH IVES

The first ever project executed with the system is the Asfordby Tunnel (see **Figure 5**) in the Melton Rail Innovation & Development Centre of Network Rail in Great Britain. The tunnel which is part of the test track there is not in heavy use, but it was a great starting point for gaining experience with the system. A particularly noteworthy project is the project in New Bailey Street, Manchester where a longitudinal version of the blocks was used on a viaduct (see **Figure 6**).

When it comes to longevity, experiences from real tracks provide better data than laboratory tests any day. IVES was installed in a portion of track of Australian Rail Track Corporation in Australia as part of the construction of a new weighbridge. The system has experienced 120 million gross tonnes (MGT) for more than seven years now, totalling around 860 MGT, while still being in very good condition. A year after Australia, the system was first installed in the network of Deutsche Bahn (DB) in the Zierenberg tunnel in the centre of Germany. This milestone was possible through extensive laboratory testing and refining the design until all the strict requirements were met. The full approval for the network of DB is expected to be released in 2025, after more than six years of successful operational testing. Since some projects were executed in Great Britain already, Rhomberg Sersa is working together with Network Rail to achieve product acceptance for the system, to simplify the use in upcoming projects.

ADVANTAGES OF IVES SLAB TRACK SYSTEM

Due to its particular design and modularity, the IVES system has the following advantages in different life cycle phases:

Advantages during construction:

- Asphalt base layer: quick to install and high proportion of recycled material possible (CO2 reduction)
- Prefabricated blocks: no in-situ concrete logistics, there is only one standard block for straight sections and bends, simplified logistics, laid blocks can be driven over for construction logistics, automation of laying possible
- Direct fastening: very precise creation of the track position in the final construction step, compensates for transverse inclination (drainage), gauge widening in tight curves and installation tolerances; setting times vary depending on the grouting material
- No readjustment ('levelling') in the rail fastening during the construction phase

Advantages in operation:

- Excellent drainage: also on straight track a transverse cross slope is possible without compromising track geometry
- In the event of an accident (e.g. derailment), individual blocks can be replaced very easily
- Complete maintenance reserve in the fastening is available for readjustment during operation
- Rail replacement simplified, as standardized rail pads layers can be used

Advantages at end of life:

- Dismantling at the end of the service life is much easier than with monolithic construction methods, as blocks only laid on the base layer or connected via form-fit with the shear dowel, an important feature for future recycling management and the circular economy

SUMMARY

The IVES high fixity system is a new way of constructing railway tracks, enabling high levels of automation during operation, easy component exchange in case of accidents and fast dismantling at the end of the lifetime. Its safety and longevity have been proven in projects in Switzerland, Germany, Australia and Great Britain since 2014.

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CELEBRATING THE 200TH ANNIVERSARY OF THE MODERN RAILWAY

Join the celebrations for Railway 200! Our Corporate and Heritage Members are hosting a fantastic range of events to mark this historic milestone, from open days and exhibitions to hands-on activities the whole family can enjoy. This is a great opportunity to explore railway heritage, connect with fellow enthusiasts, and show your support for the industry. Take a look at the events below and get a date in the diary to join the celebrations.

NETWORK RAIL

Venue: London, Greater London, SE1 8SR, United Kingdom
Dates: 3 May 2025 to 16 November 2025
www.eventbrite.co.uk/o/network-rail-43841778133

INFORMATION

A programme of tours with popular tour guide and author Rachel Kolsky. At three iconic London termini – Waterloo, Victoria and London Bridge – we will celebrate rail's remarkable past, its role today and its importance to a sustainable future they will focus on four key themes: Culture, Heritage & Tourism, Railway People, Education & Skills and Innovation, Technology & Environment.

CHURNET VALLEY RAILWAY

Venue: Stoke-on-Trent, Staffordshire, ST10 2HA, United Kingdom
Dates: 22 February 2025 to 27 September 2025
www.churnetvalleyrailway.co.uk/heritage-open-days

INFORMATION

Experience Heritage Open Days 2025: A Unique Journey across our Railway with exclusive backstage access as they unveil the site of the brand-new Leek Station!. This event is more than just a train ride; it offers exclusive access to areas not normally open to the public. Enjoy guided tours of the workshops, where you'll discover the intricate workings of our railway heritage.

GLOUCESTERSHIRE WARWICKSHIRE STEAM RAILWAY

Venue: Cheltenham, Gloucestershire, GL54 5DT, United Kingdom
Dates: 25 July 2025 to 27 July 2025
27 September 2025 to 28 September 2025
www.gwsr.com/events/
Open to the public, booking/ticket required

INFORMATION

Join us for our last Gala of 2025. With an intensive timetable on offer fully utilising the railway, steam and diesel haulage, goods trains, brake van rides, footplate trips, behind-the-scenes access and on Sunday, running after dark, this is an event not to be missed.

AVON VALLEY RAILWAY HERITAGE TRUST

Venue: Bath Road, Bristol, South Gloucestershire, BS30 6HD, United Kingdom
Dates: 27 September 2025 to 28 September 2025
www.avrht.org/about-us

INFORMATION

Family and community themed event, showcasing the social impact on the area brought about by the coming of the Railway. There will attractions for all the family including, steam train running; the Fry's factory Sentinel engine will be steaming; classic cars; carousel; Railway films from the 1950s and 1960s; model railway layouts of old stations on the line. Vintage buses to and from the car parks, and much more.

THE WATERCRESS LINE

Venue: Station Road, New Alresford, Hampshire, SO24 9JG, United Kingdom
Dates: 25 April 2025 to 27 April 2025
www.watercressline.co.uk/special-days/spring-steam-gala/

INFORMATION

The Spring Steam Gala is a rare chance to ride behind special guest and home-fleet locomotives while celebrating 200 years of train travel. Highlights include the historic T3 No. 563 from Swanage Railway, heritage station visits, behind-the-scenes tours at Ropley, and exhibits on restoration projects. Enjoy unlimited travel, brake van rides, a miniature railway, and more.

TELFORD STEAM RAILWAY

Venue: The Old Loco Shed, Bridge Road, Horsehay, Telford, Shropshire, United Kingdom
Dates: Ongoing
www.telfordsteamrailway.co.uk/

INFORMATION

A photograph display celebrating the history of the Wellington to Craven Arms Railway in the Spring Village waiting room throughout the 2025 season. Planned reunion of ex-staff of Wellington (84H) shed, recording memories and stories for posterity. History walks and talks on the history of the Wellington to Craven Arms railway and its impact on Horsehay, including the Horsehay Iron Works.

KEIGHLEY AND WORTH VALLEY RAILWAY

Venue: Station Road, Keighley, West Yorkshire, BD22 8NJ, United Kingdom
Dates: 1 July 2025 to 30 September 2025
www.bradford2025.co.uk/event/the-railway-children/

INFORMATION

The Olivier Award winning Theatre Production of the Railway Children returns with a new version. This time, staged at the location that the Railway Children was filmed, all audience members take a steam train journey to the Engine Shed Auditorium, taking in fantastic Bronte country views along the way.

CHINNOR & PRINCES RISBOROUGH RAILWAY

Venue: Chinnor Station, Chinnor, Oxfordshire, OX39 4ER, United Kingdom
Dates: 30 March 2025 to 31 October 2025
www.chinnorrailway.co.uk/

INFORMATION

Operation of heritage steam and diesel hauled trains, between Chinnor and Princes Risborough, every Sunday, with additional services over bank holiday weekends, Thursdays in school holidays and some Saturdays. Diesel and steam gala days, exhibition coach with a working model of the Watlington end of our GWR branch line in the 1940s.

WEST SOMERSET RAILWAY

Venue: West Somerset Railway, Minehead, Somerset, TA24 5BG, United Kingdom
Dates: 2 May 2025 to 5 May 2025
www.west-somerset-railway.co.uk/

INFORMATION

The West Somerset Railway's Spring Steam Spectacular will celebrate Railway 200 with at least eight steam engines, including visiting locomotives from across the country. The event will showcase 200 years of railway history, featuring engines from the 1800s to the 2000s. Expect a packed timetable with Demonstration Goods, Express, and Local services, making it a true spectacle for steam enthusiasts.

GREAT CENTRAL RAILWAY

Venue: Great Central Road, Loughborough, Leicestershire, LE11 1RW, United Kingdom
Dates: 1 March 2025 to 16 November 2025
www.gcrailway.co.uk/

INFORMATION

As the UK's only double-track main line heritage railway, we will be celebrating Railway 200 by reinventing the story of how rail has impacted our society, and the story of our own railway, one that isn't yet complete... Together with our sister railway at Great Central Railway (Nottingham) at the Nottingham Transport Heritage Centre, we will be holding a Railway 200 celebration, joining our railways together with a classic rail replacement bus service!

SPA VALLEY RAILWAY

Venue: Spa Valley Railway, Tunbridge Wells, West Station, Tunbridge Wells, Kent, TN2 5QY, United Kingdom
Dates: 13 June 2025 to 15 June 2025
www.spavalleyrailway.co.uk/product.php/7451/cuckoo-line-gala

INFORMATION

Step back in time to the 1960's when steam still ruled supreme and join us as we commemorate 60 years since the closure of the famous Cuckoo Line which once ran between Tunbridge Wells West via Eridge and Hailsham to Polegate and we join the countrywide celebrations of 200 years of rail in the United Kingdom. This event will feature historic steam and diesel locomotives operating on the Spa Valley Railway between Tunbridge Wells West and Eridge.

EAST LANCASHIRE RAILWAY

Venue: Bolton Street, Bury, Greater Manchester, BL9 0EY, United Kingdom
Dates: 14 March 2025 to 16 March 2025
www.eastlancsrailway.org.uk/events-activities/legends-of-steam/

INFORMATION

East Lancashire Railway's celebration of Railway 200 continues thanks to legendary locomotives with film and royal connections. Climb aboard for the first large scale steam event of the year. This is your chance to ride up and down the line behind a strong line-up of express steam locomotives. An intensive timetable is planned for this extended weekend, with dining options featuring 'Tornado' on the Saturday night, whilst the Friday night features an authentic 'Golden Arrow' menu, hauled by one of the Southern locomotives.

RAILWAY 200: SKILLS & EDUCATION

As part of the Railway 200 campaign to help tell the story, there are four main themes that are being explored; Skills & Education, Innovation, Technology & Environment, Heritage, Culture & Tourism and Celebrating Railway People. In this edition of the Journal we are going to highlight the different opportunities available within railway engineering to continue to develop skills, undertake further education, achieve Professional Registration, and highlight the careers of members who have done just that.

WHERE WILL YOUR CAREER **TAKE YOU?**

Scan to visit the Knowledge 200 website

TEXTBOOKS

- Design of Railway Switches & Crossings in Flat Bottom Rail
- Design of Railway Track in Bull Head Rail
- Overhead Line Electrification for Railways
- Switch & Crossing Maintenance
- Track Terminology
- Understanding Rails & Rail Welding
- Understanding Track Engineering

TECHNICAL EDUCATION AND TRAINING PROGRAMMES

- Advanced Track Technician Course
- Earthworks and Drainage
- Switches and Crossings
- 3rd and 4th Rail
- Electrification Diploma (IEng top-up)
- Track Engineering Diploma (IEng top-up)

PROFESSIONAL REGISTRATION

EngTech

IEng

CEng

A CAREER IN DIGITAL & AI

KNOWLEDGE 200 DIGITAL & AI

Alison's career path into railway engineering was unconventional. Beginning with degrees in archaeology and forensics, she discovered an interest in land surveying while working on excavation sites.

FROM ARCHAEOLOGY TO ENGINEERING: A DATA-DRIVEN CAREER PATH

"I was working on archaeological digs in the Shetland Isles and Bath, and I found myself drawn to the survey teams. I started learning from them and realised that I enjoyed the technology and precision involved. That eventually led me to railway surveying."

Alison's ability to translate data-driven insights into real-world applications made for a seamless transition into rail. After gaining experience in railway surveying with AECOM, she joined London Underground and later TfL, where and now leads a team responsible for collecting and managing critical engineering data.

Alison's work is centred on ensuring the accuracy and accessibility of railway survey data, enabling TfL to make informed engineering decisions.

