

 THE PWI

THE JOURNAL

JANUARY 2025 | VOLUME 143 | PART 1



THE PAST

1802 - WORLD'S
FIRST STEAM RAILWAY
LOCOMOTIVE (REPLICA).

THE FUTURE:

BULLET TRAIN READY
FOR 'LIFT-OFF' AT
TOKYO STATION.

CELEBRATING 200 YEARS
OF THE MODERN RAILWAY

200



KNOWLEDGE 200

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THE JOURNAL

January 2025 | Volume 143 | Part 1

Article and advertising deadlines

April 2025 deadline - 1 February 2025
July 2025 deadline - 1 May 2025
October 2025 deadline - 1 August 2025
January 2026 deadline - 1 November 2025

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ISSN 2057-2425
Publishing and layout by
Permanent Way Institution

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SUBMIT A JOURNAL ARTICLE

If you would like to share a project you've been working on within the Journal then please get in touch.



PRESENT A LUNCH & LEARN

If you would like to present a live Lunch & Learn session, please do let us know.



A LETTER FROM YOUR PRESIDENT

As the year draws to a close, I've found myself reflecting on the incredible breadth of experiences and milestones that have defined the past months. Being part of this vibrant and committed PWI community has been nothing short of inspiring. Our Members, Sections, and collective achievements have demonstrated once again why we stand as a leading Institution in the railway engineering profession.

MEETING THE MEMBERSHIP

This year, my travels and engagements have provided me with countless opportunities to connect with you and see the extraordinary work being carried out across the PWI network. Among the highlights was my visit to Ireland Section meeting held in Belfast, where I toured the remarkable Grand Central Station. The station's focus on maintenance-first design was a shining example of engineering done right. Straight platforms and unified systems are decisions that might seem straightforward, but they represent a profound commitment to long-term reliability and simplicity for maintenance teams. Meeting the Programme Manager - someone who began their career as a Network Rail drainage engineer - was a wonderful reminder of how small and interconnected our community truly is.

In York, I was delighted to present an update on PWI activities and hear more about innovative developments in technology. One exciting focus was the integration of data through the StrEAMS and Insights technology, enabling engineers to access all the information they need in one place for better-informed decision-making. These innovations underline the importance of ensuring that cutting-edge technology supports our work as we strive for safer, more efficient railways.

SEMINARS AND EVENTS

The Light Rail Technical Seminar was another standout moment, providing a fascinating look at the sector's unique challenges and opportunities. From embedded track maintenance to the push for standardisation, light rail systems face hurdles that demand collaboration and innovation. Yet their critical role in reducing urban car use and connecting key city locations makes these efforts essential. The event highlighted the shared challenges across light and heavy rail systems and the vital need to champion light rail in the fight for sustainable infrastructure funding.

Of course, no year would be complete without celebrating the achievements of our Members. The annual awards ceremony is a crowning highlight for me. Recognising the efforts of those achieving Professional Registration and diplomas is a privilege, and this year's honorary life Members left a lasting impression. Collectively contributing over 200 years of voluntary service, these individuals have shaped the PWI through their dedication, mentorship, and commitment to the next generation of railway engineers. Their humility and genuine surprise at receiving the recognition was deeply touching and reminded me of the vital role that each of us plays in supporting one another's journeys.

Yet, as we celebrate these milestones, we also face significant challenges. Climate resilience has emerged as a pressing priority for our industry. Recently, Storm Bert highlighted the challenges posed by extreme weather to our railways, underscoring the vulnerabilities of legacy infrastructure and the importance of adapting our designs to meet the demands of a changing world. Seeing images of submerged platforms and storm-damaged stations was a stark reminder that we can no longer design for the past. Instead, we must integrate future climate projections into every aspect of our planning and design. The extreme and unpredictable weather patterns we're experiencing demand innovation and resilience at every level.

**BEING PART OF
THIS VIBRANT AND
COMMITTED PWI
COMMUNITY HAS
BEEN NOTHING SHORT
OF INSPIRING.**

THE STRENGTH OF OUR COMMUNITY

Despite these challenges, I am heartened by the dedication of our Members and the support systems the PWI provides. Whether through Professional Registration workshops, mentoring sessions, or sharing expertise in our Journal, the strength of our community lies in its willingness to help others succeed. I've made it my

mission to encourage more Members to tell their stories and share their knowledge. Whether it's through Lunch & Learn sessions or Journal articles, every contribution enriches our community and strengthens our profession.

At the time of writing, the Network Rail Track Engineering conference in Birmingham is set to deliver a dynamic program exploring the latest advancements in track renewal and maintenance. Shortly after, I'll be visiting our Ireland Section meeting which will be held in Dublin to connect with Members and hear about the significant railway projects underway in Ireland. I'm also looking forward to attending the Institution of Mechanical Engineers Railway Division luncheon, a valuable opportunity to foster collaboration and strengthen ties between our organisations. These upcoming events highlight the exciting opportunities we have to come together as a profession and share knowledge.

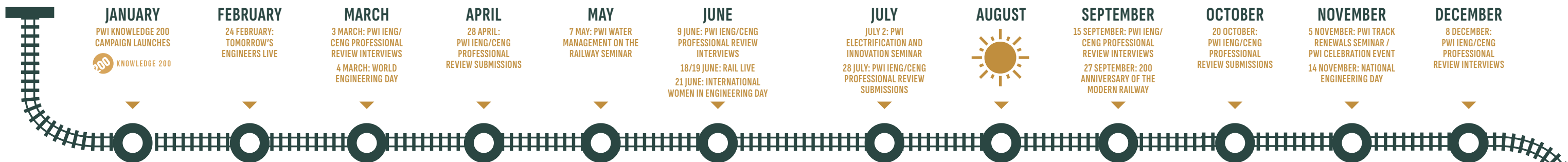
In all these moments, the PWI's mission - to support, develop, and connect railway engineers - remains at the heart of everything we do. Whether you are a seasoned Member or just beginning your professional journey, I encourage you to engage with the wealth of opportunities available. Together, we are shaping the future of railway engineering, tackling challenges with resilience, and driving innovation that benefits the entire industry.

Thank you for your continued dedication to the PWI and to advancing our shared profession. I look forward to meeting many of you in the year ahead and continuing to celebrate your remarkable contributions.



MONA SIHOTA
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FROM THE CEO

WELCOME TO THE JANUARY JOURNAL

2025 – A YEAR IN PROSPECT

A very Happy New Year to all Members and friends of the Institution: a year that promises further growth and development as we build on 2024's successes and work to introduce more and better member services and shape the Institution to attract and serve even more of those who work in the railway engineering sector. The scale of the challenges facing the UK railway industry as it leaves the first quarter of the 21st Century seem no less daunting than in any recent years, but the Institution is determined that its members are well informed and equipped to meet those challenges. And I hope you will agree that there are some reasons for optimism...

PWI 140 – A YEAR IN RETROSPECT

Whilst a fuller review was published in December's Newsletter, I make no apology for noting that, with membership numbering over 4000 (its highest level since the mid-1990s), a record number of Members achieving Professional Registration, and having delivered its biggest ever education and training programme, the Institution has much to celebrate at the end of 2024. Members can look back on the 140th anniversary year confident that the Institution remains true to its founding ethos and purpose: the acquisition, advancement, and sharing of scientific and engineering knowledge relevant to the construction and maintenance of railways. 2025 will see continuing work and developments to that end.



RAILWAY 200 – KNOWLEDGE 200

I trust that by now most readers will be well-aware of the industry's **Railway 200** campaign which is planning and coordinating activities and events to celebrate 200 years of the modern railway, its role today, and its importance to a sustainable future. I encourage you to visit the Railway 200 website¹ and look at what is planned - and I'm sure you'll find some things of interest!



Scan to visit the **Railway 200 website**

¹ <https://railway200.co.uk/about-railway-200/>

Railway 200 focuses on four main themes: Skills and Education; Innovation, Technology and Environment; Celebrating Railway People; and Heritage, Culture and Tourism. These themes sit at the heart of our Institution, its aims and objectives, and its membership. We are joining the Railway 200 celebration and working with the Railway 200 team to ensure that the Institution's activities are dovetailed into the overall campaign. With a particular focus on innovation, technology, and education, we are running our own **Knowledge 200** campaign spotlighting four key railway engineering disciplines throughout 2025: **Electrification, Earthworks & Water Management, Digital & AI, and Track**. Each week, Knowledge 200 will feature articles, presentations, and insights showcasing both cutting-edge developments and established practices across the four disciplines, reinforcing the importance of sharing knowledge to enhance competence and empower the railway engineering industry.



Scan to visit the **Knowledge 200 website**

2025 AT THE INSTITUTION

2025 will see further work towards achieving the seven goals within the Institution's five-year strategy described in last January's Journal. The Institution's Mission, Vision, and Values, comprehensively updated following the survey of Members and non-members reported in the October '24 Journal, will be rolled out in June in conjunction with our presence at the 2025 Rail Live event. Building on the successful growth of the Institution's technical education and training programmes over the last five years, the executive team will be looking in great detail at what further technical areas should be included within our suite of courses, how course content will be developed, in what timescales, and where and how future programmes are to be delivered. This major piece of analytical work will take some months to complete, and its conclusions will set the Institution's direction in this area for the next four to five years.

A VERY HAPPY NEW YEAR TO ALL MEMBERS AND FRIENDS OF THE INSTITUTION: A YEAR THAT PROMISES FURTHER GROWTH AND DEVELOPMENT AS WE BUILD ON 2024'S SUCCESSES

The Institution's 'new' website went live in February 2022, nearly three years ago (how time flies when you're busy!). The site's content is managed by our in-house team and has been well-received. Whilst the site has worked well, some further enhancement is now required both to streamline visitor journeys and to future-proof the site to cope with continuing expansion of the Knowledge Hub and the introduction of more sophisticated search tools. In 2025 we will be working to specify the required changes and enhancements in detail, ready for development and implementation later in 2026.

The Institution's critical business processes and procedures are already formalised, notably those around Professional Registration, membership administration, financial management, operational safety, data management and protection, and areas related to customer relationship management. In 2025 we will continue work to formalise and streamline further process and procedure, as a prelude to seeking formal Management System accreditation towards the end of this strategic plan period.

You may have noticed that we are aiming to expand the Institution team to deal more effectively with a growing workload in technical education and training, and in managing our ever-increasing volume of technical resources. We are seeking a Head of Technical Education to support Technical Director Brian Counter in the development of further technical education and training programmes, and a Technical Manager with knowledge and experience in the electrification and fixed plant disciplines to support Technical Services Director Joan Heery. I very much look forward to introducing our appointees! I must also welcome new team member Helen Rowe who has taken over as our Events Manager – a role central to the success of our seminars and many other Member facing activities.



NAME CHANGE

As intimated in last January's Journal, the Board believes that changing the name of the Institution is critical to its long-term success and to maximising the support and development opportunities it can offer to all who work within the field of railway engineering.

Encouragingly, feedback from last year's member survey, along with extensive discussions across a broad spectrum of members, has been hugely supportive of this proposed change.

Following discussions last year with other Professional Engineering Institutions (PEIs), the Board has revised its proposed new name to **Railway Engineering Institution (RailEI)**. Institution Membership and Fellowship would be indicated respectively by the post nominals **M RailEI** and **F RailEI**.

RailEI is intended to provide a clearly identifiable, highly visible, sector-specific presence within the wider UK engineering establishment, maintaining an externally focussed profile and voice for the railway industry, and emulating successful high-profile sector-specific PEIs such as the Nuclear Institute and Royal Aeronautical Society.

The Board has absolutely no desire or intention for this Institution's identity to be mistaken for that of another PEI, nor does it have any ambition or intention to challenge those bodies that are already the established homes of specialist railway engineering expertise. Indeed, the Institution remains committed to collaborating with other PEIs, fostering opportunities to share and expand knowledge, understanding, and experience in railway engineering, and working positively with all within, and associated with, the railway industry towards delivery of the efficient, low-carbon, sustainable, integrated transport systems that all modern societies require and deserve.

The proposal to change the name of the Institution will be put to Member vote. However, the timing of that vote will depend on several procedural hurdles which have yet to be cleared. I will provide updates via the Journal and newsletters as we navigate the process.



STEPHEN BARBER
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TRANSPORT POLICY – A WIDER VIEW

WHAT CAN OUR INSTITUTION DO?

Against a background of occasional press hostility and government scepticism, I am often asked by Members what our Institution can do, or is doing, to promote railways and rail-based transport. Historically, the PWI did not seek to contribute to or influence government or industry policy formulation. However, since becoming a fully-fledged Professional Engineering Institution (PEI) and rubbing shoulders with our 38 colleague PEIs, it has become clear that the considered and informed views of such institutions can provide valuable context and advice to policy makers in government and public authorities. Largely through the Royal Academy of Engineering's National Engineering Policy Centre but occasionally (where particularly relevant) directly, our Institution is making its voice heard on matters related to railways and railway engineering.

The Government, elected in July 2024, has launched consultations on a wide range of issues, seeking ideas and views on how management of the public realm and delivery of public services might be improved. Two of those recent consultations cover matters having a direct impact on rail-based transport in the UK and the railway industry. I thought it would be helpful to describe the two consultations in a little more detail below, before looking at a couple of topical areas where policy is being enacted as I write...

CONSULTATION ON INDUSTRIAL STRATEGY

In October 2024 the Government published a Green Paper outlining its proposed industrial strategy and seeking UK industry's views on its proposals. The Institution team prepared responses to those parts of the Green Paper relevant to railway transport and the railway engineering industry, initially intended for inclusion within a submission by the National Engineering Policy Centre (NEPC) setting out a collective view from the professional engineering sector. Whilst NEPC included summaries of our responses within its submission, it suggested that it would be both appropriate and helpful for our Institution to submit its own responses directly to Government.

There is not sufficient space here to reproduce our submission in full¹, but its key themes are: the critical role that sustainable, effective, and efficient transport has in driving a sustainable and growing economy; the fundamental role played by rail-borne transport in the ongoing physical, environmental, and economic health of urban Britain;

the importance of recognising the integral link between industrial strategy and transport strategy (and associated land-use planning) in the development of those strategies; and the important role that rail transport should play in driving decarbonisation.

INTEGRATED NATIONAL TRANSPORT STRATEGY

To support and inform Government's development of a strategy setting the direction for how transport should be designed, built and operated in England over the next 10 years, the Department for Transport issued a call for ideas in late November '24. The strategy is intended to set out a single national vision which will focus on the needs of people who use transport and facilitate the delivery of integrated transport solutions that meet the needs of communities. The PWI has submitted a response drawing on the evidence submitted to the Great British Railways Transition Team in 2021 supplemented by further material developed subsequently covering transport integration. The key themes of the submission are: the benefit that would accrue to the UK, over time, from much greater modal integration (rather than modal competition), structured to a large extent around the UK's railway network; the absence of ongoing mechanisms to actively develop the railway network to meet current and predicted national transport demands; and the changes to the objectives and governance of public bodies necessary to deliver a properly integrated system.

WHITHER HS2?

A question that hopefully Mark Wild, fresh from the recovery and final delivery of the Elizabeth Line project in London, should be able to answer by mid-2026 when a robust baseline plan and credible estimates of the truncated scheme's final cost are expected to be available. We can only wish Mark well in his endeavours, whilst continuing to puzzle over how the project reached its current crisis.

...AND FUTURE MAJOR RAILWAY PROJECTS?