"My job is about making sure we're not just collecting data, but collecting the right data—data that can be used across multiple projects to create efficiencies and improve decision-making."

From track geometry surveys to tunnel clearance assessments, her team plays a pivotal role in ensuring infrastructure upgrades are executed with millimetre precision.

A recent track renewal project in London's deep tube network exemplifies the value of precision engineering and robust data management.

"We started by surveying the existing track geometry and tunnel structures, using total stations and laser scanning technology to create a detailed 3D model. That data was then used by the design team to develop the new track alignment. Fast forward three years, and we were back on site setting out the new track to millimetre precision, ensuring it was installed correctly before the concrete was poured."

This level of accuracy is critical for ensuring safe and reliable railway operations. Advanced surveying tools allow Alison's team to detect misalignments that could affect performance, while high-quality data ensures that new infrastructure integrates seamlessly with existing assets.

Her team also plays a key role in integrating survey data with digital design models, supporting a more efficient transition from design to construction.

With digitalisation transforming infrastructure management, Alison sees AI and data science as critical to the future of railway engineering.

"The key challenge isn't just collecting data—it's making sure it's properly structured, named, and accessible for long-term use. AI could help us analyse trends and automate quality checks, but we need to ensure we're asking the right questions before we dive in."

She highlights the need for robust data governance, ensuring that datasets are correctly labelled, stored, and integrated across multiple projects.

"AI will be most effective when we structure our data in a way that allows it to be used across disciplines. If we're collecting data for one purpose, can it be structured in a way that benefits multiple teams? That's where the real efficiencies will come from."

As new technologies emerge, Alison stays ahead by engaging with industry events, supplier collaborations, and professional development initiatives.

"Rail Live, Geo Business, and PWI technical meetings are all invaluable. They provide insight into the latest surveying technologies and how they can be applied in a railway context."

By maintaining close relationships with technology providers, her team also plays a role in shaping new solutions.

"We've had ongoing conversations with suppliers about what would improve their products for our needs. That two-way dialogue has been incredibly useful in pushing innovation in a direction that benefits railway engineering."

Alison's work demonstrates the growing importance of data-driven engineering in the railway industry. From high-precision track alignment to AI-driven data management, her team's expertise ensures that infrastructure projects are delivered with accuracy and efficiency.

ALISON TIGG
PRINCIPAL ENGINEERING LEADER IN THE LAND SURVEY TEAM AT TRANSPORT FOR LONDON (TFL)

ROUTE TO CHANGE SEMINAR 10 APRIL MANCHESTER

Like all industries, the rail sector is under constant evolution to ensure it remains successful. This Seminar will reflect on past ways of working, how these have changed in recent times and what they could potentially look like in the future.

With a focus on changes across all aspects of asset life; from processes deployed through to the utilisation of technology, giving due consideration to ethical matters faced by those working in the industry.

Resources from this Seminar will be available on the PWI Knowledge Hub

EXCLUSIVE **MEMBER RESOURCES**

Scan to visit the Digital & AI webpage

A CAREER IN TRACK

KNOWLEDGE 200 TRACK

For Thomas Utley, a career in engineering was almost inevitable. Inspired from an early age by technical problem-solving. He initially developed an interest in engineering through childhood experiences of building with Lego and learning from his father, who worked as a gas turbine engineer.

ENGINEERING ON THE FRONTLINE: A CAREER IN RAILWAY MAINTENANCE

Thomas' journey into track maintenance began with a placement on the Piccadilly Line maintenance team, where he worked under the mentorship of Tom Kiely. "I really enjoyed the challenge of it," he says. "It was fast-paced, involved quick problem-solving, and no two nights were ever the same."

This practical experience led to a role in track maintenance engineering, where he was responsible for planning and overseeing campaign works. He later became an Assistant Track Manager on the District Line before transitioning to Network Rail, where his responsibilities broadened beyond track to managing the maintenance of all railway assets within his geographical region.

"Working across different disciplines, including signalling and off-track infrastructure, has been a fascinating experience," he explains. "It's given me a much deeper understanding of how all the elements of the railway integrate."

Unlike project-based roles that focus on long-term planning, track maintenance requires engineers to be reactive as well as strategic. Thomas' current role involves overseeing a large geographical area from South London to Hastings, coordinating multiple depots, and ensuring the safe and efficient running of the network.

"A typical day starts with a conference call reviewing overnight risks and planning responses to any urgent issues," he says. "Beyond that, there's the longer-term strategic work—looking at how we can improve reliability and performance in the future."

Maintenance engineering also means being on call—every 12 weeks, Thomas is responsible for handling any major failures or safety incidents outside office hours. "Some weeks, I won't get any calls. Other times, it can be relentless—like a recent week where we had two broken rails, which is highly unusual."

Reflecting on what makes his role rewarding, Thomas highlights the direct impact track maintenance has on people's lives. "Our job is to make sure passengers get home safely and on time. On a good day, when everything runs smoothly, I take real satisfaction in knowing we've provided a reliable service."

"At the end of the day, the railway is an essential part of society. If we do our jobs well, millions of people benefit."

Every discipline in the railway comes with its own challenges, and track maintenance is no exception. One of the biggest is access to infrastructure—finding the time to carry out maintenance without disrupting services where possible.

"Passenger trains take priority, and we also manage freight traffic down to the Channel Tunnel. Negotiating access slots that suit everyone is a complex process," he explains.

Another major challenge is climate change. "We're seeing more extreme weather events, with drainage systems designed decades ago struggling to cope with today's conditions. As an industry, we need to be more proactive in building resilience into the railway."

Safety remains at the heart of everything. "We have a responsibility to provide a safe railway, both for our passengers and our staff. The industry has made great strides, but there is always more to do—whether that's reducing trackside working or adopting new technologies that improve safety."

Looking ahead, Thomas is excited about how technology is transforming railway maintenance. "Network Rail has made huge progress in remote monitoring—train-borne sensors, geospatial analysis, and static measurement systems are revolutionising how we predict and prevent failures."

There is also a shift towards mechanisation—replacing labour-intensive work with more automated solutions. "For example, in vegetation management, we're moving towards drone and robot-based technology, reducing both risk and cost."

However, some aspects of track maintenance remain unchanged. "We're still using methods that have been in place for over a century, like manually changing rails. While new technology is emerging, there's still a long way to go."

As the industry continues to evolve, professionals like Thomas—combining technical expertise with a commitment to continuous learning—are at the forefront of ensuring a safer, more efficient railway for the future.

THOMAS UTLEY
INFRASTRUCTURE MAINTENANCE
Engineer at Network Rail | CEng MICE

TRACK RENEWAL SEMINAR 5 NOVEMBER 2025 BIRMINGHAM

TECHNICAL EDUCATION AND TRAINING PROGRAMMES

- Advanced Track Technician Course
- Switches and Crossings
- Track Engineering Diploma (IEng top-up)

EXCLUSIVE **MEMBER RESOURCES**

Scan to visit the Track webpage

A CAREER IN EARTHWORKS & WATER MANAGEMENT

KNOWLEDGE 200 EARTHWORKS & WATER MANAGEMENT

Meet Angus, who embarked tertiary education in the field of Civil Engineering and Geology 32 years ago, his present focus is planning and preparing for underground construction projects for hydropower generation in Scotland's West Highlands for our sustainable future.

How did you start your career in the rail industry?

My first contact with the railway was learning to ride a bicycle in the former engineering and freight siding by Conon Bridge Station pre-school (in the doldrum years before the station was reopened). Since that time the railway has always been part of my life journey. In 1990 as a work experience pupil aged 15, I was involved in a large diameter sewer pipe jack performed by Morrison Construction below the railway in the same vicinity. I first obtained my Personal Track Safety Certificate (PTS) in 1998 and have kept it valid and up to date thorough out my career.

My first outing on the railway as an engineering professional was at what was to become known as the Wallyford Subsidence Incident by some, and Wallyford Diversion by others. I was the first engineer on scene at the famous cabbage field charged with investigating depressions that had appeared in the ballast shoulders of UP and DOWN lines on the East Coast Main Line [ECML]. What followed were several weeks of drilling investigation works which then resulted in a temporary diversion of the ECML, to then allow a piled track slab to be installed over what was proven to be voids created by legacy coal extraction, and the recent cessation of pumping mine water.

Tell us a little about your career experiences to date

I first trained as a COSS and Machine Controller in 2011, and for a brief time I also held a competency in operation of ontrack plant. I have been Contractor' Responsible Engineer (CRE) and Contractor's Engineering Manager (CEM) in the specialist area of underground structures and legacy buried features for which perhaps the most intense projects were my two-year deployment into Haymarket Tunnels as Project Manager.

I accrued 21 years of frontline experience, generally on site, or directly managing site operations with a fair spread of nightshift possession works and intense periods of extended blockade delivery of various infrastructure enhancements and renewals – almost all unrelated to track but all essential to the safe and efficient running of our railway. Now I use this experience to support our customers, my colleagues and the wider industry in the field of what is called Business Development. My biggest joy comes from nurturing our people to realise their potential, and achieve great things together. I provide training and support, connecting people in my network to provide solutions.

Tell us about your role on the railway

Every day is different and the tasks I deal with are varied, although all technically linked with underground and in-the-ground. My days

are reasonably flexible as my work commitments are not necessarily during what some would call general working hours. The railway never sleeps.

Most weeks involve some time on my bike, and some extent of rail travel to almost anywhere in the country – generally I travel with my Brompton which allows me flexibility at each end of any journey. In the modern age there can be 3-4hrs of formal online meetings each day. I spend some time dealing with a vast array of correspondence about matters relating to my experience and expertise – in this modern era I still get letters but the majority is by email, and increasingly by direct messages over various platforms. Most correspondence starts with "can you help?", "have you come across this problem before?", or "what do you think?". I present regularly on technical and safety subjects internally within BAM UK and Ireland and to external organisations. I am frequently asked to present at technical conferences and local technical groups.

I have voluntary roles outwith my employment. I am a Director and Trustee with a local charity who provide learning opportunities for young people with additional support needs – I Chair the board of Trustees and this occupies a few hours a week. I am on the management group of my local community woodland – we have 65 hectares of mixed woodland and this is where I spend my leisure time over weekends.

Time spent sleeping, resting and reflecting is the most important part of my day; I've learned that without these I cannot sustain the pace required in the working environment.

The biggest challenge we face as experts is understanding what we don't know and sharing what we do know with others in a way that is accessible and can be digested without oversimplifying the issue.

ANGUS MACGREGOR
Chartered Engineer | Registered Ground Engineering Professional | Business Development | STEM Ambassador | Volunteer Trustee

WATER MANAGEMENT SEMINAR 7 MAY LONDON

TECHNICAL EDUCATION AND TRAINING PROGRAMMES

- Earthworks and Drainage Course

UPCOMING SECTION MEETING

- Earthworks on the Core Valley Lines

James Dyke, Geotechnical Engineer, Transport for Wales
April 14 | 17:15 – 18:15 | South & West Wales Section

EXCLUSIVE **MEMBER RESOURCES**

Scan to visit the Earthworks & Water Management webpage

A CAREER IN ELECTRIFICATION & PLANT

KNOWLEDGE 200 ELECTRIFICATION & PLANT

The Permanent Way Institution is pleased to welcome John Merriman as our new Electrification Technical Manager. With a distinguished career spanning over four decades in railway electrification, John brings a wealth of experience, leadership, and technical expertise to this pivotal role.

A Lifelong Dedication to Electrification

John's career in engineering began in 1977 as an apprentice electrician at the Ministry of Defence in Pembrokeshire. Since then, he has worked across multiple disciplines within the railway and electrical engineering sectors, gaining a broad perspective that has shaped his approach to project delivery and technical leadership.

His extensive experience includes roles as an electrification engineer, project manager, and director for leading organisations such as Network Rail, Powerlines UK, Alstom, Colas Rail, and VolkerRail. His ability to lead complex, multi-disciplinary projects, combined with his deep technical knowledge, has made him a respected figure in the field.

John is a Chartered Engineer (CEng), a European Engineer (EUR ING) and a Fellow of both the Institution of Engineering and Technology (FIET) and the Permanent Way Institution (FPWI). His academic achievements include an MSc in Professional Engineering from Aston University and an MA in English from the Open University, reflecting both his technical acumen and his commitment to lifelong learning.

Delivering Electrification at Scale

One of John's most notable contributions to the industry has been his leadership on major electrification programmes. In his most recent role as Departmental Engineering Manager at Network Rail, he was the principal engineer for the Midland Mainline Route Electrification programme. Overseeing a portfolio of projects worth £1.5 billion, he led a team of over 300 engineers from Network Rail and the supply chain, ensuring the successful delivery of electrification works from Kettering to Sheffield.

John's role extended beyond technical oversight. He played a key part in strategic decision-making, setting delivery targets, managing stakeholder relationships, and driving innovation to control costs and improve efficiency. His leadership in engineering governance and regulatory compliance ensured that electrification was delivered to the highest standards while maintaining safety and operational integrity.

Prior to this, John worked with SPL Powerlines as a Project Engineering Manager, gaining first-hand experience of electrification from the contractor's perspective. He has also held senior positions at ABC Electrification, Colas Rail, and VolkerRail, where he contributed to the successful delivery of major rail infrastructure projects across the UK.

A Passion for Mentorship and Industry Development

John is a strong advocate for professional development within the railway industry. He has mentored many engineers through the professional registration process and continues to work as an IET mentor, supporting the next generation of railway professionals.

His work with Aston University as a Professional Supervisor further highlights his commitment to education and knowledge sharing. By guiding students through MSc programmes, he ensures that academic learning is aligned with real-world engineering challenges.

As Electrification Technical Manager at the PWI, John is keen to use his expertise to support engineers across the industry. Whether through technical guidance, training, or industry engagement, he aims to provide valuable insights that help railway professionals navigate the complexities of electrification projects.

The Future of Electrification at the PWI

John joins the PWI at a crucial time for railway electrification. As the UK continues its journey towards decarbonisation, electrification remains a key focus for improving sustainability and efficiency within the railway network. In his new role, John will be instrumental in shaping the PWI's technical approach to electrification. He will work closely with members, industry stakeholders, and technical committees to advance best practices, promote innovation, and address the challenges facing electrification projects.

He is particularly passionate about integrating new and innovative solutions into railway infrastructure, ensuring that electrification projects are not only cost-effective but also future-proofed for evolving railway needs. With his extensive background in engineering governance and systems integration, John is well-positioned to drive improvements in electrification design, delivery, and maintenance.

A Warm Welcome to the PWI Community

John's appointment as Electrification Technical Manager is a significant addition to the PWI's technical leadership. His vast experience, strategic thinking, and commitment to professional development will undoubtedly benefit the Institution and its members.

JOHN MERRIMAN
ELECTRIFICATION TECHNICAL MANAGER, THE PWI
Chartered Engineer (CEng) | European Engineer (EUR ING) | Fellow of the Institution of Engineering and Technology (FIET) | Fellow of the Permanent Way Institution (FPWI

ELECTRIFICATION SEMINAR, 2 JULY HILTON, CARDIFF

TECHNICAL EDUCATION AND TRAINING PROGRAMMES

- Electrification Engineering Diploma
- 3rd – 4th Rail Electrification Course

EXCLUSIVE **MEMBER RESOURCES**

Scan to visit the Track webpage

TAKING YOUR CAREER TO THE NEXT LEVEL

EngTech | IEng | CEng

Professional Registration is a career milestone that is within reach for all our Members - but often there can be all manner of excuses getting in the way. Here we take some of the most common barriers we hear, and bust those myths!

10 MISCONCEPTIONS ABOUT PROFESSIONAL REGISTRATION

I NEED ACADEMIC QUALIFICATIONS

While academic qualifications can help demonstrate your technical knowledge and understanding, many successful applicants use their career experience instead, using one of our Routes to Registration.

I NEED TO MANAGE PEOPLE TO ACHIEVE IEng OR CEng

You don't need to have direct reports to demonstrate leadership.

Technical leadership, such as overseeing aspects of projects or mentoring others, is equally valuable.

I DON'T HAVE THE TIME

Yes, Professional Registration requires a time investment, but once you've achieved it, your title is yours for life. By setting aside time regularly and breaking the process into manageable steps, you'll find it much easier to complete your application.

IT WILL COST TOO MUCH

Professional Registration requires PWI membership, which costs around £10 per month. When you're ready to apply, there is a one-off fee: EngTech is just £60; IEng / CEng is £225. Many employers are happy to cover these costs, so it's always worth asking!

MY APPLICATION MUST ONLY FOCUS ON MY CURRENT ROLE

While your current role is important, assessors welcome examples from previous positions, placements, or even voluntary work.

You should use the most relevant example.

MAINTAINING MY REGISTRATION WILL BE TOO DEMANDING

There are two key commitments: maintain membership and keep CPD records. Fail to renew membership, and you'll be removed from the Register. As a PWI Member, your CPD will automatically be recorded. You simply need to add your reflections!

I NEED TO BE SKILLED AT WRITING ACADEMIC REPORTS

Writing is required for all applications, but this isn't as daunting as it sounds.

You're telling the story of your career. There's no need for complex reports or research projects!

MY LINE MANAGER ISN'T A REGISTRANT

Your line manager doesn't need to be professionally registered to support your application. In fact, your decision to gain a title might even inspire them to do the same!

MY COLLEAGUES ARE TOO BUSY TO HELP ME

You do need someone who is already a registrant with EngC to be your Sponsor, to guide you through the process. As part of their CPD obligations, they need to support the development of others, and many want to pay it forward. It can be very rewarding. Don't take the decision for them - ask them!

IT'S NOT WORTH IT FOR ACADEMICS

Holding a professional title and being a member of a professional body is a great way to set an example for students and encourage them to follow the same path. It also enriches the educational experience by demonstrating the value of professional recognition.

Tom Utley
Network Rail

"I BECAME A CHARTERED ENGINEER IN 2017, JUST BEFORE PWI STARTED OFFERING PROFESSIONAL REGISTRATION. I'M REALLY PASSIONATE ABOUT ENSURING OTHERS HAVE THE SAME OPPORTUNITIES I DID."

PROFESSIONAL REGISTRATION: SET UP FOR SUCCESS

If you are considering Professional Registration in 2025, we're here for you. We've broken down some key steps you can take to set yourself up for success. Follow the early steps toward an application. Create your PDP and CPD records. Join a Registration Surgery to get answers for any queries you have. Put the interview date in your diary, and work backwards from there in setting progress milestones. We're here to support you!

GETTING **STARTED**

1. Find your route to registration
2. Download guidance and application forms
3. Encourage colleagues to join you and stay accountable together
4. Find a Sponsor and Supporter

SCAN TO LEARN MORE

WHICH ROUTE **WILL YOU TAKE?**

YOUR BACKGROUND

TITLE	QUALIFICATIONS					
	NO FORMAL QUALIFICATIONS	LEVEL 3	HNC LEVEL 4	HND / FDENG LEVEL 5	BACHELOR DEGREE LEVEL 6	MASTERS DEGREE LEVEL 7
EngTech	✔ + 3-5yrs	✔ + 2-3yrs				
IEng	✔ via Technical Report+ 5-10yrs		✔ via Experiential Learning + 5yrs	✔ via PWI Diploma & Supplementary Report + 5yrs Supplementary Report + 5yrs	✔ Recognised Qualification + 3-5yrs ✔ Academic Panel Approval + 3-5yrs	
CEng	✔ via Technical Report + 10-15yrs				✔ via Experiential Learning + 5yrs ✔ via MSc + 3-6yrs	✔ Recognised Qualification + 3-6yrs ✔ Academic Panel Approval + 3-6yrs

Years in industry are indicative only. Qualifications need to be relevant to engineering.

STEP 1
REVIEW YOUR PDP AND **ATTEND CPD EVENTS**

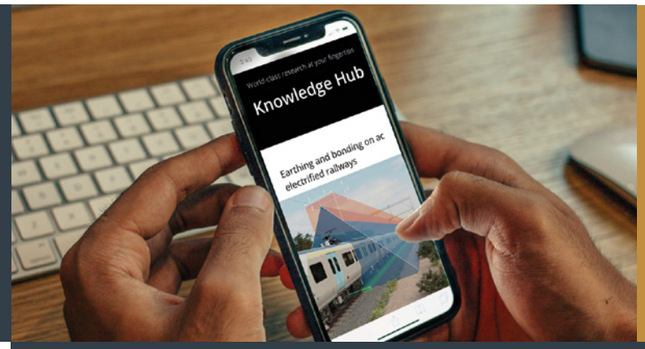
Your Personal Development Plan should set out knowledge or skills you want to develop, or things you want to achieve. This could be gaps you've identified to be able to show competences A1-E5 for your application. Once you are clear on the how - how you want to develop, your CPD record should log the what - what you are doing to develop.

Every application needs your PDP and CPD records. If you're not yet in the habit of writing it down, you can create them retrospectively.

TOP TIP...

As a Member of the PWI when you attend a Section Meeting, Lunch & Learn presentation, Technical Seminar or one of our courses, this is automatically logged in your online CPD record.

We've made it easy, so all you have to do is update it with your reflection!



USEFUL RESOURCES
TO SUPPORT YOU IN PUTTING TOGETHER YOUR PDP AND CPD RECORD

SCAN TO VIEW

STEP 2
STAY ON TRACK WITH OUR MONTHLY PROFESSIONAL REGISTRATION **DROP-IN SURGERY**

On the last Friday of every month, from 12:30 to 13:30, a member of our Registration Team will be available to assist you with any Professional Registration questions you may have. Whether you're looking for guidance on the application process, need advice on meeting the requirements, seeking technical guidance, or looking for examples to strengthen your submission, we're here to support you. Don't miss this opportunity to get expert advice and ensure your Professional Registration journey is on track!

BOOK YOUR PLACE

DATES FOR YOUR DIARY

- 25 April 2025
- 23 May 2025
- 27 June 2025
- 25 July 2025
- 26 September 2025
- 24 October 2025
- 28 November 2025

STEP 3
IENG/CENG **SUBMISSION DEADLINES**

- 28 April 2025
- 28 July 2025
- 20 October 2025

Applications for EngTech can be submitted at any time.

STEP 4
IENG/CENG **PROFESSIONAL REVIEW INTERVIEWS - W/C**

- 9 June 2025
- 15 September 2025
- 8 December 2025

THE PWI

LEARN WITH **US**

TECHNICAL EDUCATION AND TRAINING PROGRAMMES: **LEVEL 6 DIPLOMAS**

TRAINING DELIVERED BY **INDUSTRY EXPERTS**

EARTHWORKS, DRAINAGE & OFF-TRACK ENGINEERING COURSE

One course, one week.

This course provides delegates with the knowledge, understanding, and insights necessary to manage the risks presented by earthworks, drainage and associated Off-Track railway infrastructure assets.

PROGRAMME AIM

Delegates will learn about track formation, earthworks, drainage and water management, vegetation, level crossings, line-side security, and their relationships with interfacing engineered systems such as track. Weather related effects are examined and the potential longer term impact of climate change explored.

Through theory, worked examples, case studies, and exercises, attendees will gain an appreciation of good practice in the design, installation, and ongoing safe management of critical Off-Track assets.

SCAN TO SIGN UP TODAY

ADVANCED TRACK TECHNICIAN COURSE

ROUTE TO EngTech

One course, three weeks.

The aim of this course is to give delegates advanced technical knowledge and understanding of track systems, and their associated methodologies and plant. It is comprised of three consecutive modules and involves 120 hours of taught study all mapped to HE Level 4.

PROGRAMME AIM

Delegates learn how innovations in survey, design, maintenance, renewal, and project work can be harnessed to help make safe and efficient plans. Diversity and sustainability issues are explored, as are the interdependencies between the various engineering functions and train operations, so that key management skills including decision making, prioritisation, record keeping, data analysis, and report writing are developed. Practical skills are developed in plain line and S&C surveying and inspection, rail and rail defect management, mechanised alignment maintenance, and rail stressing.