It is, to say the least, hugely unfortunate that HS2 now joins West Coast Route Modernisation, Great Western Electrification, the Elizabeth Line, Railway Reform, and several other high-profile railway-

related projects where control has at some point been lost and where delivery timescales and costs have exceeded those initially planned by very large margins. From 2006 a library of reports by the National Audit Office, National Infrastructure Commission, and other oversight bodies has been created, each report including a list of sensible recommendations intended to prevent recurrence.

Over the last 40 years or so, countries including Spain, France, Italy, Austria, Switzerland, Denmark, Japan, China and India have successfully built networks of new lines, some very high-speed, some limited to 230km/h (or lower). Some of those same counties have also successfully upgraded existing lines to meet more arduous loading requirements and deliver higher transit speeds. Whilst a proportion of those projects have undoubtedly experienced their own financial and timescale troubles (notably Stuttgart 21), the majority appears to have been delivered broadly as planned. So, it appears that major railway projects can be successfully delivered.

If railways are to play an increasing role in a decarbonised UK transport system, it seems imperative that the lessons (both positive and negative) from previous UK major projects and from those in other countries are finally learnt and effectively applied. As to how that is to be achieved: a suitable topic for some enterprising PhD students perhaps?

PERHAPS THE BRIGHTEST INDUSTRY PROSPECT FOR 2025 AND BEYOND IS THAT OF ORGANISATIONS REINTEGRATED TO FACILITATE SHORTER COMMUNICATION LINES, DECISIONS INFORMED BY FULLER INFORMATION, AND MORE FLEXIBILITY TO REACT TO CHANGES BOTH IN CUSTOMER DEMAND AND IN THE CLIMATE AND ENVIRONMENT.

GREAT BRITISH RAILWAYS (GBR) AND TRANSPORT INTEGRATION

Perhaps the brightest industry prospect for 2025 and beyond is that of organisations reintegrated to facilitate shorter communication lines, decisions informed by fuller information, and more flexibility to react to changes both in customer demand and in the climate and environment. But we must wait until late in 2026 for a fully established GBR with its own tailored legal powers. In the meantime, clear industry strategic direction will depend on effective collaboration between Network Rail, the Department for Transport, the (public sector) Operator of Last Resort, and the GBR Transition Team.

Royal Assent to the Passenger Railway Services (Public Ownership) bill late last November has enabled the eventual transfer of all currently franchised passenger services to one or more public sector train operators. To further facilitate coordination with other transport modes, in plans for restructuring local government in England, the



Westminster Government has indicated its intention to increase the powers of mayors and local authorities, working in partnership with GBR, to shape rail services within their areas to better meet local needs. Taken with the powers given to Local Transport Authorities (LTAs) to define and control bus services in their areas (discussed in my November update), the UK is moving to a position where all LTAs will possess equivalent legal powers to those enjoyed by Transport for London (and by regional administrations in many other countries). Whilst such powers to integrate city and regional public transport are a necessary step in moving transport provision towards internationally high standards (such as enjoyed by Londoners), they will not of themselves deliver high quality networks. At some point significant investment will be required (see above).

GBR will face the challenge of balancing the needs of longer distance inter-city and inter-regional rail travellers, those of rail freight operators, and those of local and intra-regional passengers. There is no handy textbook to resort to and, in an environment where investment funds are likely to be constrained, there are likely to be many difficult choices and decisions. In arriving at sensible answers, an excellent understanding of overall transport costs and revenues, and social benefits and costs will be critical, as will the capability to work constructively with LTAs and other rail service operators to achieve optimal outcomes within very real constraints.

Pursuing the theme of integration a little further, an obvious next step (at least to me) would be for GBR and National Highways to consider overall transport capacity on key transport corridors and how road and rail capabilities might be used, in combination, to best national advantage. Work of this type is being carried out in Poland but in the UK would require a shift away from a culture in which competition rather than cooperation between transport modes has been a touchstone of much national transport policy for the last 60 years and more. As our national government looks more closely at overall transport policy, I hope that, as with industrial policy, our Institution can work with other professional bodies under the umbrella of the National Engineering Policy Centre to encourage the application of engineering principles and a whole system approach to policy decision making...



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Aerial view of HS2's London Euston Station site (Image courtesy of www.hs2.org.uk media centre).

¹ The full response will be accessible via the Institution website.



DR BRIAN COUNTER
TECHNICAL DIRECTOR
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2025 WILL BE THE YEAR IN WHICH THE INSTITUTION BUILDS UPON THE RECENT UPLIFT IN ITS INTERNATIONAL PROFILE FOR EXCELLENT TECHNICAL KNOWLEDGE SHARING, EDUCATION AND RECOGNISED PROFESSIONAL MEMBERSHIPS

The autumn of 2024 brought a flurry of events not to be forgotten as we start 2025. We got together with young and old, the early career starters and the vastly experienced engineers with a global twist!

We were at Southampton and Sheffield Hallam Universities to meet students and had a great Light Rail seminar in Nottingham which clearly opened us up to a new and exciting range of railway folk. We also toasted the success of new registrants, diploma and award winners at our celebration event and met international engineers. It was great to welcome our Hong Kong MTR colleagues and carry out education and training for Irish Rail in Portlaoise, 75km south of Dublin (Figure 1).

It is also important for us to give a great thank you to our amazing band of volunteer professional reviewers who met in London for the annual event in November. We have achieved our highest ever number of Engineering Council registrants in one year. This is a clear reflection of the quality and competence of railway engineers that are committed to the profession and developing others.



Figure 1: Brian Counter with Irish Rail delegates on PWI Track Engineering Diploma receiving their Module 1 certificates from Cathal Mangan, Chief Engineer Irish Rail and PWI Deputy President and Liam Hickey Infrastructure Manager Dublin Iarnród Éireann. (Photo courtesy of B.Counter).

PROFESSIONAL REGISTRATION

A superb year in 2024 with Liz and Charlotte registering 92 engineers! A lot of behind-the-scenes work done by our committees superbly led by Jeff Hills (Membership) and Dr. Matthew Frost (Academic). We are focussing on streamlining routes to Chartered and Incorporated Engineer status as these qualifications are becoming increasingly essential for railway engineers. Our courses are being validated and these will support registration routes especially where we need maths for railway engineers.

We have registered to date 267 EngTechs, 78 IEng and 127 CEng and with now having over 80 corporate members we expect this to rise in 2025, especially with your support!

I am happy to formally report 15 new IEng registrations of the London South Bank University Level 6 Rail Engineer degree apprentices in all railway disciplines and look forward to more in 2025.



Figure 2: The Hong Kong MTR and CHKRI delegation meeting up with the PWI in York. Pictured from left to right King Ting, Alex Lo, Winson Tse, Brian Counter, Brian Parkinson, Louise Walley and Peter Dearman. (Photo courtesy of B.Counter).

TECHNICAL EDUCATION AND DEVELOPING PEOPLE FOR THE FUTURE

We completed 42 week long courses last year with more planned for 2025, so we are seeking more staff at all levels to deliver this work as the railway demand is growing. We are doing more bespoke courses for Network Rail and TfL with orders for courses in Ireland (face to face) and Hong Kong (virtual). Future exciting areas will be Advanced S&C, DC OLE with opportunities in Australia being talked about. Certainly, I get requests all the time, so we must be doing it right!

We are continuing to have exciting developments in the PWI Technical Education provision with many additional requests coming through recently. These include more Track Engineering Diploma modules in Ireland and additional courses for Advanced Track Technician, S&C Refurbishment and Earthworks Drainage and Off-track Engineering for Network Rail in Glasgow, Derby and Wessex.

It was also great to meet up with our colleagues from the China Hong Kong Railway Institution (CHKRI) who visited the UK. CHKRI was formed from the PWI Hong Kong section 26 years ago and is going strong. Over the last 2 years, we have been strengthening our links especially through education. Figure 2 shows our official PWI meeting group held in York after a trip to the National Railway Museum.

The purpose of the visit was for MTR CHKRI colleagues to come on a fact finding trip in October. They were kindly hosted by Dr. Sin Sin Hui from Network Rail where they looked at Mobile Maintenance Trains for Rail replacement and Crossing weld repair, Plain Line Pattern Recognition and AIVR sharing on the NR Class153 train modification project and latest management of Rolling Contact Fatigue (Figure 3).



Figure 3: Winson Tse Chair of CHKRI presenting gifts to PWI CEO Stephen Barber and Dr. Sin Sin Hui. (Photo courtesy of K. Ting).



Figure 4: CHKRI MTR team on a night shift at Leeds watching track repairs carried out on the mobile maintenance train. (Photo courtesy of K. Ting).

There were meetings in London but most importantly, they visited actual work taking place on the UK railway with site visits at Leeds (Figure 4) and Darlington and also a trip on the test train from Stratford.

TECHNICAL AND SAFETY

As mentioned in the last Journal, safety appeared to be improving, however in the latter part of 2024, we were sadly made aware of two very serious technical incidents. These were related to track engineering and the wheel-rail interface. We are grateful to Jon Graham of RAIB for his presentation at the Technical Board on 13th November in Nottingham.

The first one was a gauge spread derailment of a freight train at Audenshaw, Manchester (Figure 5) on a long timber underbridge where chairscrews had sheared under loads associated with sharp curvature. It appears that the screws were not high tensile and possibly the local team were unaware of the risk. I would like to think that the issue could be the lack of fully-effective risk-based maintenance in a difficult location. I was involved in a similar incident at Nottingham 27 years ago and understand the management of this type of issue, however, we will await the formal RAIB report.

The second incident, unfortunately with a fatality and several injuries, was the collision at Talerddig in Mid-Wales. This appears to have been a wheel slip and a SPAD ("signal passed at danger") in a leafy area and was clearly adhesion problems with wheels and the rail.

Again, we await the full RAIB report and I remind members that it is important for us to learn from these incidents and strive to improve understanding through education and research.



Figure 5: Derailment of freight train over a curved long timber bridge at Audenshaw, Manchester September 2024. (Photo courtesy of RAIB).

EDUCATIONAL CONSULTATION FOR THE FUTURE

I was pleased to represent the PWI at this national review and give comments on behalf of the UK rail engineering industry about education for children and young people (Figure 6). My contribution was related to understanding the importance and excitement of engineering especially in railways and embedding this earlier in school curriculums emphasising the importance of systems and working in groups. The nine review and themes are these:

- Science as a core subject
- The importance of breadth
- Addressing diversity issues in STEM teaching and learning especially gender

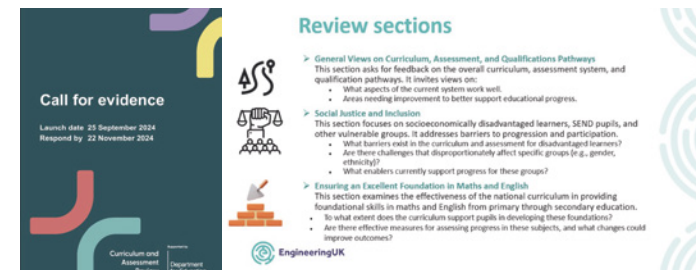


Figure 6: Royal Academy of Engineering (NEPC) Response to Department for Education review of UK Schools Curriculum

- Making space for more practical hands-on learning – bringing the 'fun' back into STEM teaching and learning
- Increasing the visibility of engineering in the curriculum
- Assessment methods and the impact on the number of young people studying engineering
- Equipping a generation of digitally literate young people
- Educating the net zero generation
- Ensuring all young people know about careers opportunities in the engineering sector

I hope all readers agree with most of this and rest assured that the PWI will continue to participate in national engineering policy development!

AND FINALLY, LET'S GET TECHNICAL...

Railway Engineering can often be seen as a black art!

We all can never stop learning and as we manage the railway as a system, knowing more about the inter-related aspects will ensure full understanding and better results for design and problem solving.

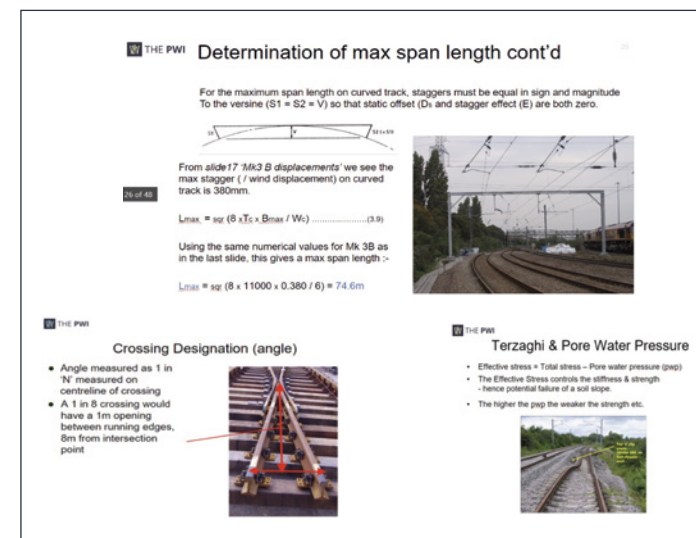
The three areas I have picked on relate to OLE stagger, S&C Measurement and Slope failure.

Most railways in the world follow topographic conditions which involve vertical and horizontal curves which inflict greater forces on the infrastructure and our role is to manage this aspect as professional railway engineers.

Curved track is a challenge for the track designers who often have to locate S&C on curves which affects the measurement of crossings and switches with complex radii. The OLE designers have to calculate the stagger so that we can safely optimise the pantograph contact wire interface.

What about the problem of what is happening below the track and its stiffness and slope stability?

Let 2025 be another year of railway engineering learning, come to our meetings, seminars and lunch and learns and invest in one of our courses (see back page).



ON THE RIGHT TRACK: EXPLORING YOUR FUTURE IN RAILWAY ENGINEERING

6 NOVEMBER 2024

SHEFFIELD HALLAM AND SOUTHAMPTON UNIVERSITIES



A selection of photos from the events at both Universities.

In 2023, a group of PWI Ambassadors came up with the idea of engaging with university students to show them the rail industry can be a great career choice. The PWI subsequently contacted a number of universities to gauge their level of interest. Both Southampton and Sheffield Hallam Universities confirmed they would like to partake, and we subsequently created an event where speakers were present at both universities and their presentations were streamed using an online platform.

Our goal was to show the audience there are a diverse range of technical careers within the rail industry and to create a level of curiosity amongst the participants. The seminar was opened by Dr. Brian Counter who spoke enthusiastically about the various technical disciplines that have an involvement within rail infrastructure and the role of the PWI as an Engineering Institution. Steve Fletcher, Director of Engineering at the Office of Road and Rail (ORR) then spoke about the sums of money that are invested in rail infrastructure in any 5-year period, hence showing the students it is an industry with purpose and longevity. Steve also spoke about some of the societal challenges, for example climate change and accessibility for all which require bright minds to find suitable solutions.

The next presentation told the story of a very complex S&C layout at Lewisham from multiple perspectives. Lewisham was renewed over the Christmas period in 2022 and the audience heard from Patrick White, Network Rail's Track Maintenance Engineer who

looks after the asset on a day to day basis, Graham Bleach, the Track Designer (CRE) from AECOM who led the design of the new layout and Chris Belton, from Progress Rail who looked after the manufacture of the layout. Whilst all three of these people have their own particular relationship with the layout at Lewisham, they are also closely connected as their overall skills and experience have been instrumental in the renewal of the asset.