SCAN TO SIGN UP TODAY

S&C REFURBISHMENT COURSE

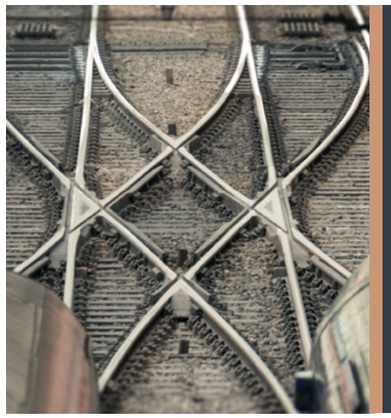
One course, one week.

This course provides the knowledge and skills needed to plan and deliver safe and effective S&C refurbishment. The processes for scoping, specification and quality assurance have been produced in conjunction with Network Rail and identify good-practice. The course is mapped to HE Level 5.

PROGRAMME AIM

Delegates will gain a comprehensive knowledge of S&C and how to undertake refurbishment safely, efficiently and to the required engineering quality. The course covers both the track assemblies and the trackbed under S&C. Participants undertake detailed analysis and inspection of layouts so they can scope and specify work to provide the necessary life extension of the layout. The course then ensures that delegates understand the various maintenance interventions suitable for S&C and its components and can plan those required in the correct sequence.

SCAN TO SIGN UP TODAY



ADVANCED SWITCH & CROSSING SYSTEMS ENGINEERING COURSE

NEW FOR 2025

Switches and Crossings (P&C, S&C) are critical to railway performance, yet maintenance of these assets often lack complete coordination between track and signalling teams.

The **Advanced S&C Systems Engineering course** bridges this gap. Equipping engineers with the knowledge and tools to optimise reliability, reduce failures and improve safety and train performance.

To find out more, see **page 57.**

TRACK ENGINEERING DIPLOMA

ROUTE TO IEng

One Diploma, three modules.

Delegates are taught by experienced rail infrastructure engineers who share their wealth of experience. Attendees receive three technical textbooks, comprehensive course materials and coursebooks with worked examples to support their learning.

PROGRAMME AIM

Delegates gain an understanding of the principles of the theory and practise of track engineering in the UK. It is comprised of three consecutive modules and involves 100 hours of taught study all mapped to HE Level 6.

Upon successful completion of all three modular assessments, candidates are awarded the PWI Diploma in Track Engineering. These courses are aimed at newly qualified and experienced engineers and gives delegates the knowledge and skills needed for professionals in track engineering.

SCAN TO SIGN UP TODAY

ELECTRIFICATION ENGINEERING DIPLOMA

ROUTE TO IEng

One Diploma, three modules.

The Diploma is comprised of three consecutive modules involving 100 hours of taught study, all mapped to HE Level 6. Delegates receive a technical textbook and comprehensive course materials with worked examples to support their learning.

This course is aimed at newly qualified and experienced engineers and gives delegates the knowledge and skills needed for professionals in electrification engineering.

PROGRAMME AIM

Delegates gain an understanding of the principles of the theory and practice of Overhead Line Electrification engineering in the UK.

Upon successful completion of all three modular assessments, candidates are awarded the PWI Diploma in Electrification Engineering. For further development we offer a stand-alone 3rd/4th rail electrification course.

SCAN TO SIGN UP TODAY

"REALLY ENJOYED THE **PASSION** SHOWN BY ALL THE **PRESENTERS** AND THE **ENGAGEMENT** FROM THE AUDIENCE **WAS GREAT!**"

TOP-UP QUALIFICATION TO IEng

The PWI Track and Electrification Engineering Diplomas are a form of further learning and, together with a short Supplementary Report, fill the academic gap to IEng for those with relevant HND or Foundation degree qualifications.

TECHNICAL EDUCATION AND TRAINING PROGRAMMES

SCAN TO **BOOK**

DUE TO **HIGH DEMAND, BOOK EARLY** TO AVOID DISAPPOINTMENT

ADVANCED S&C AND POINTS MANAGEMENT COURSE

LEVEL 5 | IN-PERSON | DERBY

NEW FOR 2025

Module 1
17-21 November 2025

Module 2
2-6 February 2026

ADVANCED TRACK TECHNICIAN COURSE

LEVEL 4 | IN-PERSON | DERBY

Module 1
30 June-3 July 2025

Module 2
1-4 September 2025

Module 3
20-23 October 2025

EARTHWORKS, DRAINAGE & OFF-TRACK ENGINEERING COURSE

ONE COURSE, ONE WEEK

LEVEL 5 | IN-PERSON | DERBY

12-16 May 2025
10-14 November 2025

S&C REFURBISHMENT COURSE

ONE COURSE, ONE WEEK

LEVEL 5 | IN-PERSON | DERBY

13-17 October 2025

ELECTRIFICATION ENGINEERING DIPLOMA

LEVEL 6 | IN-PERSON | DERBY | LONDON

Module 1
19-22 May 2025
1-4 December 2025

Module 2
14-17 July 2025

Module 3
20-23 October 2025

Module 4
7 - 10 July 2025

TRACK ENGINEERING DIPLOMA

LEVEL 6 | IN-PERSON | DERBY | ONLINE

Module 1
9-12 June 2025
3-6 November 2025

Module 2
12-15 May 2025
29 September-2 October 2025

Module 3
15-18 September 2025
8-11 December 2025

THE PWI

KNOWLEDGE 200 TRACK

ADVANCED SWITCH & CROSSING SYSTEMS ENGINEERING COURSE

NEW FOR 2025

Switches and Crossings (P&C, S&C) are critical to railway performance, yet maintenance of these assets often lack complete coordination between track and signalling teams. **The Advanced S&C Systems Engineering course** bridges this gap. Equipping engineers with the knowledge and tools to optimise reliability, reduce failures and improve safety and train performance.

The course will contain case studies of how to run effective planned preventative maintenance regimes for S&C and how to identify and analyse potential failure modes for track and signalling components. The course will be 60% track and 40% signalling engineering. This is ideal for: Track Maintenance Engineers and Assistants, Signalling Maintenance Engineers and Assistants, Designers and Asset Managers.

WHAT YOU WILL LEARN

- The fundamentals of S&C and Points Operating Equipment design, function and failure modes.
- A systems engineering approach including interfaces with track, signalling, power, electrification, structures, drainage and earthworks, Safety (CDM), Sustainability and Climate Change.
- The lifecycle from design, manufacture, installation, commissioning, maintenance, operation.
- How track and signalling teams can work together effectively with joint inspections and maintenance.
- How to measure up S&C for replacement and interpret REPW and 1:50 drawings and understand liaison with the various manufacturers.
- How to develop an Infrastructure approach to maintaining railway junctions including Points and S&C in a planned preventative manner.
- Hands-on experience of detailed inspection of Points and S&C, diagnosis and rectification of the faults found and review of case studies of track and signalling faults.
- Updates on University and Industry research into product and component innovation.

COURSE DETAILS

LEVEL 5 | IN-PERSON | DERBY

Module 1
17-21 November 2025

Module 2
2-6 February 2026

Course cost: £1295
Accommodation cost: £545

www.thepwi.org

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SHARE YOUR STORY

We would be interested to hear from our Members who would like to share their own experiences with the wider membership.

Phil Marsh reports on the current work and initiatives to encourage people with autism onto the railway.

AN UNTAPPED TALENT POOL FOR THE RAIL INDUSTRY READY TO BE SWITCHED ON

There is a well-established link between railways and autism, often identified at an early age by an obsessive interest in model railways or Thomas The Tank Engine. Why is this potentially important for the rail industry and the heritage railway movement?

The staff age profile in the rail industry clearly demonstrates it is facing a bow wave of retirements in many areas where retirees' collective experience will be lost to the industry. Conversely, some of these retirees will start, or continue their voluntary activities on various heritage railways passing on their skills and knowledge to younger people.

HERITAGE RAILWAY VOLUNTEERS

To illustrate how misunderstood this was, in 2002, when Railtrack was in Railway Administration, a Transition Monitoring Group (TMG) with about 15 representatives from across the company were invited to monitor progress to it becoming Network Rail. Each meeting was attended by a Board member and at the first meeting Iain Coucher, the Chief Executive, asked each TMG member how they could work smarter, faster and more efficiently in their particular roles. A signaller requested an intermediate block post in his signalling area and was asked what this was. He replied that when he was signalling on the Severn Valley Railway he could switch in or out an intermediate block post to increase capacity as required. The response that came back was, 'Oh, you are a train enthusiast' completely missing the point of the answer.

The next answer was from an electrical control room operator who mentioned he was a volunteer at the North Yorkshire Moors Railway. From memory, about 60% of the TMG were heritage railway volunteers, including the author. It was quickly acknowledged that professional staff who volunteered at heritage railways gained beneficial extra experience and understanding of the rail industry, therefore, helping their day job and furthering their career opportunities.

Today many heritage railways are struggling to recruit volunteers but some are countering this by setting up junior clubs to feed the volunteer training pipeline. Given the rail industry increasingly and urgently needs to recruit staff for a wide variety of office and frontline roles to replace the upcoming retirements, should recruiters regard heritage railway volunteers as an untapped talent pool?

NEURODIVERSE

The pathway for former armed forces personnel with safety critical experience to join the industry has been successful, so could tapping into heritage railway volunteers and staff be the same? Many heritage railway volunteers are neurodiverse and have acquired skills that are transferable, albeit with some upskilling, to the main line rail industry. The rail industry attracts graduates and apprentices but struggles to attract less qualified recruits who may have years of volunteering experience which, as with ex-military personnel, have largely transferable skills. They form a nationwide talent pool, largely ignored, as far as a potentially rich recruitment area is concerned.

A significant percentage of volunteers who may be neurodiverse, but not 'diagnosed', excel in many complex roles such as software development, rostering, signalling, design, project work and social media work.

THE YOUNG RAILWAY PROFESSIONALS' COHORT SUGGEST AROUND 50% OF THEIR 4,000 MEMBERS ARE FROM NEURODIVERGENT BACKGROUNDS.

There are already thousands of neurodiverse people in the rail industry today. The Young Railway Professionals' cohort suggest around 50% of their 4,000 members are from neurodivergent backgrounds. When their skillsets are recognised and matched with tasks such as data analysis, timetable planning, rostering or software development, these people become highly sought after talents to employ.

Worldline, which runs many railway computer systems, are members of Neurodiversity In Business (NiB) and are actively seeking neurodiverse software developers to upgrade the often legacy railway systems operated, such as TOPS. James Bain, Chair of the Rail Supply Group, suggested that; 'At Worldline, we have long recognised the value of inclusivity and the power of the widest range of people to contribute in their own way. Our experience has shown that an untapped talent pool for the rail industry ready to be switched on?

The northern approach routes into London all feature a number of tunnels, both short and long, such as Gasworks Tunnel heading into King's Cross Station, as pictured here.

DIVERSITY

Phil Marsh reports on the current work and initiatives to encourage people with autism onto the railway. Neurodiverse colleagues bring greater attention to detail, a powerful ability to focus on a task for an extended period of time, creative out of the box thinking and a different perspective to problem solving. Given the challenges facing the UK rail industry, those are skills and abilities that are especially valuable - and as an industry we would be foolish to ignore them.'

RECRUITMENT DRIVE

How might such a recruitment drive commence? Railway 200 could provide the answer with its 'Inspiration' touring exhibition train which will become its 'shop window'. One of the carriages will showcase up to 10 different roles in rail using STEM ambassadors which should attract those that may be interested in, but have not previously considered, a job in the rail industry.

'Inspiration' will be travelling around the UK, visiting major stations, heritage railways, railway works and freight centres creating an unparalleled opportunity for the industry to recruit neurodiverse staff at very low cost. Many neurodiverse railway fans are also very active on social media with substantial numbers of followers, but most may not consider joining the rail industry, despite being knowledgeable about it.

ADAM SERGENT

Perhaps the exemplar of the amazing work neurodiverse people can turn out is 31-year old Adam Sergent, the 2024 Young Railway Professionals' Volunteer of the year in 2024. He is the group's first EDI manager and works for Network Rail as a systems support manager, joining as a graduate entrant six years ago. He has been using his computing data skills, vision and railway knowledge carrying out highly innovative and important work which will benefit neurodiverse and ex-forces personnel rail passengers. It is well known now that the latter can suffer from Post-Traumatic Stress Disorder (PTSD) following active service, while the former often have physical sensory-related needs. Sudden noises and changing light conditions can act as a trigger to sensory overload and panic.

Adam Sergent, Systems Support Manager, Network Rail.

Adam is currently working on a 'travelling through a tunnel' project. He explains, 'When complete this year, these passengers will be able to know what sudden noises and outside conditions, such as flickering light levels, they can expect on any train journey that involves a tunnel. Currently, they may have opted not to use rail as a form of travel because unknown sensory issues can be too traumatic.'

He is creating a database containing inter-related data such as the length of a tunnel, the time a given service will be in the dark traversing the tunnel at linespeed, the effect of wind turbulence on carriage doors, and any flashes of lights or pressure wave bangs where tunnels have large air vents designed in steam days.

He is also looking at where there is a series of tunnels with frequent periods of darkness and then daylight, for example the approach to Liverpool Lime Street Station, the three tunnels near Micheldever - Popham No.1 and No. 2 tunnels, and Litchfield Tunnel - and along the Dawlish seafront. It is also of particular importance in high-speed single bore tunnels, such as Linslade near Leighton Buzzard where trains go through at up to 125mph, which generate noise and vibration.

Adam said: 'The purpose of the tunnel data capturing is that it can be used as a pre-warning tool to inform passengers as to what to expect on their journey. When I saw Lumo had a tunnel guide for their route, I decided to replicate this on a national scale covering every TOC, including diversionary routes, and even rail replacement services such as metro systems and road tunnels. Eight different data sources were used ranging from publicly available data such as the National Electronic Sectional Appendix and Freedom of Information request outcomes, through to artificial intelligence virtual reality cameras to capture tunnels further away from home.'

Adam has timed many of these tunnels personally using a stopwatch onboard a train which allowed him to listen to various sensory triggering sounds effects such as bangs, acceleration air pressure (which he says feels like a fighter jet) and helicopter rotor sounds. 'I am also tabulating other 'sudden noise' data such as neutral sections when circuit breakers open and close with a clunk.'

The North London Railway around Dalston has a series of cut and cover tunnels.

Adam Sergent explaining about his work.

Popham No. 1 and No.2 tunnels, near Micheldever, left, and Linslade Tunnel's single bore, right, are all ones that can have an effect on people with autism.

He has expanded this unique project to mainland Europe using Eurostar services which had its challenges. He described his biggest challenge; 'I was timing and measuring the Eurostar tunnels where SNCF, SNCB and NS not only had different track data, but it was also a lot harder to obtain. In terms of identifying the kilometre posts, it involved watching cab ride videos of TGVs and local trains in which I then had to measure from the kilometre post to the portal.'

He has come up with some amazing statistics saying; 'There are over 3,100 tunnel instances in which all passenger services use on our network. Around 80 of these are for the Eurostar [London direct] network abroad.' Adam described the different ways in which a 'bang' can happen in where the tunnel format varies:

- A small ventilation shaft in which the gust of air pressure can resemble a bang - such as Morley Tunnel, near Leeds.
- A large ventilation shaft which can also show daylight for less than a second and have a bang - such as Kilsby Tunnel, near Rugby.
- A long tunnel and a short tunnel near one of the ends with a blip - for example Sapperton (Stroud) and West Summit Tunnel (Greater Manchester). Three tunnels in quick succession - such as on the London side of Micheldever.
- A series of tunnels - such as on the approach to Liverpool Lime Street Station, between Birmingham New Street and Five Ways, North of Sheffield North, etc. - where trains pass slowly, but do not cause bangs. The times for these are from the start of the first until the end of the last tunnel, as if it was one tunnel.

There are anomalies such as northbound London Northwestern Railway services go through Shugborough Tunnel up to five seconds quicker than Avanti, despite having slower non-tilting trains due to the nearby Colwich Junction maximum permissible speeds for different train types. Another example is the EMR Poacher Line where, if the train skips Grantham, there are no tunnels. However, if the train calls at Grantham, it goes through the Gonerby Tunnel, twice.

But there may not be any extra noise for example, just darkness when passing through Gasworks Tunnel outside King's Cross because of the slow train speed. Conversely, approaching Lille Europe heading towards Brussels or Paris, Adam has identified a long flickering light section as the Eurostar exits the tunnel and climbs towards the station through a deep cutting with thick beams across the railway.

FRIENDLY STATIONS

The matrix of components producing different effects in Adam's data crunching is very important to an increasingly large section of the population. This is entirely complimentary to Network Rail's neurodiverse friendly policy announced in December 2024, which is to make its managed stations autism-friendly by the end of this year.

London Waterloo gained autism-friendly accreditation in 2024 awarded by the National Autistic Society, creating more accessible spaces for neurodiverse passengers with quiet rooms and designated calm spaces, in an otherwise busy rail station environment.

Network Rail's Chief Executive Andrew Haines said: 'Making my way around a station, grabbing a coffee, or getting a bite to eat before catching a train is something I take for granted. For passengers with disabilities, including those who are blind, partially sighted and neurodiverse, it requires careful planning, which is why initiatives like the station navigation app and making our stations autism-friendly matter. We want to make rail travel accessible for everyone, empowering all passengers, including those with disabilities, to travel with greater autonomy. We are not complacent; we know there is much more to do, but we believe we are going in the right direction with the progress made so far.'

NEURODIVERSE YOUNG PEOPLE

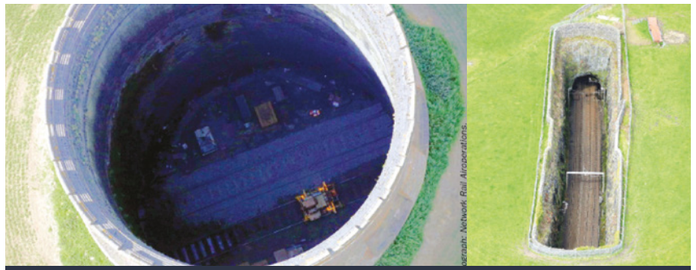
Peter Dickson, a trailblazer in attracting neurodiverse youngsters into the rail industry via the miniature and heritage railway sector, commented: 'Heritage railways' volunteers can be regarded as a talent pool just waiting to be tapped into. There is already a recognised pathway from junior model railway clubs to gaining employment in the industry.'

He described how youngsters, many before they reach 10 years old, are learning hands-on engineering skills via the thousands of UK miniature/model railway clubs.

'Many of these are affiliated to junior cubs at heritage railways where their learning and practical training leads to traincrew, signalling, or backroom roles as volunteers. These embryonic skills are to a degree transferable to the professional rail industry. Once employed, professional skills are then taken back to their voluntary roles so there is a genuine natural crossover mentoring potential,' he added.
Peter has also identified a high percentage of these neurodiverse youngsters who would love to be employed in the rail industry.

At an inaugural planning meeting he organised with Network Rail, The Autism Centre of Excellence at Cambridge and Adam Sergent, the possible main barrier to neurodiverse people joining the railway was identified as the recruitment process. Many of them cannot carry out the traditional interview process and a way of circumventing traditional methods is being looked at. Peter, in his fourth year of campaigning for this, ended by saying, 'The culture of volunteering and autism go hand in hand because they are not looking for reward but just to make things better.'

As well as the UK rail network, Adam Sergent's work has also covered recording the information for Eurostar services. This included the approach to Lille Europe Station, left, and, of course, the Channel Tunnel itself, right.



Tunnels that emit sudden bursts of light, such as the large ventilation shaft in Kilsby Tunnel on the West Coast Main Line, left, and the join between Bishopton No. 1 and No. 2 Tunnels in Scotland, right, can be a trigger for autistic people.

Some of the Swanage Railway's Sygnets after completing some work on the line (Image courtesy of Swanage Railway).

BARRIERS TO RECRUITMENT

Rufus Boyd, lead director at Great British Railways Transition Team, spoke about recruiting and utilising neurodiverse people into the rail industry, saying: 'Through our work to drive forward the diversity and inclusion agenda, we have engaged and listened to the neurodivergent community. It is clear that neurodiversity must be a key area of focus for recruiters, and by championing inclusive recruitment we can attract a broader range of talent that reflects the diverse communities we serve.'

'THE RAIL INDUSTRY STANDS TO GAIN IMMENSELY FROM THE UNIQUE SKILLS AND PERSPECTIVES NEURODIVERSE INDIVIDUALS BRING.'

It is hoped that this article will create awareness of the huge untapped talent pool of neurodiverse people who could drive change with innovative solutions in the rail industry which may not be apparent to neurotypical staff. But to repeat, not all neurodiverse people are able to go through the traditional recruitment interview process.

Softech Rail's Rajat Agrawal, a member of the Railway 200 working group, has been devising an interview pathway that lowers this barrier to autistic people. He said, 'The rail industry stands to gain immensely from the unique skills and perspectives neurodiverse individuals bring. Traditional interview processes often overlook the environments needed for these talents to shine. Understanding, communication and flexibility need to form the foundations of our approach.'

Rajat is creating a comprehensive platform to support candidates from all backgrounds to ensure they feel confident and supported from their initial introduction to the rail industry, throughout their training from day one in a new job. This includes flexible and practical solutions such as remote interviews that can fit routines and commitments for the neurodiverse community with online booking systems with live inter viewer schedules, simplifying the process.

'We are also happy to create pre-recorded videos, raising awareness of neurodiverse needs for recruitment staff training which will reduce downtime, training costs and promote inclusivity. Modernising interview practices will empower neurodiverse talent and unlock innovation for a more dynamic and thriving future in rail,' Rajat added.

A ROUTE INTO THE RAILWAY

Possibly the leading heritage railway to purposely offer a route into rail is The Swanage Railway. Their Sygnets youth group was formed in 1997 providing a range of opportunities to become involved in the practical and theoretical side of operating a railway. Their volunteer leader Lucy Clarke said; 'The Sygnets have a rich proud history. Not only are we a mainstay for Swanage, we have a track record of our past members taking their experience with us and moving onto railway careers across the country, in the main line industry and into employment on our Swanage Railway.'

Opportunities include building skills such as first aid, lifting, and manual handling focusing on developing transferable skills such as communication, teamwork, and building self-confidence. She added that currently there are 33 Sygnets, including several neurodiverse members for whom we make allowances and adjustments to ensure they feel comfortable and grow in confidence in what can be a challenging environment.

Sygnets provide the Swanage Railway once they reach 18 years old with knowledgeable and enthusiastic young volunteers, and currently over 30 former Sygnets are employed in the wider railway industry. Ben Ford, Trustee, leader of the group and one-time Sygnet remarked: 'It is quite funny really thinking back. In the early 2000s, we always used to jest about our then embryonic group taking over the railway, now it does not seem so far fetched.' This process is replicated across many other heritage railways but there is no national co-ordination.

How can the industry tap into this young talented diverse talent pool? Perhaps the answer comes from Mona Sihota, President, Permanent Way Institution (PWI). She said: 'At the PWI, equity, diversity and inclusion is included in everything we do. We support our members by being thoughtful and considerate of how information and data is communicated. We have regular touchpoints where members who are progressing in professional grading can connect to the PWI and get advice or support throughout the process. The process can seem daunting and, with a friendly advisor and sponsor, it can be achievable.

'Our EDI committee, as well as our own staff and members, feed into and challenge our approach to assure that we are easy to engage with. We continue to improve with future updates to our website and the launch of our new portal. The PWI strives to create an inclusive environment so that we can be a professional engineering institution that represents the railway community.'

This perhaps neatly sums up the way forward and will be a key aspect of proposed Railway 200 associated conferences in the coming months. These will examine ways to attract neurodiverse people to the rail industry from heritage railways and elsewhere, looking at how to remove the barriers to entry. To ensure reach into the neurodiverse community, it will be live streamed on social media, one to watch in every sense.