Mark Howells, Senior Asset Engineer, Drainage and Lineside for Network Rail then spoke about the importance of giving due consideration to drainage as a system and some possible consequences when this does not happen. Mark's presentation included a summary of Carmont, which really emphasised the absolute requirement for systems thinking.



The audience then enjoyed a joint presentation from Simon Skinner, Head of Engineering for SPL and Lucy Clarke, a recent graduate who is working with Simon on the Electrification of the Midland Mainline. Lucy talked about how much she has learned about the inter-disciplinary nature of her project and how the various elements interact with each other to ensure overall success. Simon spoke about some of the innovative workstreams on the project, for example the work on voltage controlled clearances to avoid the demolition and reconstruction of bridges, which was an excellent example of how technical people can provide cost efficient solutions.

A recent graduate from each university who has found a career in the rail industry gave the final presentations. Diana Franceva, who has an Aeronautical & Astronautical degree from Southampton is currently working for Transport for London (TfL) as a Track Maintenance Engineer and Data Analyst and Denzel Maumbe, who graduated with a degree in Mechanical Engineering from Sheffield Hallam University and is a graduate Design Engineer with Keltbray spoke about how they acquired their roles and the type of work they get involved with day to day.

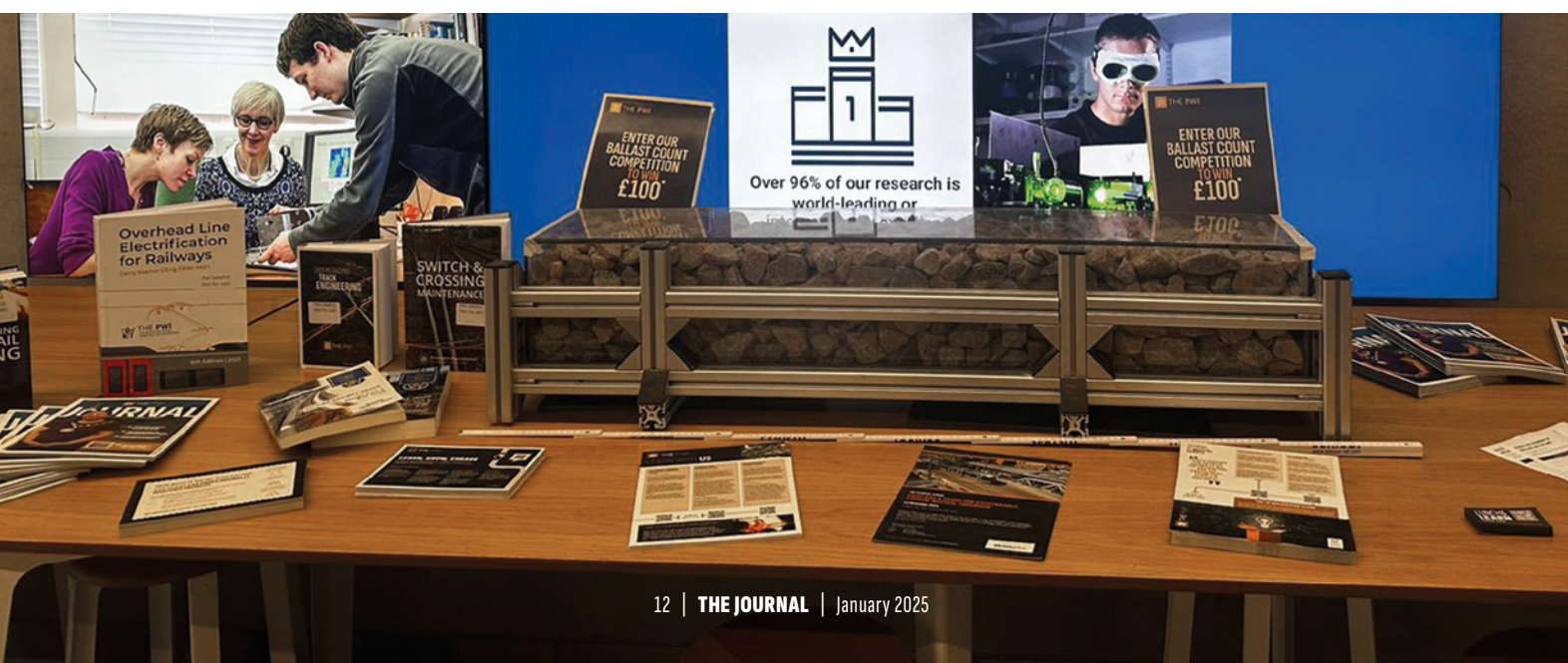
The presentations were very well received by students and university staff alike. We were also very fortunate to be supported by a number of our Corporate Members who hosted company stands on the day. Many thanks go to the following organisations - Pro Rail, Goldschmidt, Network Rail, BAM Ritchies, AECOM, AtkinsRéalis, Transport for London, Progress Rail, Amey, Voestalpine UK, QTS, Murphy, Pandrol and InoRail.

This event was "the first of type" for the PWI and we are currently evaluating what we can do next in respect of working with universities to showcase careers in the rail industry.

All the presentations are available on the PWI's Knowledge Hub.



JOAN HEERY
TECHNICAL SERVICES DIRECTOR
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LIGHT RAIL & TRAMS FOR A SUSTAINABLE, CARBON-NEUTRAL TOMORROW AND TECHNICAL VISIT TO NOTTINGHAM EXPRESS TRANSIT DEPOT

14 November 2024, Albert Hall, Nottingham
and 15 November, Wilkinson Street Tram Depot

Nottingham and Derby Section of the PWI organised this seminar, the Section proposed a fresh look at Light Rail and Trams with the focus on how this mode of transport provides a carbon neutral tomorrow. Nottingham along with other towns and cities within the British Isles including Blackpool, Edinburgh, South London, Greater Manchester, Sheffield and Rotherham, West Midlands, and Dublin operate a modern tram network. Light rail networks include Tyne and Wear and also Docklands. Many others are actively looking at building their own networks to deliver effective and carbon-neutral transportation within their towns and cities. So plenty to talk about and the Section found a wonderful venue and pulled together an excellent programme of speakers with plenty of space for the event sponsors and guests to chat, catchup and of course enjoy all on offer. As a proud member of the Nottingham and Derby Section I always like to remind our colleagues within our many other Sections that it all started in Nottingham with the first meeting of the Institution of Permanent Way Inspectors held at the Granby Hotel on the 5 January 1884, the location being adjacent to Nottingham Railway Station and within touching distance of Nottingham Station tram stop.

AS A PROUD MEMBER OF THE NOTTINGHAM AND DERBY SECTION I ALWAYS LIKE TO REMIND OUR COLLEAGUES WITHIN OUR MANY OTHER SECTIONS THAT IT ALL STARTED IN NOTTINGHAM

The Seminar started with a welcome from the morning Chair, Mona Sihota the current President of the PWI. In her welcome, Mona shared with the audience her experience at the very start of her career being a young engineer working on the construction of the VTA light rail in Santa Clara, California, North America. Then to welcome all those attending to enjoy the presentations, the day ahead and of course the opportunity to network with colleagues, sponsors, and exhibitors.

The keynote speech was delivered by James Hammett, Managing Director of UK Tram. He explained that UK Tram is the trade body for Light Rail in the British Isles being the voice of the sector. Membership includes Tramways, Light Railways, Metro, Subways, Heritage, Ultra Light Rail and Personal Rapid Transport systems. James shared UK Tram's 3 Year Business plan being split across several areas; Customer Experience, Sustainability & Environment, Sector Growth and Innovation, all collated together through benchmarking and best practice. Plenty on the horizon to see in the sector including; Extensions to existing networks, South Wales Metro, Coventry Very Light Rail and many more in the pipeline.



The first presentation of the day was a look at Tram Systems for Urban Traffic delivered jointly by Johannes Kaiser, Vice President Customer Solutions and Alexander Koch, Design Engineer R&D, both from Voestalpine Engineering. Their talk provided a detailed look at the track products available from their company. They explained in detail the various rail profiles used by trams including in-street embedded trackforms and options for rail grades and hardness to maximise life of the rails installed. The use of modern design tools to improve geometry to optimise smooth running through switches and crossings was explained and how their system approach is ideal for embedded rail systems including switch actuation equipment.



The second presentation of the morning session was based on the day-to-day experiences of those maintaining infrastructure of the local Nottingham Tram network. Marek Szejewski: Track Asset Manager, Nottingham Trams presented his paper entitled Advanced Inspection and Maintenance Strategies for Nottingham Tram Infrastructure. Marek explained the operational relationships between the organisations that enable the users of the tram system to travel the network along with the regulatory framework in place. Marek also outlined the challenges faced by his team of track engineers to keep the infrastructure in safe condition to allow trams to operate. The presentation is full of interesting facts, all of which are available to view on the PWI knowledge Hub including track types, network length, number of switch and crossing units and much more. Concluding his presentation summarised existing and future challenges and considerations.

After a short break to stretch legs and enjoy refreshments the morning session continued with a presentation by Andreas Biesinger: Technical Principal & Engineering Manager, Mott MacDonald on In Street (Embedded) Track Forms. Andreas explained the various types of tram and light rail trackforms in use today, going on to talk through the challenges including the interface between rails and road surfaces with plenty of images of examples. As is often the case water management is a constant challenge! The presentation concluded with examples from around the world where aesthetics and performance have delivered sustainable, maintainable in-street embedded trackforms.

Next up in the morning session was Jamie Kelly: Programme Manager, Volker Rail with his view on how those leading infrastructure construction projects can Extract Value from the Supply Chain. Based on many years of delivering light rail and other rail infrastructure project Jamie differentiated Cost and Value being the 'Price is what you pay, value is what you get'. Then challenging those who undertake the delivery of infrastructure projects including light rail to add value by; 1) Defining what success looks like – the goal, 2) Communicating the goal, 3) Secure very early contractor involvement, 4) Understand risk and assumptions, 5) Design for life and generational renewals, 6) Promote National standards anyone, is this available in Light Rail? 7) Manage resource availability, smooth industry out peak period resource allocation, and finally aggregate and don't compete for resources.

Wrapping up the morning session before lunch and more networking was Marilena Papadopoulou: Asset Renewals Manager, Edinburgh Trams promoting Proactive Asset Renewals Planning. Marilena began with a brief introduction to Edinburgh Tram systems moving on to outline their renewals journey and the 5 stages of the asset life cycle being, to plan, acquire, operate, maintain and dispose. She reinforced the need to plan for any renewals activities with a clear view on forming long-term asset renewals plans of three to ten years. Of course, renewals includes two options to refurbish or to replace assets. Promoting longer term planning requires good knowledge of your assets, keeping them well maintained for as long as possible. If done well the benefits include; enhanced safety and compliance, reduction in operational disruptions, optimised lifecycle costs and improved financial planning.

Over lunch, delegates enjoyed a fine spread of food and refreshments and plenty of time to talk to event exhibitors. For me a personal highlight was seeing Women in Rail promoting their raison d'être; breaking down diversity barriers, helping to change the image of rail and ultimately bridge the skills gap in our sector.

The afternoon session Chair was Susanne Smith: Principal Engineering Leader, TFL who's responsibility includes the broad range of permanent way asset types that make up all the tracks providing transportation in London. Susanne welcomed all the delegates back for the three afternoon presentations.

First for the afternoon session was Pete Sommers: Metrolink Engineering Manager, TfGM and Chris Fielding: Metrolink Engineering Manager, Keolis Amey Metrolink with their presentation exploring Risks and Collaboration based upon their experiences renewing Metrolink infrastructure in Manchester. Following on from Marilena, Pete and Chris reinforced the need for long term planning to enable renewal of the infrastructure. Activities including developing a detailed work bank, building partnerships with suppliers to deliver renewals with a focus on prioritising what needs doing. The presentation then focused on their experiences with regard to rail breaks and the significant challenges related to those occurring in embedded rail, including the need to excavate materials to get improved welding kits in place. The presentation went on to share their rail defect inspection experience using ultrasonic inspection adapted for embedded rails and how early identification helps with planning and reduction in service. All of which requires collaboration today and going forward.



Next up was Craig O'Brien: Head of Engineering Safety & Innovation, LRSSB promoting the case for adopting innovation and technology. Craig listed recent and ongoing innovation forms in light rail such as technological advancements, business models and organisational processes. A wide range of recent successes were highlighted including; speed management, inattention devices, trap and drag solutions, collision avoidance and improvements to reduce risks at user crossings. Craig introduced several global case studies, the lessons learnt and



challenged audience to consider these in future projects. In 2025 £1m will be invested by Light Rail Safety and Standards into the light rail sector across 9 themes.

The final talk of the afternoon session was delivered by someone who needs no introduction to the mainline rail network but was invited to share his experiences with those managing rail breaks in Tram and Light Rail networks. Brian Whitney: Technical Expert, Network Rail presented Network Rail's Broken Rail Journey. Whilst rail breaks are nothing new, the journey to target the reduction of rail breaks challenge followed the accident on the 17 October 2000 at Hatfield, Brian pointed out that unfortunately track rarely fails safe. Brian's broken rail per annum bar chart updated to include 2024 as far as is to date shows how the rate of rail breaks year on year has reduced with focus on inspection and removal of rail defects. Brian explained that early wins included classification of rail breaks onto a national system, this being followed by many campaigns over almost 25 years. Most notable is the introduction of inspection methods which Brian explained automated visual inspection technology is now picking up defects at the same rate as ultrasonic inspection, so two chances of picking up the defects going forward.

The afternoon session was brought to a close by Susanne, with a thank you to all those who made and supported this event including the event Sponsors; VolkerRail, Voestalpine and Getzner and those from the Nottingham and Derby Section especially to Dermot Kelly and the event hosts. Finally, Susanne thanked all the seminar delegates for attending and wishing them all a safe trip home.

But that wasn't all...

The following day Nottingham Tram opened up their Wilkinson Street depot to those who attended the seminar to take a look around the depot and all that happens to ensure the network

operates reliably and safely. The tour included a walk around the site including a tour of the Operations room with a detailed explanation of the network and how various systems provide visibility of operations across the whole network. The volume of information and speed of access is truly impressive. The tour also included a walk-through of the site explaining a typical day

AUTOMATED VISUAL INSPECTION TECHNOLOGY IS NOW PICKING UP DEFECTS AT THE SAME RATE AS ULTRASONIC INSPECTION...

operating the network with normal tram operation and how infrastructure and rolling stock maintenance is planned around that to ensure safe and reliable operation whilst allowing time to get in a keep the asset well maintained. Thank you to the team at Nottingham Tram for being so welcoming, taking time from their normal day to day roles to provide a brief but complete view of their working lives at the tram.

For me I then popped onto the Tram and enjoyed a trip into Nottingham City centre and reflected on a successful Seminar and Technical Visit. Until the next event...

All the presentations from the seminar are available on the PWI's Knowledge Hub.



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THE PWI



PWI TECHNICAL SEMINAR

ELECTRIFICATION AND INNOVATION: RAIL'S PATH TO DECARBONISATION

2 JULY 2025

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 and understanding of water management across rail infrastructure.

£97 MEMBER
£177 NON-MEMBER
£20 STUDENTS

Sponsorship and exhibition spaces available.
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SCAN TO BOOK





Rafael Kamalov completed his Ph.D. in Civil Engineering in 2021 at the University of Birmingham, focusing on railway subgrade stability within the Birmingham Centre for Railway Research and Education.