UPCOMING SECTION MEETINGS
SPRING 2025

APRIL 2025

EARTHWORKS ON THE CORE VALLEY LINES
14 April 17:15 - 18:15
James Dyke
HYBRID | SOUTH & WEST WALES SECTION

SUSTAINABLE MATERIALS – TIMBER
16 April 17:30 - 19:00
Roderick Aitken
HYBRID | GLASGOW SECTION

PREDICTIVE MAINTENANCE, NETWORK USAGE AND TRAFFIC MONITORING
23 April 17:00 - 18:30
Tim Flower and Andrew Turner
IN-PERSON | NOTTINGHAM & DERBY SECTION

MAY 2025

VAMPIRE MODELLING
1 May 16:15 - 17:30
Halley Porkess
HYBRID

OLE SIEMENS
1 May 17:30 - 19:30
Ethan Giles
IN-PERSON | EDINBURGH SECTION

TAMPING ACTIVITIES
6 May 16:30 - 18:30
TBC
IN-PERSON | NORTH EAST SECTION

BRADFORD FORSTER SQUARE PLATFORM ZERO
6 May 17:00 - 19:00
BAM Nuttall and CRSA
HYBRID | YORKSHIRE SECTION

CONSERVATION OF REWLEY ROAD SWING BRIDGE
7 May 17:45 - 19:15
David Mather
HYBRID | THAMES VALLEY SECTION

LONDON TRAMS
14 May 17:30 - 18:30
Omar Bingham
HYBRID | LONDON SECTION

PRESENTATION FROM D/GAUGE
15 May 17:00 - 19:00
D/Gauge
HYBRID | YORKSHIRE SECTION

BELFAST GRAND CENTRAL STATION: PERMANENT WAY AND CIVILS ENABLING WORKS
21 May 17:30 - 19:00
Connor Fitzpatrick
HYBRID | GLASGOW SECTION

CANADA PROJECTS
22 May 17:00 - 18:30
David McPherson
IN-PERSON | NOTTINGHAM & DERBY SECTION

GLASGOW SECTION AGM
28 May 18:00 - 19:30
ONLINE | GLASGOW SECTION

JUNE 2025

STRENGTHENING YARM VIADUCT
3 June 16:30 - 18:30
Paul Wright
HYBRID | NORTH EAST SECTION

PICADILLY LINE UPGRADE
4 June 17:30 - 18:30
Andrew Brice Mansfield
HYBRID | LONDON SECTION

ROTHER VALLEY RAILWAY RECONSTRUCTION
4 June 17:45 - 19:15
John C Sreeves
HYBRID | THAMES VALLEY SECTION

ENCOURAGING INVESTMENT WHILST ASSURING SAFETY - ASSET PROTECTION
19 June 17:00 - 19:00
Roland Kettle
HYBRID | YORKSHIRE SECTION

PWI ANNUAL INTERSECTION QUIZ 2025
14 June 11:30 - 15:15
PWI Social Event
IN-PERSON | EDINBURGH SECTION | GLASGOW SECTION | NORTH EAST SECTION | LANCASTER, BARROW & CARLISLE SECTION

SCAN HERE TO RESERVE YOUR PLACE

1) Log into your Member Dashboard
2) Book an event
3) Your CPD will be automatically recorded.

Please note: This information is correct at the time of going to print.

Please check up-to-date information on the website, as on occasion topics, speakers, venues, times and dates may change:

thepwi.org/whats-on/section-meetings

FREE CPD COME ALONG TO NETWORK WITH LOCAL ENGINEERS, SHARE GOOD PRACTICE AND LEARN SOMETHING NEW.

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Jaydan Manyan
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Venue: Online until further notice
Nottingham & Derby Secretary:
John Garlick
Email: nottingham-derby@thepwi.org
Phone: 07532 071727
Venues: Aston Court Hotel, 16-17 Midland Road,Derby, DE1 2SL / Leonardo Hotel, Waterfront Plaza, Nottingham, NG2 3BJ

IRELAND
Vice President: Cathal Mangan
Ireland Secretary: Joe Walsh
Phone: 00 353 872075688
Email: pwiirishsection@gmail.com

NORTH EAST ENGLAND
Vice President: Ben Brooks
Email: vpnortheast@thepwi.org
North East Secretary: Peter Cowens
Email: northeast@thepwi.org
Venue: Newcastle College Rail Academy, NE10 0JP
Yorkshire Secretary: Louise Walley
Email: yorkshire@thepwi.org
Venue: Network Rail, George Stephenson House, YO1 6JT / Mallard House, Marshgate Depot, DN1 1QU / Aecom Offices, 2 City Walk, Leeds, LS11 9AR

NORTH WEST ENGLAND & NORTH WALES
Vice President: Rob Cummings
Email: vpnorthwest@thepwi.org
Cheshire & North Wales Secretary:
David Banister
Email: cheshire@thepwi.org
Venue: YMCA, 189 Gresty Road, Crewe, CW2 6EL
Lancaster, Barrow & Carlisle Secretary: Philip Benzie
Email: lbc@thepwi.org
Phone: 01704 896924
Venue: Station Hotel, PR1 8BN / Network Rail, CA28 6AX / Network Rail, CA1 2NP / Network Rail, Warton Road, Carnforth LA5 9ET
Manchester & Liverpool Secretary:
Richard Wells
Email: manchester-liverpool@thepwi.org
Phone: 07817 302652
Venue: Online until further notice

SCOTLAND
Vice President: Hannah Persson
Email: vpscotland@thepwi.org
Edinburgh Secretary: Mark Taylor
Email: edinburgh@thepwi.org
Phone: 07710 959630
Venue: The Scots Guards Club, EH12 5DR
Glasgow Secretary: Jonathan Lowe
Email: glasgow@thepwi.org
Venue: Arcadis Office, 3rd Floor Aurora Building, 120 Bothwell Street, Glasgow, G2 7JS

SOUTH CENTRAL ENGLAND
Vice Presidents: Anup Chalisey & Darren Sharp
Email: vpsouthcentral@thepwi.org
London Secretary: Sean Tarrant
Email: london@thepwi.org
Phone: 07764 429211
Venue: RSSB Offices, 25 Fenchurch Avenue, London, EC3M 5AD
Thames Valley Secretary:
Richard Antliff
Email: thamesvalley@thepwi.org
Phone: 07804 329497
Venue: Network Rail Ltd, Apex Plaza, Forbury Road, Reading, RG1 1AX
Wessex Secretary: Paul Meads
Email: wessex@thepwi.org
Phone: 07919 470293
Venue: Varies, see PWI events calendar

SOUTH EAST ENGLAND
Vice President: Jonathan Bray
Email: vpsoutheast@thepwi.org
Phone: 07976 199011
Ashford Secretary: Daniel Fosdike
Email: ashford@thepwi.org
Venue: Online until further notice
London Secretary: Sean Tarrant
Email: london@thepwi.org
Phone: 07764 429211
Venue: RSSB Offices, 25 Fenchurch Avenue, London, EC3M 5AD

SOUTH WEST ENGLAND & SOUTH WALES
Vice President: Andy Franklin
Email: vpsouthwest@thepwi.org
Phone: 07901 512293
West of England Secretary:
Simon Warren western@thepwi.org
Venue: Engine Room, Atkins, SN1 1DW
South & West Wales Secretary:
Lee Holland
Email: southandwestwales@thepwi.org
Phone: 07817 004510
Venue: Network Rail Offices, CF10 5ZA

INDIA
Secretary: Sankardev Chowdhury
Email: bengaluru@thepwi.org
Venue: Online until further notice

INTERNATIONAL CONTACTS
Malaysia:
Email: pwimalaysia@gmail.com
New South Wales:
Email: meetings@pwinsw.org.au
Queensland: Robin Stevens
Email: robin.stevens@qr.com.au
South Australia:
Email: pwisasecretary@iinet.net.au
Email: victoria.pwi@pwinsw.org.au

OUR COMMUNITY

NEW MEMBERS:

We're honoured to have you on board and look forward to working with you. Watch out for us in your inbox, we don't want you to miss a thing! We're here to help, so if you have any questions, then get in touch!

Ashford: Lee Evans, Spa Valley Railway, Adrian Bishop, Richard Iddenden, Georgi Georgiev, George Lake, Scott Buglass, John Stone, Gareth Burgess, James Gibb

Birmingham: Huike Zeng, Maksim Latosev, Mark Withington, Alex Powell, Chelsea Guy, Paul Price, Andy Seeney, Liban Alale, Thembinkosi Ngwenya, Liam Hood-Cooling, Mani Entezami, Shaun Mackinnon, Abdullah Chaudhry, Felix Murphy, Alfie Davies, Ariyo Adanikin, Liam Green, David Griffiths, Tanuja Kavuri, Liu Yang, Jamie Barber, Lei Wang, Desmond Coulson

Cheshire & North Wales: Jason Ball, Malachai Dodd, Ricky Bailey

Edinburgh: Jordan Pedersen, Dale McCartin, Julia Rodriguez

Exeter: Alexander Blake

Glasgow: Steven Frew, Logan Morton, Scott Maclaren, Emma Walter

International: Vijay Raj Peravali, Harshad Mehta, Terry Wing Kin Wong, Pui Lai To, Mike Robinson, Rick Hoi Wah Wong, Frankie Sze Ho Ng, Ravi Patel, Urvaksh Contractor, Ming Him Yuen, Jaiyun Jeong, Gary Jordan

Ireland: Seamus O'Sullivan, Matthew Cassidy, Rob Merry, Robert Nesbitt, Maura Ryan, Stephen Wilson, Diarmaid Meagher, Alexander Hoy

Lancaster, Barrow & Carlisle: Faith Bolarinwa, Luke Doran, Matthew Brown, Richard Sutch

London: Ian Huxtable, Pei Ying Li, Rene Boadi, Vishnu Dhanabal, Amber Parmar, Kirsty Willis, George Wakely, Farzana Sharmeen, Hilal Ak, Parthiban Muthukumar, Benjamin Brewster, Franz Messerli, Martin McMahon, Terry Harris, John Miles, Driton Kozmaqi, Matthew Rabarts, Petrus Marx, Brendan McLaughlin, Radoslav Stanoev, Kai Wing Ting, Michael Jones, Hibo Omar, Hannah Adekunle, Tre Kirwan, Saeed Sotoudeh, Megat Riza Makhzan, John Richardson, Joseph Wambui, Henock Adane, Jason Martin, Adrian Cercelaru, Jack Prankhard, Kelechi Kalu, Lukasz Szeloch, Philip Holgado, Ademola Ajimobi, Alwyn Nicolaas Lesch, Andrew Hendren, Andrew Ho, Craig Howley, Darren White, David Heron, George Davenport, James Fenton, Jason Abbott, John Griffin, Kimberley Budd, Matthew Patten, Mohammed Wahid Sahil, Robert Rayner, Sean Lynch, Iliyan Donchev, James Baron, Katie Simkins-Muir, James Dowling, Daniel Cunningham, Ashley Spearman, Vincent O'Leary, Jamie Parrish, Daniel Peet, Dean Harris, Hayley Oakhill, Martin Beischer, Carl Wilford, Stephen Walthew, Adam Foss, Bradley Ray, Okebugwu Ogbonna, Ashley Carter, Glen Dowdall, Ethan Baldry, Dean Palmer, Michael Kindleysides, Parimol Mamtora, John Farkas, Fungai Mukusha, David Choudhry, Harvey Hall, Yan Louie, Paul Meenan, Darren Newman, Thomas Payne, Brian Mason, Ajay Bassan, Rhys Evans, Ermal Todri, Zoie Deadman, Luke Austin, Mishane Peiris, Jack Parsons, Adam Morton, Kristiyan Tsvetkov, John Knowles, David Precious, Daniel Colling, Obed Hammond, Daniel Leach, Lucas Dambitis, Mortone Malota, Matthew Hunt, Venkat Pamarthi, Ahmed Mohamed

Manchester & Liverpool: Andrew Dobson, Jayson Pape-Jones, Daniel Bostock, Mark Horridge, Marcus Dockray, David Howland, Lucas Stevenson, Samuel Osei, Paul Dean, Abdulsamad Afolabi, Philip Wolvin, Ian Large, Shimon Shapiro, Forbes Gusha, John Hopton, Shan Richards

Milton Keynes: Brace Chaffey, Jerome Bartlett, Tom Flannery, Anthony Harris, Dean Kinane-Powell

North East: David Reed, James Street, James Sykes, Philip Qualie, James Wade, Ethan Morrison

Nottingham & Derby: James Riley, Joshua Stewart, Alan Ismail, Neil Gove, Benjamin Walker, Husnain Mushtaq, Nathan Nelson, Shailendra Gupta, Sam Cartwright

South & West Wales: Matthew Timms, Adam Gronow, Faheem Wignall, Lewis Cardwell, Rhys Mason, Louis Allcock, Kilian Bailey-Richards, Micheal Olawale, Harry Bryant, Alec Critten

Wessex: Daniel Mitchell, Julian Singh

West of England: Emmanuel Kwablah, Rachel McDonnell

Yorkshire: Charlotte Currie, Pattarapong Nuasri, Tianhao Xie, Olesia Khrypunova, Rotimi Dayo, Wensleydale Railway, Alexander Wood, Gareth Tudor, Suresh Sakthivel, Dexi Li, Chris Morrill, Muhammad Ibraheem Ibn Saleem, Ian Barley, David Pyatt, Philomenah Holladay, Maryam Mohammadi, James Scott, Kieran Goulding, James Heginbottom, Mostafa Hegazi, Reza Saboori

ENGINEERING TECHNICIAN:

Mark Attenborough, Shaun Hawkins, John Glennon, Dominic Taylor, Matthew Oliver, Kane Smith, Samuel Tanner, Adam Williams, Charlie Simmons, Thomas Payne

INCORPORATED ENGINEER:

Luke Seabright, Stephen Varley, Trideep Ghosh, Alex Paterson, Danny Whitworth, Oliver Lawrence

CHARTERED ENGINEER:

Donald McCartney, James Edmondson, David Milne, Damian Jones, Allen Kayirasora, Tonye Altraide, Michael de Botte (Additional)

FELLOWSHIPS:

Tim Laverye - West of England, Kieran McLeod - Manchester & Liverpool, Jonathan Barnes - International, Frankie Sze Ho Ng - International, Rick Hoi Wah Wong - International, Zoe Yu Yuk Tse - International, Terry Wing Kin Wong - International, Dr Sakdirat Kaewunruen - Birmingham, Gary Desmond - London, Mark Eves - Manchester & Liverpool, Robert Winfield - Birmingham, Andy Vickerstaff - London

EARTHWORKS, DRAINAGE & OFF-TRACK ENGINEERING:

Simon Day, Antony Prescott, Emma Wigglesworth, Bradley Hart, Andrew Humphrey, Tommy Bradley, James Bayley, Robert Buckley, Matthew Williams, Paul Granger, John Bartlett, Leo Anderson, Rhys Bentley, Jason Richardson, Ben Dalton, Matthew William, Sean Mulpeter, David Smith, Andrew Anastasi, Andrew McGahan, Thembinkosi Ngwenya, Lee Carter, Jamie Bell

PWI ELECTRIFICATION ENGINEERING DIPLOMA:

Rory Chiverton, Conor Lenehan, Paul Josey, Mohammad Hamza Khalid, Liam Spalding, Faizan Khan, Benjamin Osebor, Jose Jimenez Lledo, James Powell, Emmet Dunne, Mariusz Marciniak, Stuart McGowne, Chris Edmeades, Alan Horton, Ryan Hoyle, Ryan Searle, Stephen McManus, Aeneas Lenihan, Richard Turner , Simon George, Paul Gray, Toby Grayson, James Trevithick, Jahmar Rogan, Seamus O'Sullivan, Michael Bradley, James Hutt

PWI TRACK ENGINEERING DIPLOMA:

Shaun Mackinnon, Carwyn Humphreys, Myles Manihera, Sanmit Kaimal, Ravikumar Patel, Urvaksh Contractor, Paul Challinor, Dean Speakman, William Hammond, Terence Keegans, Keir Gillan, George Budgell, Charles Slavin, Matthew Morton, Scott Crow, Adora Hilton, Ryan McCoy, Ethan Allt, Jamie Pogson, Bridget Damjor, Garry Mills, Steven Ormston, Bernabe Diaz, Karl Morgan, Dan Cairns, David Drake-Sloane

YOUR PWI

AGM AGENDA

Friday 6 June 2025
15:00 - 16:30

DoubleTree by Hilton,
Manchester - Piccadilly.
One Piccadilly Place,
1 Auburn Street,
Manchester, M1 3DG

The full agenda and accompanying papers will be published on the website www.thepwi.org in April 2025.

1. To receive apologies for absence.
2. To celebrate the lives of members who passed away during 2024.
3. To receive the roll call of the Sections.
4. To receive and agree the minutes of the 2024 Annual General Meeting, held on Friday 5 July from 16:00 at the Macdonald Burlington Hotel, Birmingham.
5. To receive a report from the President.
6. To receive a report from the Chief Executive Officer.
7. To receive and adopt the Directors' Report and Accounts for the year ending 31 December 2024.
8. To confirm Chrisma Jain as President.
9. To elect officers of the Institution.

Any member wishing to propose a candidate must advise the Secretary in writing not less than 28 clear days in advance of the Annual General Meeting. Any candidate must meet the requirements of Clause 4(1) of the Articles of Association. Details of the person specification for each role are available from the Secretary.

A member entitled to attend and vote at the meeting, but who is not able to attend, is entitled to appoint a proxy to vote in their place. Proxy forms will be available on the PWI website or can be obtained from the Secretary and must be returned not less than seven clear days in advance of the Annual General Meeting.

To increase the accessibility of the Annual General Meeting, and to mitigate against any cause that would prevent the meeting from taking place in a face-to-face environment, the AGM will also be streamed online. Any member joining virtually will have the opportunity to listen to the presentations and ask questions in real time. Voting online will not be possible and members joining the meeting virtually and wishing to vote must signify their voting intentions in advance via the submission of a proxy form. Full details of how to register to attend and vote by proxy will be published on the PWI website in April 2025.

PERMANENT-WAY INSTITUTION (INCORPORATED)

COMPANY INFORMATION

Directors	Katharine Hatwell	
	Stephen Barber	
	Steven Bell	
	Simon Blanchflower	
	Brian Counter	
	Joan Heery	
	Michelle Nolan-McSweeney	
	William Powrie	
	Chrisma Redahan	
	Mr Gareth Davies	
	Mr Jeff Hills	
	Moninder Sihota	
	Mr Cathal Mangan	(Appointed 5 July 2024)

PERMANENT-WAY INSTITUTION (INCORPORATED)

DIRECTORS' REPORT

FOR THE YEAR ENDED 31 DECEMBER 2024

The directors present their annual report and financial statements for the year ended 31 December 2024.

Principal activities
The principal activity of the company continued to be that of activities relating to professional membership organisations.

Statement from the Board of Directors
This statement complements the quarterly updates from the President and the CEO provided in each PWI Journal.

The PWI continues to provide invaluable knowledge sharing and knowledge leadership within the railway engineering industry. 2024 saw continued growth in all areas of activity with further notable growth in education and training activity.

The Institution delivered a turnover of somewhat over £1.6m, 26% up on 2023. At 3.7%, 2024's operating surplus margin was broadly in line with the Board's objectives: above the 1.0% achieved in 2023 and reflecting stronger than anticipated demand for education services. The value of the PWI's investments remained stable and that of its software assets increased, the latter reflecting the implementation of the new customer relationship management system. Coupled with interest payments, the resulting surplus margin before tax was 5.0%, up from 1.9% in 2023. On a longer-term basis, the PWI's investments continue to perform satisfactorily at around market norms. Members' funds represented by net assets increased by 30.0% over the year. On 31 December 2024 the Institution was supported by 4,159 Personal Members, representing 7.3% growth over the year, and by 82 Corporate and Heritage Members. Driven by the Institution's highly successful *PWI140* initiative, professionally registered membership grew by 23.9% in the year, standing at 384 at the year end.

During 2024 the Board of Directors met four times. Three of these meetings were held using an online platform and one was held face-to-face. The July AGM was held face-to-face though members were offered an option for online attendance. 180 Section meetings were held in 2024, with a majority of Sections offering a mix of face-to face and online meetings. Section structure remained stable through the year. Online and face-to-face PWI educational programmes registered total attendance of 758 in 2024, up by 31% on 2023's total of 498.

2024 saw the launch of the Institution's 2024-28 five-year strategy, with progress made on several projects aligned with the framework for the Institution's continuing development published in the January 2024 edition of the PWI Journal. The Institution has continued to work with the Royal Academy of Engineering, EngineeringUK, the Engineering Council, and other professional engineering institutions to promote engineering generally, and to raise the profile of railway engineering within the broader UK engineering community.

2024 saw further expansion of the PWI's "Lunch and Learn" programme of short online seminars aimed at younger engineers, though by no means exclusive to that group. 20 such events attracted a total audience of 3,117. The average audience size of 156 showed a marked increase on 2023's figure of 92. Whilst 2024 saw significant growth in the volume of education and training programmes delivered, no new programmes were introduced. As a now established member of the Joint Board of Moderators, the Institution continues to raise the profile of railway engineering within higher education establishments and is seeking to ensure that all transport engineering course modules include reference to railways.

Whilst the uncertainties and challenges surrounding the future of the UK railway transport industry show little sign of abating, Member support for the Institution remains strong and its international profile is growing. The Institution's strategy explains how it intends to support its individual and corporate Members as they face those challenges, and it remains committed to delivering the strong support that will enable all to develop and prosper.

PERMANENT-WAY INSTITUTION (INCORPORATED)

DIRECTORS' REPORT (CONTINUED)

FOR THE YEAR ENDED 31 DECEMBER 2024

Directors
The directors who held office during the year and up to the date of signature of the financial statements were as follows:

Katharine Hatwell
Stephen Barber
Steven Bell
Simon Blanchflower
Brian Counter
Peter Dearman (Resigned 5 July 2024)
Joan Heery
Michelle Nolan-McSweeney
William Powrie
Chrisma Redahan
Mr Gareth Davies
Mr Jeff Hills
Moninder Sihota
Mr Cathal Mangan (Appointed 5 July 2024)

Auditor
Taylor Viney & Marlow Limited were appointed as auditor to the company and in accordance with section 485 of the Companies Act 2006, a resolution proposing that they be re-appointed will be put at a General Meeting.

Statement of disclosure to auditor
So far as each person who was a director at the date of approving this report is aware, there is no relevant audit information of which the company's auditor is unaware. Additionally, the directors individually have taken all the necessary steps that they ought to have taken as directors in order to make themselves aware of all relevant audit information and to establish that the company's auditor is aware of that information.

Small companies exemption
This report has been prepared in accordance with the provisions applicable to companies entitled to the small companies exemption.

On behalf of the board

Stephen Barber
Director

Mr Gareth Davies
Director

26 February 2025

PERMANENT-WAY INSTITUTION (INCORPORATED)

DIRECTORS' RESPONSIBILITIES STATEMENT

FOR THE YEAR ENDED 31 DECEMBER 2024

The directors are responsible for preparing the annual report and the financial statements in accordance with applicable law and regulations.

Company law requires the directors to prepare financial statements for each financial year. Under that law the directors have elected to prepare the financial statements in accordance with United Kingdom Generally Accepted Accounting Practice (United Kingdom Accounting Standards and applicable law). Under company law, the directors must not approve the financial statements unless they are satisfied that they give a true and fair view of the state of affairs of the company and of the surplus or deficit of the company for that period.

In preparing these financial statements, the directors are required to:
- select suitable accounting policies and then apply them consistently;
- make judgements and accounting estimates that are reasonable and prudent; and
- prepare the financial statements on the going concern basis unless it is inappropriate to presume that the company will continue in business.

The directors are responsible for keeping adequate accounting records that are sufficient to show and explain the company's transactions and disclose with reasonable accuracy at any time the financial position of the company and enable them to ensure that the financial statements comply with the Companies Act 2006. They are also responsible for safeguarding the assets of the company and hence for taking reasonable steps for the prevention and detection of fraud and other irregularities.