His research addressed foundational challenges in subgrade resilience, significantly enhancing the understanding of railway infrastructure performance. Rafael also holds an MSc in Geotechnical Engineering and has worked as an Engineer at Atkins, where he worked on major infrastructure projects, including HS2. His interdisciplinary expertise combines rigorous academic research with practical engineering applications, making him well-equipped to contribute to advancing the field of civil engineering.

Gurmel Ghataora (PhD, MIMMM) has over 50 years of experience in Civil and Geotechnical engineering. He worked with a ground investigation contractor and Arup for eight years before joining the University of Birmingham in 1990.

He retired in 2021 as Associate Professor and started his own company (Geo G Ltd) providing research project and research student support. His research interests included geotechnics of railway track, ground improvement and use of waste/marginal materials in construction, particularly in rural roads in developing countries. He has worked on numerous research projects and supervised 60 PhD students and has published 175 papers and co-authored 5 books.

EFFECT OF UNDER SLEEPER PADS ON RAILWAY TRACK SUBGRADE



INTRODUCTION

Under sleeper pads (USPs) have been used under concrete sleepers since the 1980s. Their main function is to increase the contact area between the sleeper and ballast (Getzner, 2014, Ghataora, and Burrow, 2016) thereby mitigating the pressure between the ballast and the concrete sleepers at the interface. Other benefits include a reduction in inter-particle abrasion and sleeper-ballast attrition (Müller-Boruttau et al., 2001, Schneider et al., 2011), improved stability (Lakušić et al., 2010), reduced vibration (Müller-Boruttau et al., 2004) and Piaxao et al., 2015) and they help to reduce the impact of change in stiffness at transition zones (UIC, 2019).

There are, however, few, if any, studies that investigated the effect of USPs on the subgrade soil. The study reported herein, based on laboratory experimental work, considers the effect of USP on the deformation of the track in both wet and dry conditions for four types of clayey subgrade. In particular, the study focused on the erodibility of the subgrade, which can lead to the development of wet beds (also known as ballast fouling). It was found that the benefits achieved depended on the consistency of the subgrade soil.

BACKGROUND

Clayey subgrade soil erosion of clay and its migration into the overlying layers can take place under certain conditions, particularly poor drainage (Selig and Waters, 1994; Alobaidi and Hoare, 1996; Ghataora, 2006; Duong et al. 2014). Instances of fines migration into the ballast have been observed at locations with imperfections in the rail running surface and at rail joints, where dynamic load from train wheel impacts can be substantial (Ghataora, 2005; Ghataora et al., 2006; Rushton & Ghataora, 2009; Nguyen et al., 2019). The presence of clayey fines in the ballast leads to its inability of the ballast to provide adequate support to the track (Takatoshi, 1997, Ghataora and Burrow, 2010, Liu et al. 2013; Hudson et al., 2016; Nguen and Indraratna, 2019). Numerous solutions for this problem include the use of geotextiles/geotextile composites Alobaidi (1994, 1996, and 1998); Indraratna et al. (2010); Chawla and Shahu (2016); Ghataora and Burrow (2014, 2016 and 2018), sand blanket (Selig and Waters, 1994), asphalt overlay (on subgrade) Ito (1984), cement stabilization of subgrade amongst others.

The use of sand blankets and sub-ballast in addition to its action as a filter layer helps to reduce dynamic stress at the subgrade level and hence reduce the development of erosion (Selig & Waters, 1994). The asphalt layer serves as a separation barrier, further diminishing dynamic loading at the subgrade level to some extent, while also potentially sealing the subgrade surface from rainwater (Ito, 1984). However, this impermeable seal may pose challenges if it results in the accumulation of porewater pressure in the underlying subgrade (Ghataora & Burrow, 2010). The utilization of USP, is engineered to alleviate stress in the uppermost layer of ballast at the ballast/concrete interface and to dampen vibrations, consequently reducing dynamic stress at the subgrade level (Müller-Boruttau et al., 2001). Using USP results in reduction in the ballast sleeper contact stresses which reduces the deterioration of both the ballast and sleepers. (Lundqvist et al., 2006; Johansson et al., 2008; Dahlberg, 2010; Schneider, 2011). Abadi et. al. (2019) show the use of USPs may reduce the requirement for track maintenance and hence improve whole life costs.

Although the benefits of USPs have been reported over the last 20 years and are used in railways, there is limited, if any, information about the effect of USPs on the subgrade. There is no available information on the effect of USPs on the development of pore water pressure, which is the main factor in the creation of the mud-pumping phenomenon (Alobaidi and Hoare 1994; Selig and Waters, 1994; Ghataora, 2006, Duong et al., 2014). The study reported herein considered the behaviour of the subgrade-subbase system with and without USP through a laboratory-based experimental investigation. In particular, the focus of the study was on investigating the behaviour in terms of permanent deformation, stiffness, subgrade erosion, and the development of pore water pressure.

METHODOLOGY

Materials - Subgrade soil

Some types of fine-grained, clayey subgrade soils in a railway track, under certain conditions, can liquefy and erode. Four medium to high plasticity soils, namely, London clay (LC), Etruria marl (EM), and two manufactured soils: English China clay (CC) and a mixture of English China clay and Bentonite (CCB) were tested at a range of moisture contents, namely 80%, 100% and 120%, of optimum moisture content (OMC). Berkbent 163 Bentonite was used to modify the China clay to form the CCB. Atterberg limits, particle size analysis, specific gravity, compressibility and permeability were determined in accordance with BS 1377-2:1990 and results are listed in **Table 1**.

Soil	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	Maximum dry density (Mg/m³)	Optimum moisture content (%)	Specific gravity	c _v (mm²/min)	m _v (m²/MN)	K (m/s)
Etruria marl	48	18	30	1.89	17	2.54	19.4	0.71	2.2*10 ⁻⁹
London clay	60	25	35	1.68	21	2.41	13.2	0.79	1.55*10 ⁻⁹
China clay	55	27	28	1.53	30	2.35	27.2	1.13	7.65*10 ⁻⁹
China clay plus 5% bentonite	63	30	33	1.51	32	2.32	24.6	1.04	5.71*10 ⁻⁹

Table 1: Summary of properties of subgrade soils

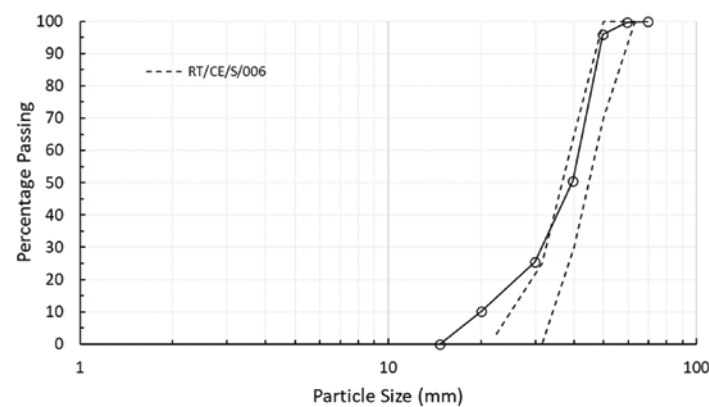


Figure 1: Particle Size Distribution of ballast.

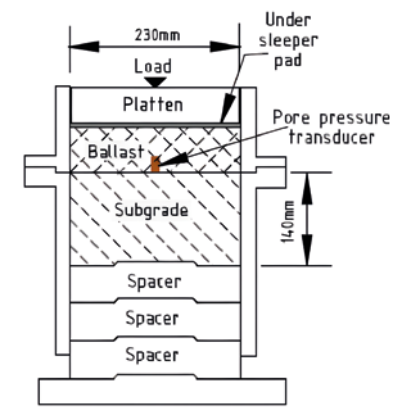


Figure 2: Cross-section of the Terram cell layout with USP.



Figure 3: Set up of the Terram cell in the load frame.

MATERIALS - BALLAST

The selected ballast material used in this research was in the range of the industry requirements provided by Network Rail Standard (RT/CE/S/006, 2019), with approximately 70% falling within the 32-50mm size range. (See **Figure 1**).

MATERIALS - UNDER SLEEPER PAD (USP)

The USPs used in this study were provided by Getzner Werkstoffe, GmbH and identified as SLB 3007. The static bedding modulus of the USP was 0.36 N/mm³ and the static spring stiffness was 70 MN/m when applied to half the bottom surface area of the sleeper.

TEST APPARATUS AND PROCEDURE

The apparatus used for this study was the Terram cell, described by Ghataora (2006). Its development was based on previous studies on the erosion of subgrade soils in roads and railway tracks at the University of Birmingham, UK (Hoare, 1982; Alobaidi and Hoare 1994; 1996, Hoare, Alobaidi and Ghataora, 1995). The Terram cell was built and supplied by Terram Ltd. UK.

The test cell comprises two 230mm (id) steel tubes with flanges such that the two parts can be clamped together. The lower cylinder had a base plate and spacers. The latter were used to adjust the thickness of the subgrade soil. The Terram cell was developed to assess the migration of fines through a geocomposite placed on the subgrade. A 75mm thick layer of ballast was placed directly on the subgrade. The load platen was either directly on the ballast or on the USP

which was placed on the ballast as shown in the cross-section of the apparatus in **Figure 2**. In some tests pore water pressure developed under the ballast was measured by installing a fluid-filled tube in a ballast rock and connecting it to a transducer. The position of the pore water pressure measurement is also shown in **Figure 2**.

The test cell was placed in a 50 kN load frame and the cyclic load was applied at 3 Hz to give minimum and maximum pressures of 0.6 kPa and 128 kPa respectively at the top of the subgrade. The arrangement of the cell setup is shown in **Figure 3**.

Subgrade soils at 80% Optimum Moisture Content (OMC), 100% OMC, and 120% OMC were compacted at Maximum Dry Density (MDD) to a depth of 140mm on the spacers (see cross-section layout, Figure 2). Four test types were conducted: ballast/subgrade; ballast/subgrade/water; ballast/subgrade/USP; and ballast/subgrade/water/USP. Water was added in two tests to simulate lack of drainage. In such tests, 500ml water was added before the application of cyclic load in accordance with the procedure developed by Ghataora (2006). The setup procedure is shown in **Figure 4 (a) to (d)**.

Load was applied in steps of 50,000 cycles up to a total of approximately 200,000 cycles. Upon completion of the test, the ballast and the USP (where used) were removed, and all the slurry was collected and oven-dried to quantify the amount of subgrade material eroded (i.e., slurried). The strength of the subgrade soil immediately under the slurry was measured using a hand vane in accordance with BS 1377-2:1990. Additionally, the moisture content of the upper layer of the subgrade was determined.

Test designations follow a specific format: dry tests on each clay type have a suffix "bs" (e.g., CC-bs for China clay/ballast/subgrade),



Figure 4: Key stages of the test setup.

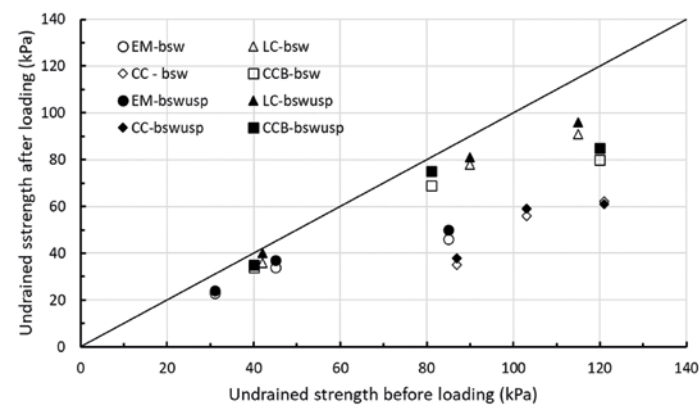


Figure 5: Comparison of strength of subgrade with water added, both with and without USP before and after application of 200,000 load cycles.

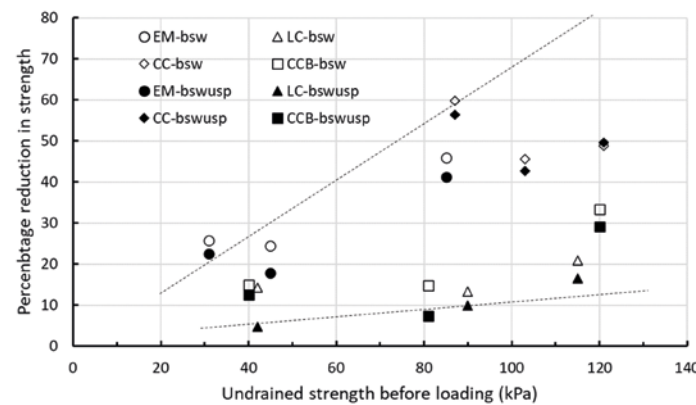


Figure 6: Percentage reduction in strength after loading relative to initial strength with and without USP.

while wet tests have a suffix “bsw” (e.g., CC-bsw for China clay/ballast/subgrade/wet test). For tests conducted with USP, “usp” is added to the suffix (e.g., CC-bswusp for China clay/USP/ballast/subgrade/wet test).

RESULTS

Ballast/sleeper contact area

Prior to investigating the effect of USP on the subgrade, the contact area between ballast and sleeper with and without USP was studied using the Terram cell described in the ‘Test Apparatus and Procedure’ section above. To study the contact between the sleeper and the ballast a sheet of paper was attached to the bottom of the steel load platen and the top of the ballast particles were coated with ink. The cell was assembled, and 250,000 load cycles were applied, as suggested by Ghataora and Burrow, (2016). The paper was removed, and impressions of ballast on the paper measured as the contact area. The procedure was repeated with USP instead of paper. At the end of the tests, the areas of impressions of ballast in USP were measured.

The contact area between the sleeper and ballast was found to be about 1.8% (expressed as a proportion of load plate area), which aligned closely with the findings of Ghataora and Burrow, (2016), who reported values ranging from 1 to 1.5%. Potocan and Dorfner, (2013) noted that the contact area between ballast and sleeper may be 3 to 5%, whereas Abadi et al. (2015) demonstrated ballast/sleeper contact area of less than 1%. Thus, although the ballast used in this study was slightly finer than the Network Rail specifications, the results were considered reasonable. Based on the small areas contact stresses may increase by up to 100 times (up to 10MPa) greater than that based on uniform contact. Using the USP, contact area increased to about 29%. Sol-Sanchez et al., (2014) stated that the contact area may increase by up to 35% depending on the stiffness of the under-sleeper pad. Ghataora and Burrow (2016) and Getzner (2021) have shown that the contact area may be increased to between 20 to 30%.

Bearing in mind that the stiffness of the USPs used by the various researchers may differ, the contact area results of this work were in line with other researchers’ findings. Therefore, it was deemed that the test results of this study would give a reasonable indication of the of clay subgrade behaviour of the effect of using USP at the sleeper/ ballast interface.

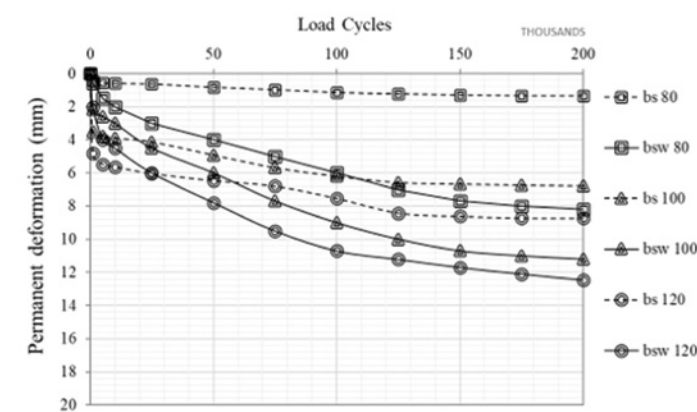
SUBGRADE STRENGTH

The strength of the upper 10 mm of the subgrade was measured using a hand penetrometer before and after applying 200,000 load cycles, for all the wet tests. A comparison of strengths of subgrade (with water added) both with and without USP before and after application of 200,000 load cycles are shown in **Figure 5** and percentages of reduction in strength after loading relative to initial strengths are shown in **Figure 6**. Results show (**Figures 5** and **6**) that reduction in strength is greater for stiffer clays. Although there may be a trend line expressing the behaviour of each clay type, the available data do not allow for the establishment of a general relationship for all clay types. Nevertheless, the data suggest that, in general, there is a slightly lesser reduction in strength with the use of USP.

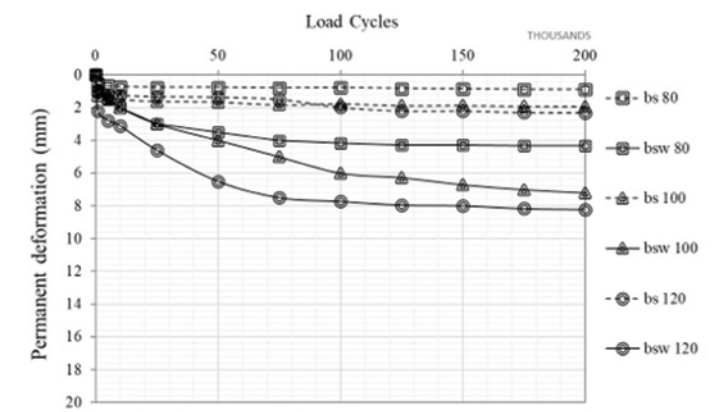
DEFORMATION - EFFECT OF WATER ON SUBGRADE

The focus of the study was primarily on investigating the long-term impact of USP on subgrade, and hence, only permanent deformation is discussed herein. Cyclic deformation was used to assess the stability of the tests. In all cases, this was not an issue.

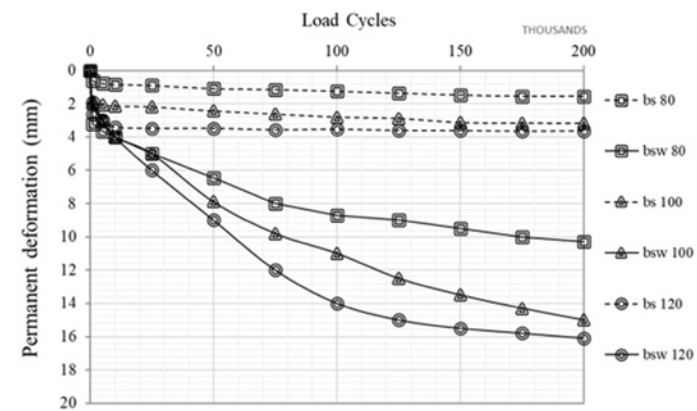
The deformation trends observed were consistent across all soil types, demonstrating initial high deformation levels during the early loading stages, up to approximately 50,000 cycles.



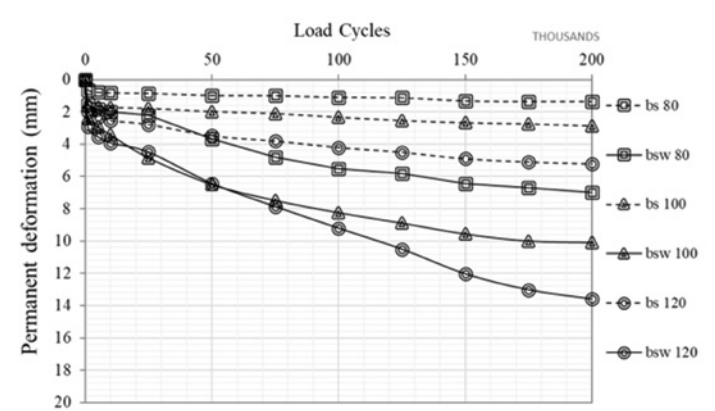
(a) Etruria marl (EM).



(b) London clay (LC).

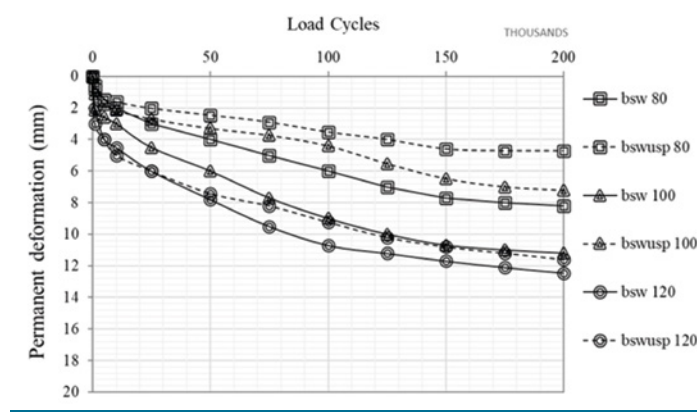


(c) China clay (CC).

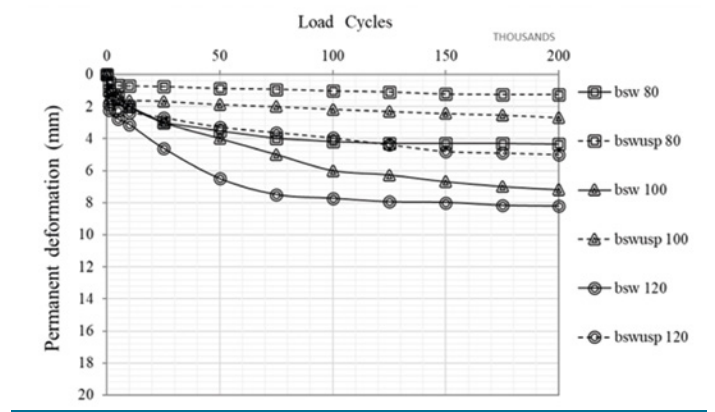


(d) China clay with bentonite (CCB).

Figure 7: Effect of free-standing water on permanent deformation subgrades with and without standing water.



(a) Etruria marl (EM).



(b) London clay (LC).

Figure 8: Relationship of permanent deformation and compaction moisture content for subgrade with standing water and both with and without USP.

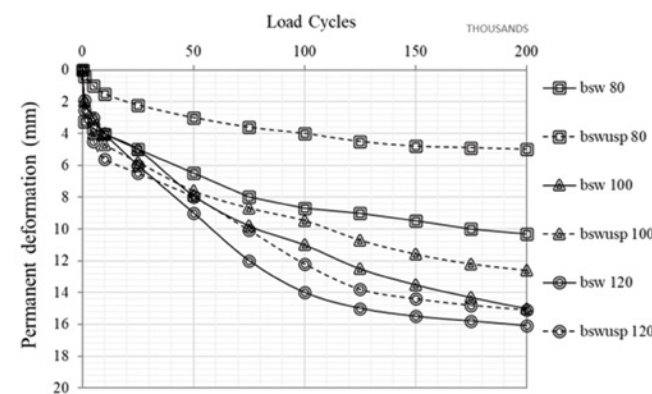
As the number of load cycles increases, the rate of deformation generally decreases. Across all soil types, the subgrade subjected to water infiltration consistently displayed up to approximately four times greater deformation compared to the dry subgrade, regardless of their initial moisture content. This trend persisted over the entire loading range examined, encompassing 200,000 cycles, as depicted in **Figure 7**. In addition to this change in settlement generally continues for a much greater period of loading for inundated subgrade. This behaviour is expected as soils become softer with time when inundated with water and the rate of softening depends on their plasticity. The findings are in general agreement with those of Alobaidi and Hoare (1994) and Li and Selig (1995).

This trend was as expected, and the tendency was the same with and without USPs. All subgrades without USP and with initial moisture content of OMC 120% showed a large permanent deformation with

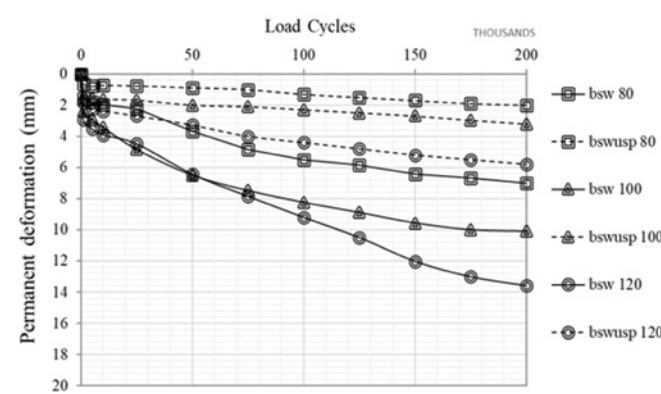
both CC-bsw120 and CCB-bsw120 exhibiting the largest deformation of 16 mm and 14 mm respectively. All four soils tested with USP deformed less and did not exceed values observed without USP, see **Figure 8**. The most significant reduction in permanent deformation was observed with the CCB-bsw which showed a change from 14mm to 6mm (with USP). However, EM and CC showed the least reduction at high moisture contents of 120%. This reduction is considered to be due to the reduction of stress due to dynamic loading at the subgrade level as the USP reduces the impact from repeated loading.

DEFORMATION OF SUBGRADE AND SUBGRADE SOIL TYPE

Figures 9, 10, and 11 show the permanent deformation of subgrade soils for each compaction moisture content (80, 100, and 120% OMC). Across all moisture contents, China clay consistently displayed the



(c) China clay (CC).



(d) China clay with bentonite (CCB).

Figure 8: Relationship of permanent deformation and compaction moisture content for subgrade with standing water and both with and without USP.

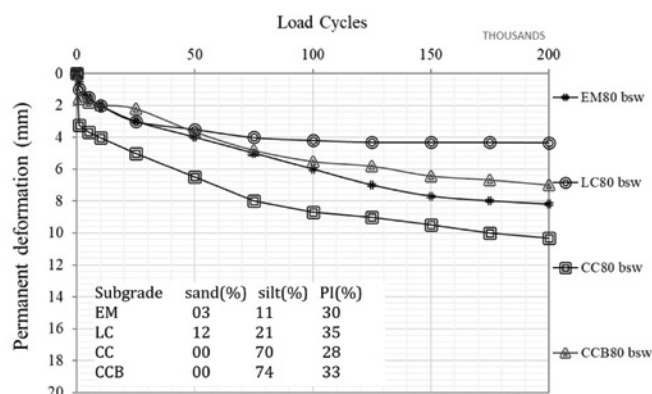


Figure 9: Comparison of permanent deformation and the effect of soil type, OMC 80%.

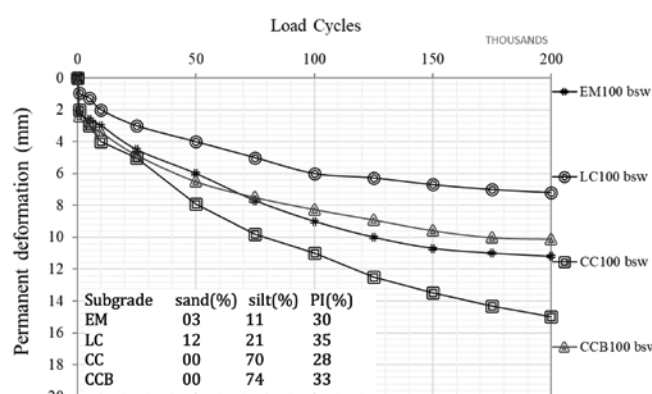


Figure 10: Comparison of permanent deformation and the effect of soil type, OMC 100%.

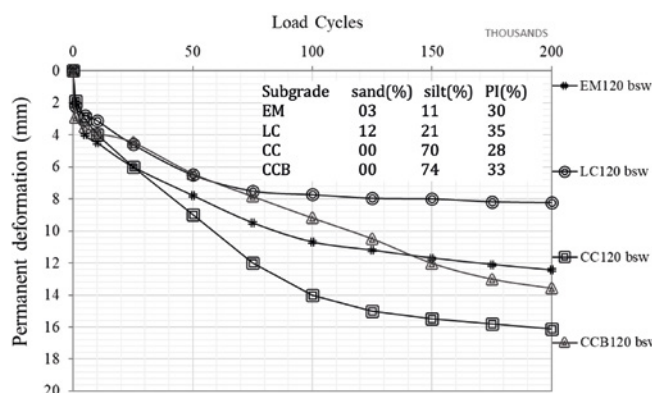


Figure 11: Comparison of permanent deformation and the effect of soil type, OMC 120%.

PORE WATER PRESSURE

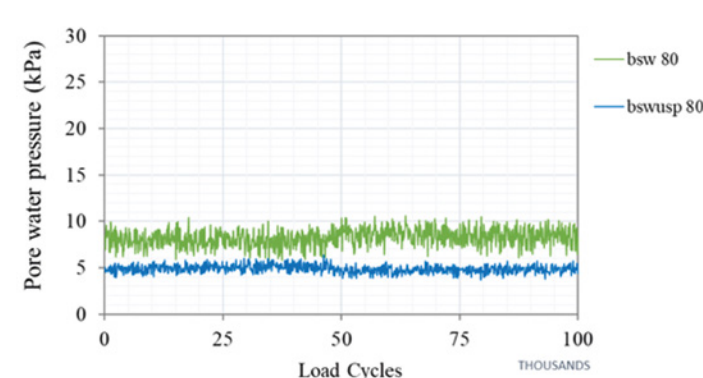
Development of pore water pressure due to repeated loading is one of the main reasons of the migration of fine particles and mud pumping phenomenon (Alobaidi and Hoare 1996, 1998; Ghataora et al. 2006; Trinh et al. 2012; Duong et al. 2014, Chawla 2016). Therefore, it was deemed important to measure the dynamic pore water pressure to assess the effect of USPs.

Results of pore water pressure in the subgrade immediately under the ballast for the four soils, with and without USP, compacted at three moisture contents are shown in **Figures 12, 13, and 14**. Generally, for all the soils at 80%OMC and 100%OMC, pore water pressure tended to remain steady throughout the test without USP, but for 120% OMC it tended to increase with number of load cycles. Also, lower pore water pressures, were observed (by as much as 50% with some soils) where USPs were used. Lowest pore water pressures were noted in all the soils compacted at 80% OMC. The pore water pressure attenuating effect of the USP was largest for subgrade soils compacted at a moisture content of 120% OMC for both CC and CCB.

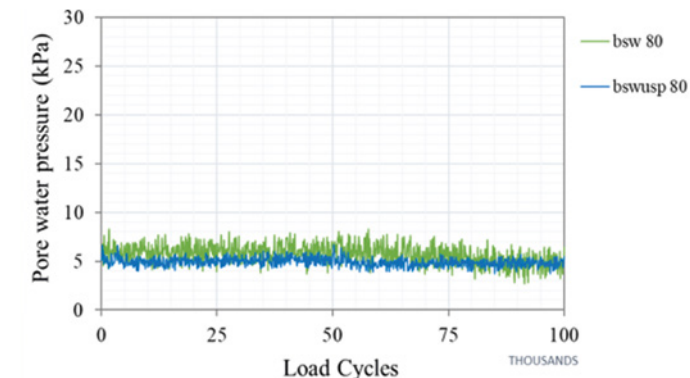
In terms of erosion, it is important to note that although the pore water pressure generated was less than about 18 kPa (maximum) it was enough to reduce the effective shear strength of subgrade at or near the surface to cause particle detachment and form slurry i.e., result in erosion. Since the use of USP reduced pore water pressure developed, it may help to reduce erosion of soil due to cyclic loading.