PERMANENT-WAY INSTITUTION (INCORPORATED)

INDEPENDENT AUDITOR'S REPORT

TO THE MEMBERS OF PERMANENT-WAY INSTITUTION (INCORPORATED)

Opinion
We have audited the financial statements of Permanent-Way Institution (Incorporated) (the 'company') for the year ended 31 December 2024 which comprise the income and expenditure account, the balance sheet, the statement of changes in equity and notes to the financial statements, including significant accounting policies. The financial reporting framework that has been applied in their preparation is applicable law and United Kingdom Accounting Standards, including Financial Reporting Standard 102 *The Financial Reporting Standard applicable in the UK and Republic of Ireland* (United Kingdom Generally Accepted Accounting Practice).

In our opinion the financial statements:
- give a true and fair view of the state of the company's affairs as at 31 December 2024 and of its surplus for the year then ended;
- have been properly prepared in accordance with United Kingdom Generally Accepted Accounting Practice; and
- have been prepared in accordance with the requirements of the Companies Act 2006.

Basis for opinion
We conducted our audit in accordance with International Standards on Auditing (UK) (ISAs (UK)) and applicable law. Our responsibilities under those standards are further described in the *Auditor's responsibilities for the audit of the financial statements* section of our report. We are independent of the company in accordance with the ethical requirements that are relevant to our audit of the financial statements in the UK, including the FRC's Ethical Standard, and we have fulfilled our other ethical responsibilities in accordance with these requirements. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

Conclusions relating to going concern
In auditing the financial statements, we have concluded that the directors' use of the going concern basis of accounting in the preparation of the financial statements is appropriate.

Based on the work we have performed, we have not identified any material uncertainties relating to events or conditions that, individually or collectively, may cast significant doubt on the company's ability to continue as a going concern for a period of at least twelve months from when the financial statements are authorised for issue.

Our responsibilities and the responsibilities of the directors with respect to going concern are described in the relevant sections of this report.

Other information
The other information comprises the information included in the annual report other than the financial statements and our auditor's report thereon. The directors are responsible for the other information contained within the annual report. Our opinion on the financial statements does not cover the other information and, except to the extent otherwise explicitly stated in our report, we do not express any form of assurance conclusion thereon. Our responsibility is to read the other information and, in doing so, consider whether the other information is materially inconsistent with the financial statements or our knowledge obtained in the course of the audit, or otherwise appears to be materially misstated. If we identify such material inconsistencies or apparent material misstatements, we are required to determine whether this gives rise to a material misstatement in the financial statements themselves. If, based on the work we have performed, we conclude that there is a material misstatement of this other information, we are required to report that fact.

We have nothing to report in this regard.

Opinions on other matters prescribed by the Companies Act 2006
In our opinion, based on the work undertaken in the course of our audit:
- the information given in the directors' report for the financial year for which the financial statements are prepared is consistent with the financial statements; and
- the directors' report has been prepared in accordance with applicable legal requirements.

2024 ACCOUNTS

PERMANENT-WAY INSTITUTION (INCORPORATED)

INDEPENDENT AUDITOR'S REPORT (CONTINUED)
TO THE MEMBERS OF PERMANENT-WAY INSTITUTION (INCORPORATED)

Matters on which we are required to report by exception
In the light of the knowledge and understanding of the company and its environment obtained in the course of the audit, we have not identified material misstatements in the directors' report. We have nothing to report in respect of the following matters in relation to which the Companies Act 2006 requires us to report to you if, in our opinion:

- adequate accounting records have not been kept, or returns adequate for our audit have not been received from branches not visited by us; or
- the financial statements are not in agreement with the accounting records and returns; or
- certain disclosures of directors' remuneration specified by law are not made; or
- we have not received all the information and explanations we require for our audit; or
- the directors were not entitled to prepare the financial statements in accordance with the small companies regime and take advantage of the small companies' exemption in preparing the directors' report and from the requirement to prepare a strategic report.

Responsibilities of directors
As explained more fully in the directors' responsibilities statement, the directors are responsible for the preparation of the financial statements and for being satisfied that they give a true and fair view, and for such internal control as the directors determine is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error. In preparing the financial statements, the directors are responsible for assessing the company's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless the directors either intend to liquidate the company or to cease operations, or have no realistic alternative but to do so.

Auditor's responsibilities for the audit of the financial statements
Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance but is not a guarantee that an audit conducted in accordance with ISAs (UK) will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

The extent to which our procedures are capable of detecting irregularities, including fraud, is detailed below.

We gained an understanding of the legal and regulatory framework applicable to the company and the industry in which it operates, and considered the risk of acts by the company that were contrary to applicable laws and regulations, including fraud. We designed audit procedures to respond to the risk, recognising that the risk of not detecting a material misstatement due to fraud is higher than the risk of not detecting one resulting from error, as fraud may involve deliberate concealment by, for example, forgery or intentional misrepresentations, or though collusion. Audit staff with sufficient knowledge and expertise to identify non-compliance with laws and regulations were deployed on the audit.

We focused on laws and regulations which could give rise to a material misstatement in the financial statements, including, but not limited to, the Companies Act 2006 and UK tax legislation. Our tests included agreeing the financial statement disclosures to underlying supporting documentation and enquiries with management. There are inherent limitations in the audit procedures described above and, the further removed non-compliance with laws and regulations is from the events and transactions reflected in the financial statements, the less likely we would become aware of it. We did not identify any key audit matters relating to irregularities, including fraud. As in all our audits, we also addressed the risk of management override of internal controls, including testing journals and evaluating whether there was evidence of bias by the directors that represented a risk of material misstatement due to fraud.

A further description of our responsibilities is available on the Financial Reporting Council's website at: https://www.frc.org.uk/auditorsresponsibilities. This description forms part of our auditor's report.

PERMANENT-WAY INSTITUTION (INCORPORATED)

INDEPENDENT AUDITOR'S REPORT (CONTINUED)
TO THE MEMBERS OF PERMANENT-WAY INSTITUTION (INCORPORATED)

Use of our report
This report is made solely to the company's members, as a body, in accordance with Chapter 3 of Part 16 of the Companies Act 2006. Our audit work has been undertaken so that we might state to the company's members those matters we are required to state to them in an auditor's report and for no other purpose. To the fullest extent permitted by law, we do not accept or assume responsibility to anyone other than the company and the company's members as a body, for our audit work, for this report, or for the opinions we have formed.

S. McCallum

Stuart McCallum
Senior Statutory Auditor
For and on behalf of Taylor Viney & Marlow Limited

Date: 14 March 2025

Chartered Accountants
Statutory Auditor

46-54 High Street
Ingatestone
Essex
CM4 9DW

PERMANENT-WAY INSTITUTION (INCORPORATED)

PROFIT AND LOSS ACCOUNT
FOR THE YEAR ENDED 31 DECEMBER 2024

	Notes	2024 £	2023 £
Turnover		1,676,706	1,330,052
Cost of sales		(796,332)	(668,062)
Gross surplus		880,374	661,990
Administrative expenses		(818,940)	(649,541)
Other operating income		436	429
Operating surplus		61,870	12,878
Interest receivable and similar income		21,580	12,412
Surplus before taxation		83,450	25,290
Tax on surplus	4	(4,255)	(5,829)
Surplus for the financial year		79,195	19,461

The income and expenditure account has been prepared on the basis that all operations are continuing operations.

PERMANENT-WAY INSTITUTION (INCORPORATED)

BALANCE SHEET
AS AT 31 DECEMBER 2024

	Notes	2024 £	2024 £	2023 £	2023 £
Fixed assets					
Intangible assets	6		184,910		116,684
Tangible assets	5		3,131		3,922
Investments	7		64,401		61,466
			252,442		182,072
Current assets					
Stocks		9,890		13,692	
Debtors	9	128,095		127,846	
Cash at bank and in hand		509,472		493,728	
		647,457		635,266	
Creditors: amounts falling due within one year	10	(542,485)		(539,833)	
Net current assets			104,972		95,433
Total assets less current liabilities			357,414		277,505
Provisions for liabilities			(15,108)		(14,394)
Net assets			342,306		263,111
Reserves					
Non-distributable profits reserve	12		47,705		45,483
Income and expenditure account			294,601		217,628
Total members' funds			342,306		263,111

These financial statements have been prepared in accordance with the provisions applicable to companies subject to the small companies regime.

The financial statements were approved by the board of directors and authorised for issue on 26 February 2025 and are signed on its behalf by:

Stephen Barber
Director

Mr Gareth Davies
Director

Company registration number 0099838 (England and Wales)

2024 ACCOUNTS

2024 ACCOUNTS

PERMANENT-WAY INSTITUTION (INCORPORATED)

STATEMENT OF CHANGES IN EQUITY

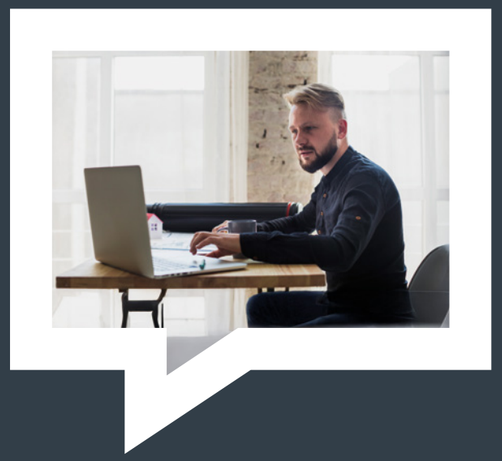
FOR THE YEAR ENDED 31 DECEMBER 2024

	Non-distributable profits	Income and expenditure	Total
	£	£	£
Balance at 1 January 2023	46,987	196,663	243,650
Year ended 31 December 2023:			
Profit and total comprehensive income for the year	(1,504)	20,965	19,461
Balance at 31 December 2023	45,483	217,628	263,111
Year ended 31 December 2024:			
Profit and total comprehensive income for the year	2,222	76,973	79,195
Balance at 31 December 2024	47,705	294,601	342,306

THE PWI

LUNCH & LEARN

JOIN US ONLINE ON ALTERNATE TUESDAYS 12:30 - 13:30



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PWI TECHNICAL SEMINAR

ELECTRIFICATION AND INNOVATION: RAIL'S PATH TO DECARBONISATION

2 JULY 2025

KNOWLEDGE 200 ELECTRIFICATION & PLANT

HILTON, CARDIFF

Step into the future of rail at this dynamic Seminar, where electrification takes centre stage as the key to a net-zero transport system. Discover how 21st century electric traction requires a whole systems approach to power supply, operations, signalling, train control and rolling stock illustrated through the cutting-edge Core Valley Lines project.

With Rail already being one of the largest electricity consumers in the UK, further electrification and the need to charge battery trains, along with a modal shift from road to rail, will increase that demand. The plan for the railway must be an integral part of the planned Great Grid Upgrade.

Get inspired by innovative approaches to designing electrification for faster installation, easier maintenance, and maximum efficiency. Explore the game-changing potential of AI to revolutionise electrification programmes and gain exclusive insights into international electrification successes. Hear about how sustainability is being woven into the very fabric of electrification planning on HS2, setting bold new standards for future rail projects.

Whether you're an engineer or project manager involved in electrification, a railway operator or have an interest in sustainability, this event will spark fresh ideas and actionable strategies to facilitate electrifying the railway for a greener, cleaner tomorrow.

Ready to be part of the conversation? Book now to advance your knowledge on how electrification of the railways contributes to a net zero transport system.

£97 MEMBER
£177 NON-MEMBER
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PWI TECHNICAL SEMINAR

WATER MANAGEMENT ON THE RAILWAY... WHAT DOES IT MEAN TO ME?

7 MAY 2025

KNOWLEDGE 200
EARTHWORKS & WATER MANAGEMENT

ONE GREAT GEORGE STREET, LONDON

Water is one of the world's most precious commodities. The level of interaction between the railway and the water cycle is significant. Not only is the safe performance of all asset groups intrinsically linked to the management of water; consideration also has to be given to rail infrastructure at a system level and its relationship with the wider catchment area.

We all have a responsibility to manage the risks and realise the benefits posed by water.

In this Seminar we will explore water management at both a rail infrastructure and an alternative transport network level. Presentations will be shared on practical solutions to current challenges, albeit too much or too little water.

The Seminar will include opportunities for delegate interaction and participation, offering facilitated discussions and Q&A.

Ready to be part of the conversation? Book now to advance your knowledge and understanding of water management across rail infrastructure.

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