RELATIONSHIP BETWEEN LIQUIDITY INDEX AND DEFORMATION UNDER CYCLIC LOADING

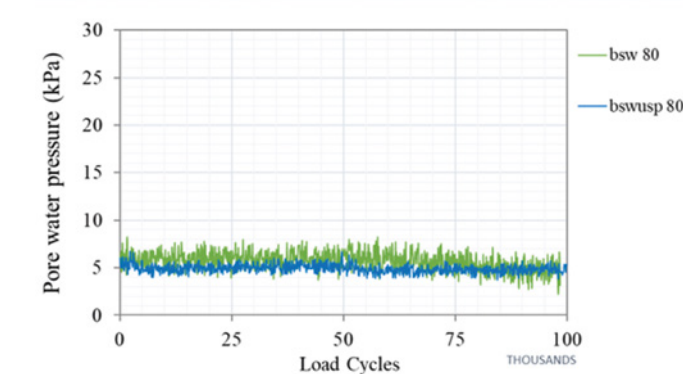
The undrained strength of clays is related to the Liquidity index (Vardanega and Haigh, 2014). Generally, as the soil Liquidity index is reduced to 1, its strength tends to be in the region of 1 to 1.7 kPa and



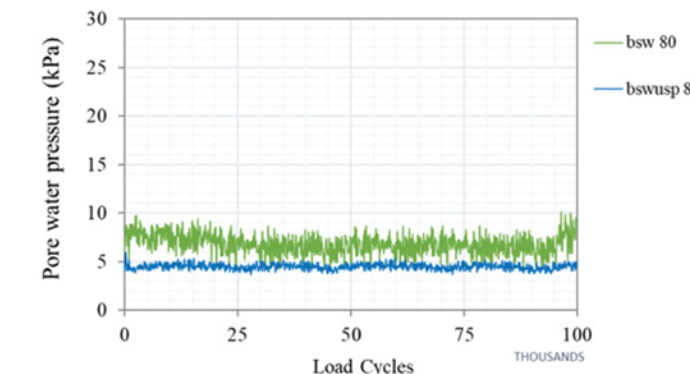
(a) Etruria marl (EM).



(b) London clay (LC).

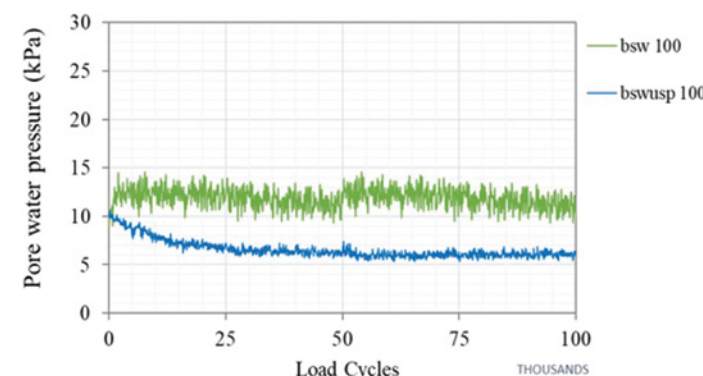


(c) China clay (CC).

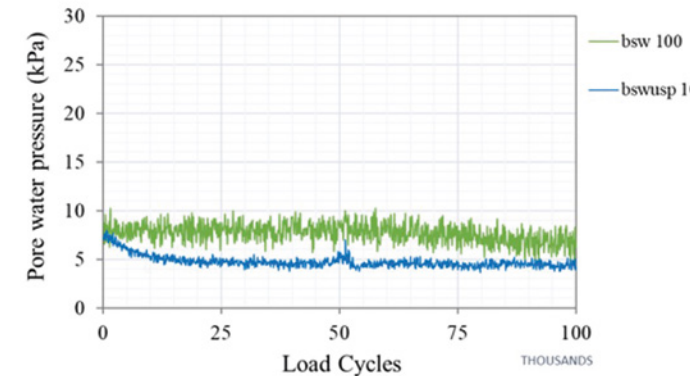


(d) China clay with bentonite (CCB).

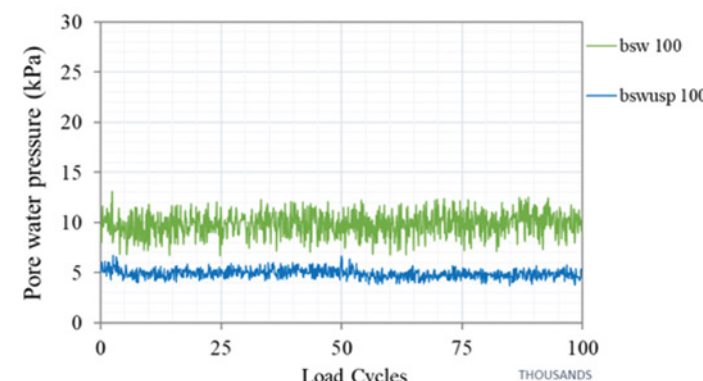
Figure 12: Development of pore water pressure – subgrade at 80% OMC.



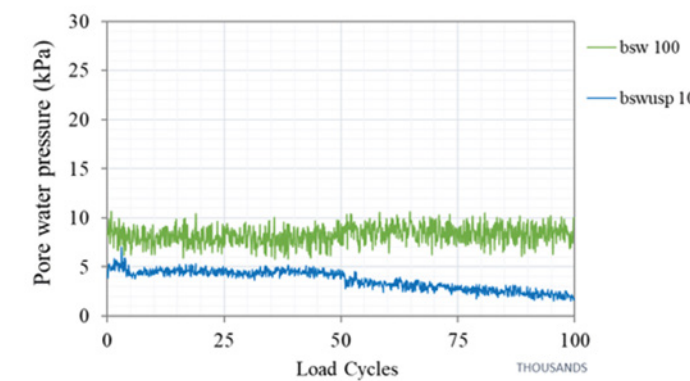
(a) Etruria marl (EM).



(b) London clay (LC).



(c) China clay (CC).



(d) China clay with bentonite (CCB).

Figure 13: Development of pore water pressure, 100% OMC.

highest permanent deformation, while London clay exhibited the least susceptibility to deformation. Etruria marl (EM) exhibited intermediate settlement patterns, showing trends similar to those of China clay but with lesser magnitude.

London clay at 80% OMC, with an initial shear strength of 115 kPa, showed the least deformation, and China clay (initial strength (120kPa) exhibited the highest permanent deformation. These results were expected, as the undrained shear strength before and after the test reduced by about 21% and 50% respectively. The results also showed that with an increase in initial moisture content (100% OMC to 120% OMC) the permanent deformation increased by approximately 15-20%. These findings are in general agreement with Alobaidi and Hoare (1996) and Duong et al., (2014).

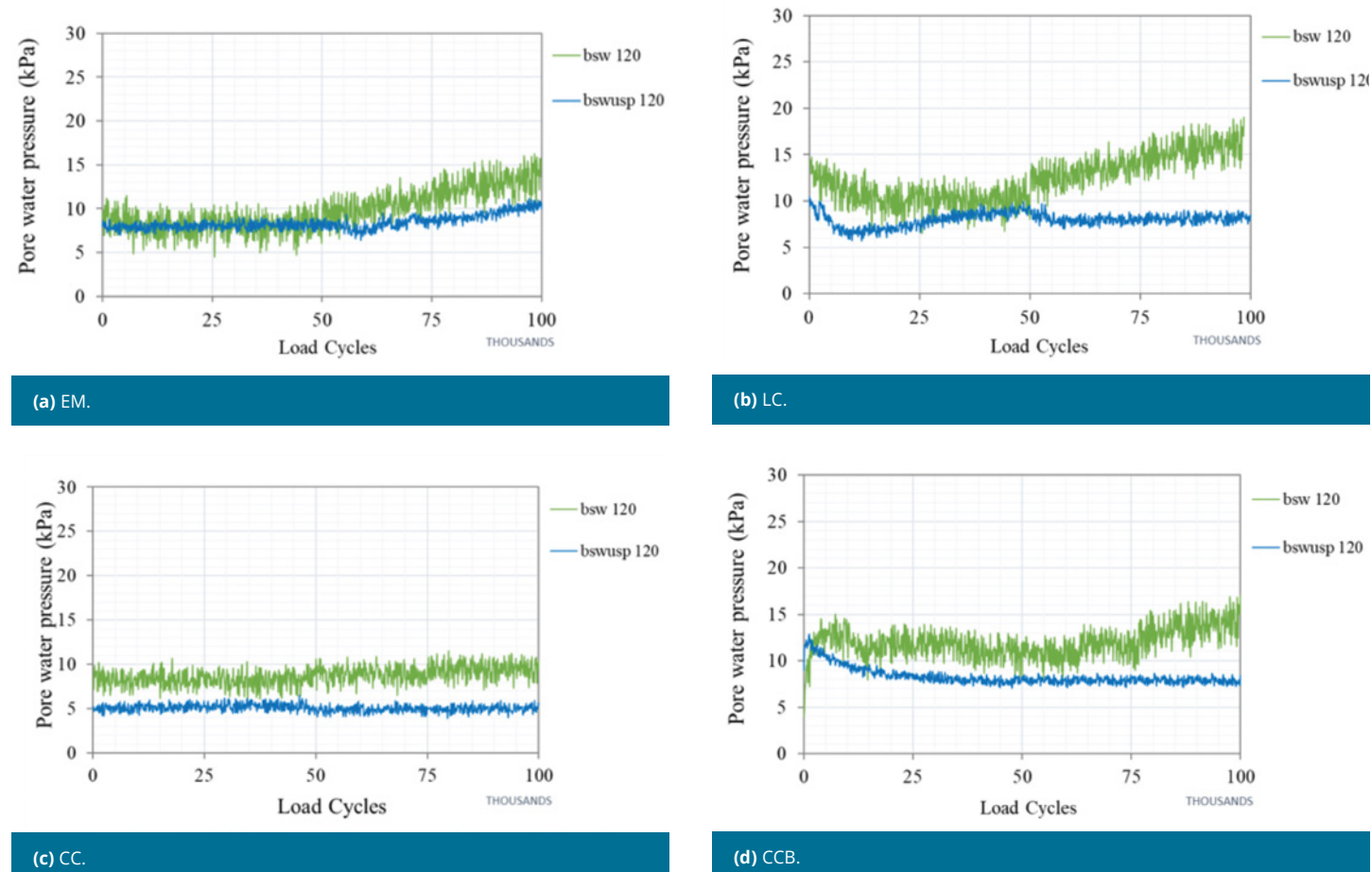


Figure 14: Development of pore water pressure, 120% OMC.

when Liquidity index is zero strength is about 100 kPa. This general trend of change in strength was observed for all the soils as can be seen in **Figure 15**. In order to identify strengths beyond which USP is more effective permanent deformation/Liquidity index relationship for all the soils was examined as shown in **Figure 16**. Results suggest that although USP has some benefit in terms of reduction in deformation for all moisture contents, a more significant effect seems to occur for Liquidity index values less than 0.1 equivalent to a strength of about 60 kPa. Liquidity index of about 0.1 also corresponds with a point beyond which (i.e., Liquidity index >0.1) significant increase in erosion as can be seen in **Figure 17**.

RELATIONSHIP OF LIQUIDITY INDEX AND ERODED SOIL

Alobaidi and Hoare (1996) suggested that the quantity of eroded subgrade soil rises with an increase in its moisture content, a notion also supported by Selig and Waters (1994). The findings from this investigation align with this pattern. As depicted in **Figure 17**, the amount of eroded soil increases proportionally with the rise in the Liquidity index determined at the as-placed moisture content. This trend indicates that the rate of increase in eroded soil is higher in the case of subgrade soil without USP. Under similar conditions, USP demonstrates a reduction in the erodibility of the subgrade soil as the moisture content of the subgrade increases beyond the Plastic Limit. The increase becomes very significant with moisture content increases with Liquidity index for values greater than about 0.1.

The increase in erosion of soil between the stronger and weaker subgrades corresponds with the findings of Ghataora (2006); Duong (2014); and Chawla (2016).

EFFECT OF USP ON SOILS STIFFNESS

The effect of USP is depicted in terms of stiffness and Liquidity index in **Figure 18**. It confirms that USPs reduce the stiffness of the track

only when the subgrade soils are firm or stronger, with a strength greater than about 60 kPa (Liquidity index > about 0.1). At lower strengths, subgrade soils deform more readily compared to USP, and the use of the latter in the track does not exhibit any significant effect.

CONCLUSIONS

The effect of USP (SLB 3007 supplied by Getzner Werkstoffe) on the four clay subgrade soils (Etruria marl, London clay, China clay (Kaolin) and China clay with 5% Bentonite) was investigated through a laboratory experimental study simulating railway ballast and subgrade system, subjected to 200,000 load cycles, in a test cell. The key aim was to assess the effect of USP on erosion of subgrade placed at 80% OMC, OMC and 120% OMC when the subgrade was inundated with water.

THUS, THE OVERALL CONCLUSION FOR THE FOUR SUBGRADE SOILS AT THE COMPACTED DENSITIES EXAMINED IS THAT USP CAN HELP TO REDUCE EROSION OF SUBGRADE SOILS AND MAY HAVE OTHER BENEFITS SUCH AS POSSIBLE REDUCTION IS LONG-TERM DEFORMATION

The key findings of the study are as follows:

- the small-scale laboratory tests showed that the use of USP resulted in an increase in ballast/subgrade area from approximately 1.8% to about 29% which is similar to other researchers' findings;
- the use of USP resulted in a lesser reduction in strength with the number of load cycles in all cases compared to scenarios without USP;
- permanent deformation of the soil/ballast system was reduced across all soil types and moisture contents with the use of USP;

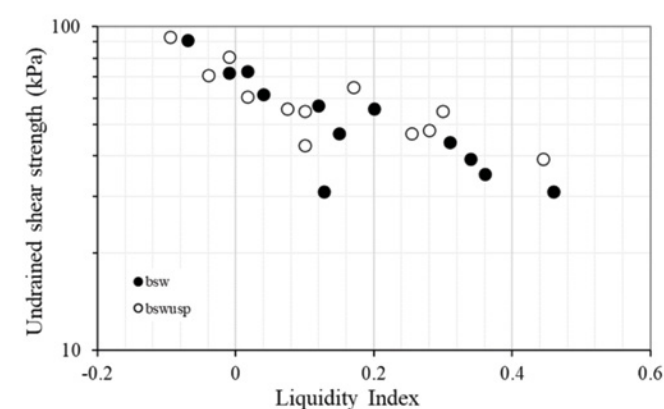


Figure 15: Relationship of shear strength and Liquidity index.

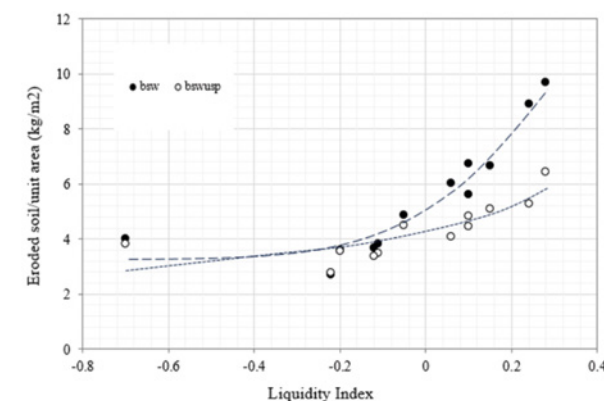


Figure 17: Relationship of Liquidity index (at the as-placed moisture content) and eroded soil at the end of the test.

- USP led to a decrease in pore water pressure development across all test cases;
- a general trend of increase in soil erosion with an increase in the initial moisture content of the soils examined was observed. USP reduced erosion at all moisture contents greater than the plastic limit as the moisture increased, the benefit increased.
- there was a reduction in stiffness with USB only when the subgrade soils had strengths greater than about 60 kPa.

Thus, the overall conclusion for the four subgrade soils at the compacted densities examined is that USP can help to reduce erosion of subgrade soils and may have other benefits such as possible reduction is long-term deformation, provided the strength of the soils is greater than about 60 kPa.

ACKNOWLEDGEMENTS

The authors are grateful to The Global Education Programme and the School of Civil Engineering, at the University of Birmingham for financial support. The researchers are also very grateful to Mr. Peter Musgrave and Dr Mohamed Wehbi, both previously of Network Rail. Lastly, authors are grateful to Getzner Werkstoffe, GmbH for supplying the under sleeper pads.

REFERENCES

- Abadi T., Le Pen L., Zervos A. and Powrie W., 2015. The effect of sleeper interventions on railway track performance. *ASCE Journal of Geotechnical and Geoenvironmental Engineering* 145(4), 1-14. [04019009]. DOI: 10.1061/(ASCE)GT.1943-5606.0002022.
- Abadi T., Le Pen L., Zervos A. and Powrie W., 2015. *The International Journal of Railway Technology* 4(2), pp.45-72. doi:10.4203/ijrt.4.2.

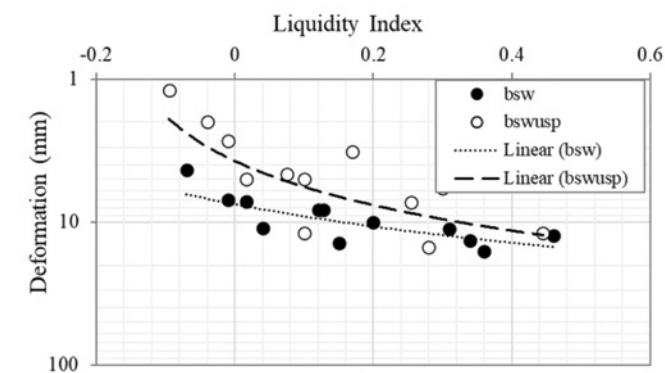


Figure 16: Relationship of Liquidity index and subgrade permanent deformation.

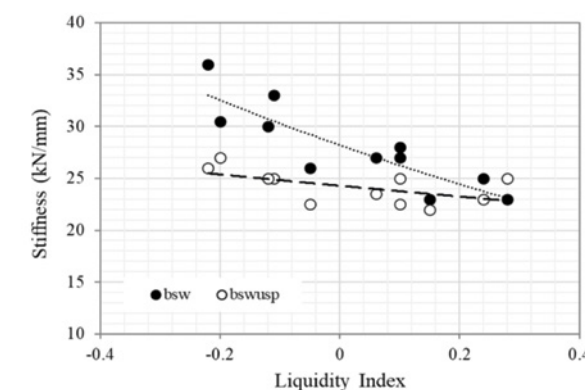


Figure 18: Relationship of Liquidity index (at the as-placed moisture content) and stiffness of subgrade.

Alobaidi, I. and Hoare, D. 1994. Factors affecting the pumping of fines at the subgrade-subbase interface of highway pavements: A laboratory study. *Geosynthetics International*, 1(2), pp.221-259.

Alobaidi, I. and Hoare, D., 1996. The development of pore water pressure at the subgrade-subbase interface of highway pavement and its effect on pumping of fines. *Geotextiles and Geomembranes*, 14, pp.111-135.

Alobaidi, I. and Hoare, D.J. 1998. Quantitative criteria for anti-mud pumping geocomposites. *Geotextiles and Geomembranes*, 16, pp.221-245.

British Standards Institution, 1990. *BS ISO 1377-1-7:1990 Methods of test for soils for civil engineering purposes - Part 1-7: Shear strength tests (total stress)*. London: BSI.

British Standards Institution, 2009. *BS ISO 11277:2009, Soil quality. Determination of particle size distribution in mineral soil material. Method by sieving and sedimentation*. London: BSI.

Chawla, S. and Shahu, J.T., 2016. Reinforcement and mud-pumping benefits of geosynthetics in railway tracks: Model tests. *Geotextiles and Geomembranes*, 44(3), pp.366-380.

Dahlberg, T., 2010. Railway track stiffness variations-consequences and countermeasures. *International journal of civil engineering*, 8(1), 1-12.

Duong, T.V., Tang, A.M., Cui, Y.J., Trinh V.N., Dupla J-C., Calon N., Canou J. and Alain R., 2013. Effects of fines and water contents on the mechanical behaviour of interlayer soil in ancient railway sub-structure. *Soils and Foundations*, 53(6), pp.868-878.

Duong, T.V., Cui, Y.J., Tang, A.M., et al., 2014. Investigating the mud pumping and interlayer creation phenomena in railway sub-structure. *Engineering Geology*, 171, pp.45-58.

Hoare D., Alobaidi I. and Ghataora G. S., 1995. Anti pumping composite patent application PCT/GB94/01603.

Getzner 2021. Under sleeper pads for railway track. Getzner Werkstoffe GmbH. [Brochure%20Under%20Sleeper%20Pads%20for%20Ballasted%20Track%20EN.pdf] – viewed December 2021.

Ghataora, G.S., 2005. Development of wet spots on railway track. University of Birmingham, Birmingham, UK. *Unpublished report*.

Ghataora, G.S., Burns, B. and Burrow, M.P.N., 2006. Development of an index test for assessing anti-mud pumping materials in railway track foundations. University of Birmingham.

Ghataora, G.S. and Burrow, M.P.N., 2010. Large scale tests on geotextiles in railway track. University of Birmingham, Birmingham, UK. *Unpublished report*.

Ghataora, G. and Rushton, K., 2012. Movement of water through ballast and subballast for Dual-Line railway track. *Transportation Research Record: Journal of the Transportation Research Board*, 2289, pp.78-86.

Ghataora, and Burrow, 2016, Factual report on the effect of under sleeper pads on subgrade soils, report for Network Rail, University of Birmingham, Birmingham, UK. *Unpublished report*.

Hoare, D.J., 1982. A laboratory study into pumping clay through geotextiles under dynamic loading. In: *2nd International Conference on Geotextiles*, Las Vegas.

Hudson, A., Watson, G. Le-Pen L and Powrie W., 2016. Remediation of mud pumping on a ballasted railway track. *Procedia Engineering*, 143, pp.1043-1050. <https://doi.org/10.1016/j.proeng.2016.06.103>

Indraratna, B., Nimbalka, S. and Tennakoon, N., 2010. The behaviour of ballasted track foundations: Track drainage and geosynthetic reinforcement. In: *Geo-Florida*, American Society of Civil Engineers, pp.2378-2387.

Ito, T., 1984. Actual situation of mud pumping and its countermeasures. *Quarterly Reports of the Railway Technical Research Institute*, 25(4), pp.117-123.

Johansson, A., Nielsen, J.C.O., Bolmsvik, R., Karlström, A., and Lundén, R., 2008. Under sleeper pads-Influence on dynamic train-track interaction. *Wear*, 265(9-10), 1479-1487.

Lakušić, S., Ahac, M. And Haladin, I., 2010 Experimental investigation of railway track with under sleeper pad. 10th Slovenian Road and Transportation Congress, Portorož, Slovenia.

Li, D. and Selig, E.T., 1995. Evaluation of railway subgrade problems. *Transportation Research Record*, 1489, pp.17-25.

Liu, D., Fu, H., Zhu, X., Liu, Y. and Rao, J., 2013. Study on the remediation of mud pumping. *Applied Mechanics and Materials*, 275-277, pp.1560-1563.

Lundqvist, A., Larsson, R., and Dahlberg, T., 2006. Influence of railway track stiffness variations on wheel/rail contact force. Paper presented at the Track for High-Speed Railways, Porto, Portugal.

Müller-Boruttau, F.N., Rosenthal, V. and Breitsamter, N., 2001, Innovative ballasted track: concrete sleepers with sole pads, WCRR. Cologne, Germany, 2001

Muller-Boruttau, F., Rosenthal, V. and Breitsamter, N., 2004. Above ground low vibration emission ballasted track with concrete trough. *CFA/DAGA 04, Strasbourg, 22-25 March 2004*.

Nguyen, T.T., Indraratna, B., Kelly, R., Phan, N.M. and Haryono, F., 2019. Mud pumping under railtracks: mechanisms, assessments and solutions. *Australian Geomechanics Journal*.

Paixão, A., Ribeiro A. C. Pinto N.M.P., Fortunato, E. and Calçada R., 2015. On the use of under sleeper pads on transition zones at railway underpasses: experimental field testing; *Structure and Infrastructure Engineering*; 11(2); pp. 112-128

Potocan, S. and Dorfner, 2013. Under sleeper pads for life cycle management used in building sustainable high quality tracks. *Proceedings, 10th International Heavy Haul Association Conference*, New Delhi, India, February, Vol 1 pp 117-122.

Rushton, K.R. and Ghataora, G., 2009. Understanding and modelling drainage of railway ballast. *Proceedings of the Institution of Civil Engineers - Transport*, 162(4), pp.227-236.

Rushton, K. and Ghataora, G., 2014. Design for efficient drainage of railway track foundations. *Proceedings of the Institution of Civil Engineers - Transport*, 167(1), pp.3-14.

Schneider, P., Bolmsvik, R. and Nielsen, J.C.O., 2011. In situ performance of a ballasted railway track with under sleeper pads. *Proceedings of the Institution of Mechanical Engineers, Part F: Journal of Rail and Rapid Transit*, 225(3), pp.299-309.

Selig, E. and Waters, J., 1994. *Track Geotechnology and Substructure Management*. London: Thomas Telford.

Selig, E. and Waters, J., 2007. *Track Geotechnology and Substructure Management*. London: Thomas Telford.

Sol-Sánchez, M., Moreno-Navarro, F. and Rubio-Gámez, M. C., 2014. Viability of using end-of-life tire pads as under sleeper pads in railway, *Construction and Building Materials*, 64 (14) pp 150-156.

Takatoshi, I. 1997. Measure for the stabilization of railway earth structure. In: *Japan Railway Technical Service*. Tokyo.

Trinh, V.N., Tang, A.M., Cui, Y.J., et al., 2012. Mechanical characterisation of the fouled ballast in ancient railway track substructure by large-scale triaxial tests. *Soils and Foundations*.

Vardanega, P.J. and Haigh, S.K., 2014. The undrained strength–Liquidity index relationship. *Canadian Geotechnical Journal*, 51, pp.1073–1086.



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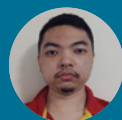




Wilson Ho
Founder of Wilson
Acoustics Limited and Jabez
Innovation Limited



Max Yiu
Design Engineer,
Jabez Innovation
Limited



Cheng Sheng Loong
Site Engineer,
Jabez Innovation
Limited

Wilson founded Wilson Acoustics Limited in 2005, and since 2012 it has grown to become the largest acoustic consulting company in Hong Kong.

He has developed several patented products, including SilentUP for easy-to-install and remove noise barrier up to 7m height, the Magnetic Tuned Mass Damper (MTMD) for noise control of pile driving and rock breaking, the Vertical Noise Reducer (VNR) for noise barrier with reduced wind load design, and Rigid Contact Tuned Mass Damper (RCTMD) for railway noise control. The RCTMD is the only rail damper proven to reduce corrugation growth by 90%. Recent laboratory test of a 6m long fastened rail also shows reduction in P2-resonance ground-borne noise.

Since 2011, Max has been a noise control specialist for construction sites and railways in densely populated Hong Kong.

Drawing on his practical experience in meeting the strict local noise requirements, he has provided reviews and recommendations to enhance the city's construction noise control practices for the Hong Kong government. Leveraging this industry expertise, Max has since transitioned into research, participating in development of innovative solutions such as SilentUP, Rigid Contact Tuned Mass Rail Damper, and Vertical Noise Reducer.

Cheng Sheng is currently an MSc Student at the University of Hertfordshire.

He was an acoustic consultant at Wilson Ho and Associates Limited in Hong Kong. Working as an acoustic assistant consultant, Cheng Sheng provided acoustic consultancy services for construction noise including providing construction airborne noise (ABN), ground-borne/structural noise (GBN) assessment, Construction Noise Permit (CNP) application (for night work), Quality Powered Mechanical Equipment (QPME) to ensure the noise of the construction activities is within the regulation. He was also included in the research of Vertical Noise Reducer (VNR).

CORRUGATION SUPPRESSION BY RAIL DAMPER



INTRODUCTION

Rail corrugation on curved tracks can be a persistent challenge, even on sections designed with the best geometric specifications. This phenomenon is particularly prevalent on the low rail side of curves, where the combination of rail rotation and lateral pinned-pinned resonance on resilient baseplates with a stiffness of 25kN/mm or less can foster the development of corrugation. While this corrugation may not significantly impact train operations, the associated noise can be a major concern, with even slight corrugation depths of around ten microns in root mean square (RMS) causing a noticeable increase in noise levels of 10dB(A) or more. Reducing ground-borne noise (GBN) along curved tracks by using softer rail pads and elastic baseplates often results in an unintended consequence: the rapid development of corrugation on the low rail of the curve. This article investigates the effectiveness of rail dampers to suppress the growth of short-pitch corrugation of wavelength 20 to 80mm on curved metro tracks, thereby reducing the resulting noise radiation. In the absence of other retrofitted noise control measures, increasing the frequency of rail grinding is currently a common mitigation approach. However, this strategy can significantly increase rail maintenance costs and shorten the service life of the rails.

Rigid Contact Tuned Mass Dampers (RCTMDs) have been installed at six Hong Kong MTR network sites. Based on visual observations on the low rail of curved track sections, installing these RCTMDs has resulted in less corrugation. On a 300m radius curve with UIC60 rails mounted on resilient baseplates (~14kN/mm stiffness), the predominant corrugation wavelength is around 32mm, inducing approximately 520Hz vibrations at 60km/h, which aligns between the 470Hz rotation resonance and 570Hz lateral pinned-pinned resonance. By installing RCTMDs, the corrugation growth rate has been reduced by an average of 90% over a 200 m section, as measured using a Corrugation Analyser Trolley (CAT). These results indicate that installing RCTMDs provides better noise control than simply increasing the frequency of rail grinding, without the drawback of shortened rail service life.

EXPLANATION OF TERMINOLOGY

P1 and P2 Resonances

P1 and P2 resonances are vertical vibration modes of the rail, resulting from P1 and P2 reaction forces at the wheel/rail interface when the wheel passes over a small discontinuity on the rail surface. P1 resonance is primarily driven by the contact stiffness at the wheel/rail interface, caused by the local elastic deformation of the wheel and rail at the contact area. In this mode, the rail vibrates against the wheel. P2 resonance is primarily driven by the vertical stiffness of the resilient fasteners. Here, the rail and wheel vibrate together in phase as a connected body.

P1 and P2 reaction forces were originally defined in the context of a wheel passing over a rail discontinuity, such as a dipped joint. The P1 force occurs at the entry to the dip, where the wheel pushes down on the rail. This force is higher in magnitude and frequency. The P2 force, on the other hand, occurs at the exit of the dip, where the rail returns to contact with the wheel. The P2 force is lower in magnitude and frequency, typically in the range of 50-100 Hz.

Pinned-Pinned Resonance

Rails are typically supported by baseplates and span freely between them. This configuration is referred to as “pinned-pinned,” with the “pinned” locations representing the baseplates supporting the rail. The natural frequency of this arrangement is determined by the rail section's modulus and the distance between the supports. Rail bending modes can occur in either the vertical or lateral directions, with the pinned-pinned resonance frequency typically ranging from 400 to 1200 Hz.

CORRUGATION NOISE AND RAIL MAINTENANCE COST

Rail Corrugation and Resilient Fastener

Over the past 30 years, railway transportation has grown rapidly worldwide. Modern railway fasteners employ softer rail pads and elastic baseplates with a stiffness of 25kN/mm or less to reduce potential GBN from railway tracks. However, this track system allows for small lateral movements of the rail head when trains run on

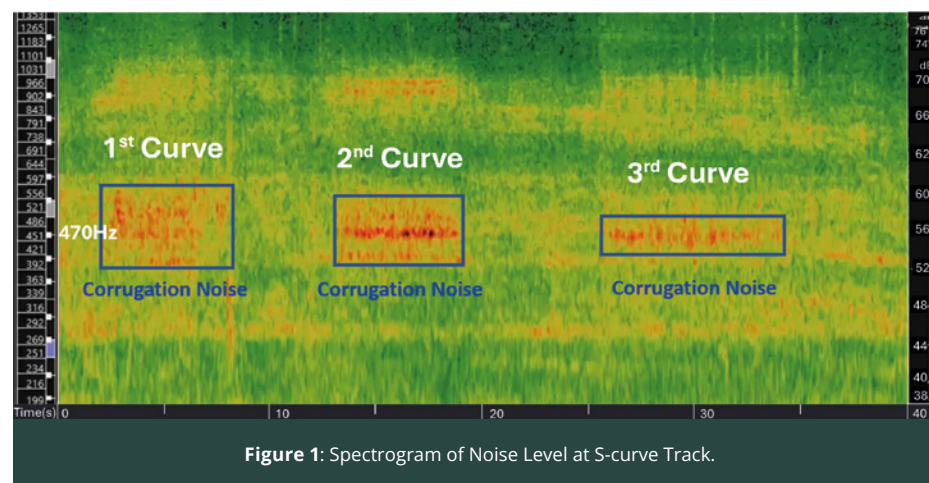


Figure 1: Spectrogram of Noise Level at S-curve Track.

curved tracks. In many cases, this prompts the rail head rotational resonance, typically between 300 and 700Hz depending on the dynamic stiffness of the rail pad and baseplates, which produces short-pitch corrugations on the running surface, especially at the low rail of the curved tracks. Therefore, reducing GBN along curved tracks by using softer rail fasteners often results in an unintended consequence of rapid development of corrugation, especially on the low rail of the curve.

Curve Track Short-Pitch Corrugation

Figure 1 illustrates the saloon noise spectrum over time as a train traverses a curved track with three distinct curves. The spectrogram representation shows the noise levels by colours, with the y-axis indicating the frequency in Hz and the x-axis denoting the elapsed time in seconds. The image shows that all three curves on the track exhibit tonal noise around 470Hz. At this specific frequency, the saloon noise levels increase by 10 to 15 dB compared to the relatively straight track sections between the curves.

This tonal noise phenomenon is attributed to the periodic up-and-down movement of the wheel-rail contact force, resulting from the short-pitch corrugation that forms on the rail surface. In this particular case, where the track utilizes a soft baseplate with a stiffness of approximately 14kN/mm, the rail head exhibits a rotational resonance at around 470Hz. This resonance triggers a lateral stick-slip behaviour at the wheel-rail interface, leading to the

periodic removal of rail surface material and the subsequent formation of corrugations at regular intervals.

Corrugation Maintenance Cost and Train Speed Reduction

While the corrugation formation on curved track sections does not typically pose any significant operational safety concerns, it does present a common challenge for rail operators worldwide. The increased noise levels resulting from corrugation lead to high rail maintenance costs, as more frequent rail grinding is required at curved track locations to smooth the corrugation and maintain train operation noise within acceptable limits. In some cases of rapidly growing corrugation, even with rail grinding every three months, the corrugation-induced noise may still exceed the stipulated noise limits. In such scenarios, many rail operators choose to not only increase the grinding frequency but also reduce train speeds to further mitigate the noise and corrugation formation. In the absence of effective corrugation mitigation measures, more frequent rail grinding and reduced train speeds have become common industry practices to manage the issue, although these approaches are not ideal long-term solutions. Besides, the need for frequent grinding and speed restrictions can be disruptive to operations and add significant maintenance costs for rail operators. Alternatively, retrofitting rail dampers can serve as a viable alternative, offering a significantly lower cost solution compared to frequent rail grinding without requiring a reduction in train speed.

CORRUGATION FORMATION THROUGH LATERAL STICK-SLIP

Rail Corrugation and Track Dynamics

Rail corrugation is a widespread phenomenon where periodic wear patterns form on the rail surface. This article focuses on short-pitch rail corrugations of wavelength 20 to 80mm on metro curve tracks. As proposed by Stuart Grassie [1], these types of corrugation are closely associated with wheel/rail resonances (see Table 1 below), which is affected by the employment of different stiffness fasteners in modern rail.

Type	Wave-length-fixing mechanism	Where?	Typical frequency, Hz	Damage Mechanism	Treatments demonstrably successful	Effective solution if feasible
Heavy haul	P2 resonance	Straight track or curves	50 - 100	Plastic flow in troughs	Hard rails	Reduce cant excess when corrugation on low rail
Light rail	P2 resonance	Straight track or curves	50 - 100	Plastic bending	Increase rail strength and EI	Reduce unsprung mass
Other P2 resonance	P2 resonance	Straight track, high rail of curves	50 - 100	Wear	Hard rails and low stiffness trackforms	Reduce unsprung mass
Rutting	2nd torsional resonance of driven axles	Low rail of curves	250 - 400	Wear	Apply friction control, hard rails, reduce cant excess, asymmetric profiling in curve	Reduce applied traction in curving, improve curving behaviour of vehicle dynamic vibration absorber
Pinned-pinned resonance	Pinned-pinned resonance	Straight track, high rail of curves	400 - 1200	Wear	Hard rails, control friction	Increase pinned-pinned frequency so that corrugation wavelength < 20mm
Trackform specific	Trackform specific	Straight track or curves	-	Wear	Hard rails, friction control	Avoid 'peaky resonance, improved steering

Table 1: Six Types of Rail Corrugations [1]

Corrugation Wavelength-fixing and Damage Mechanisms

As shown in **Table 1** on the previous page, the development of short-pitch corrugation involves two simultaneous mechanisms: a wavelength-fixing mechanism and a damage mechanism, leading to six types of rail corrugations with corresponding wheel/rail resonances.

- 1. Heavy haul corrugation (50-100Hz) due to P2 resonance leading to plastic flow rail surface damage
- 2. Light rail corrugation (50-100Hz) due to P2 resonance leading to plastic bending on rail surface
- 3. Other P2 resonance corrugation (50-100Hz) causing wear on the rail surface
- 4. Rutting corrugation (250-400Hz) due to driven axle’s torsional resonance causing wear on the rail surface
- 5. Pinned-pinned resonance corrugation (400-1200Hz) causing wear on rail surface of straight track and high rail of curves
- 6. Trackform-specific corrugation (varying frequencies) causing wear on the rail surface, for example, rail rotation induced corrugation often occurs when soft fasteners are employed.

The wavelength-fixing mechanisms for five of these corrugation types (excluding Rutting) are directly linked to certain rail resonances, such as the P2 resonance, pinned-pinned resonance, rail torsional resonance, and railhead rotational resonance. The corrugation wavelength is determined by the train speed divided by the frequency of the governing rail resonance - a higher resonance frequency results in a shorter corrugation wavelength, and vice versa.

Regarding the damage mechanisms, the formation of rail corrugation involves plastic flow, plastic bending, and wear. Plastic flow and plastic bending are caused by overloading at the wheel-rail contact, leading to changes in the rail shape without material removal. In contrast, the wear mechanism involves the gradual removal of material from the rail surface due to stick-slip oscillations.

This article focuses specifically on short-pitch corrugation resulting from the periodic stick-slip wear mechanisms where the period is governed by the certain types of rail lateral vibration resonance. Corrugation is commonly observed during curve negotiation on modern rail systems, where soft fasteners with stiffness of 25kN/mm or less are employed to reduce potential ground-borne noise from railway tracks [2]. The use of these softer rail fasteners allows for increased lateral movement of the rail, which can contribute to the formation of short-pitch corrugation.

Micrometre Scale Stick-Slip Motions at Exceptional High Acceleration

Stick-slip oscillation is the primary mechanism driving the wear of the rail surface leading to the formation of short-pitch corrugation. During curve negotiation, in addition to rolling forward, the wheel also experiences lateral creepage, which supplies the energy for continuous stick-slip actions. The slip amplitude in each stick-slip cycle is very small, typically in the range of 0.01 to 0.05mm [3]. It should be noted that a slip amplitude of 0.05mm at 500Hz stick-slip oscillation corresponds to an exceptionally high acceleration of ≈ 50g (Earth’s gravitational acceleration) as illustrated in the following estimation:

Acceleration (m/s²) = Displacement (m) × (2π × Frequency (Hz))²

Acceleration = 0.00005m × (2π × 500 Hz)² = 493m/s² ≈ 50g

(Earth’s gravitational force)

The wheel-rail stick-slip phenomenon involves a relative oscillation between the wheel and rail, where one component (either the wheel or the rail) remains relatively stationary while the other undergoes significant lateral oscillation, at high acceleration of tens of Earth’s gravitational acceleration, which generates exceptionally high dynamic forces at the wheel-rail contact patch. These forces result in material wear on the running surfaces of both the wheel and the rail.

Wheel and Rail Mobility during Stick-Slip Oscillations

Conventionally, it is often assumed that during the wheel-rail stick-slip process, the rail remains fixed while the wheel moves laterally in a repeated fashion [4]. This assumption is valid for wheel squeal generation, where the stick-slip motion is driven by a resonance of the wheel’s lateral modes because the wheel has very high mobility and low damping at its resonance. However, this assumption is generally not correct for the formation of short-pitch corrugation, where rail resonance is the major driving force of the stick-slip oscillation. In modern railway systems, the use of softer rail pads and elastic baseplates allows for small lateral movements of the rail head with resonance frequencies between 300 to 700 Hz. At the rail resonance frequency, the rail mobility is much higher than the wheel mobility, and the stick-slip movement mostly occurs at the rail, rather than at the wheel. In this case, the rail moves laterally in a repeated fashion while the wheel remains relatively fixed.

Suppression of Rail Corrugation through the use of Rail Dampers

Since rail resonance is the primary driving force behind the lateral stick-slip oscillation on the low rail, rail dampers should be effective at suppressing this stick-slip motion and the resulting rail corrugation. However, conventional rail dampers with rubber interface layers may be too soft to effectively transmit the small-amplitude rail oscillations for energy dissipation and reaction force amplification by a tuned mass damping mechanism. For conventional dampers, using a soft rubber layer is necessary to maximise the interface contact area to maximise the energy dissipation. Viewing from another angle, the rubber interface may be unable to effectively transfer the amplified TMD force from the damper back to the rail. To effectively dissipate the stick-slip-induced rail vibrations, it is necessary to have a rigid interface that can transmit strong damping forces even at small amplitudes (0.01 to 0.05mm) of rail movement.

The engineering challenges for a damper to suppress rail corrugation:

- 1. Generate a strong resistant force by using a relatively small mass by mechanism of Tuned Mass Damper (TMD).
- 2. Control the overall stiffness to ensure appropriate frequency TMD. This overall stiffness includes the stiffness of the contact interface layer, which is difficult to manage during retrofitting damper onto a profiled rail surface.
- 3. Use a rigid interface to ensure that small amplitude rail oscillations are transmitted to the TMD. This enables the TMD to respond with amplified oscillations, generating a strong damping force against rail movement.
- 4. Ensure the amplified damping force from the TMD also has a rigid interface to effectively transmit the damping force back to the rail, thereby reducing rail movement.

The conventional rail damper design with maximised contact area at the interface of the rail surface is not effective in providing strong damping force to the rail, because of the following reasons:

- 1. The TMD effect is required to generate a strong damping force by a small mass, whereas for a conventional damper with rubber layer interface it is difficult to control the overall stiffness for appropriate TMD effect.
- 2. Rubber interface is a vibration isolation layer that retains the vibration energy in the rail with very little dissipation to the rail damper.
- 3. The conventional damper, which uses an elastic clamping method to clip onto the rail, does not provide sufficient clamping force to rigidly connect the damper to the rail during violent rail vibrations.

RIGID CONTACT TUNED MASS DAMPER (RCTMD)

Two Types of Rail Dampers Based On Mounting Interface

Primarily, rail dampers can be divided into two types based on the mounting interface, elastic and rigid contact. Elastic contact rail

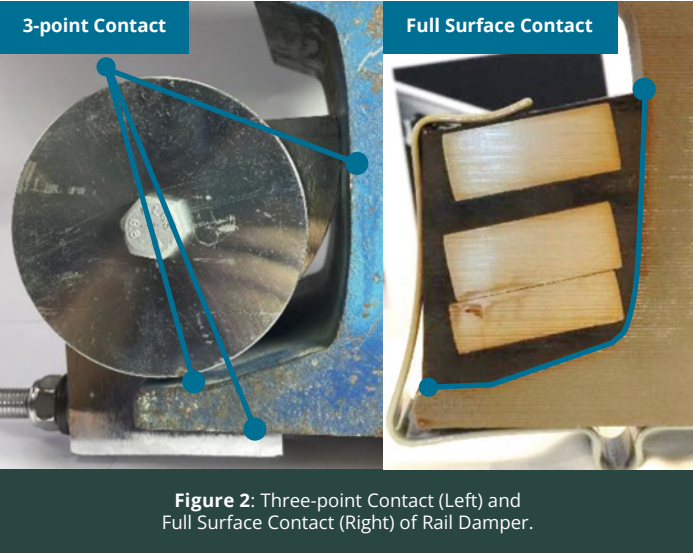


Figure 2: Three-point Contact (Left) and Full Surface Contact (Right) of Rail Damper.

dampers rely heavily on maximising the contact area connecting to the rail surface to capture maximum rail surface vibration energy. However, due to the local irregularities of the rail side profile, e.g. rust, it is very difficult to achieve the continuous contact area even using rubber material as the interfacing layer, thus deteriorating damper performance and corrugation mitigation. On the other hand, a rigid contact rail damper facilitates the strong transmission of TMD forces to the rail, effectively suppressing rail resonance by eliminating the rubber interface layer. It only requires 3-point rigid contact at the rail web, rail foot tip and under rail as shown in **Figure 2**. Rigid contact at these points can also ensure the effective transmission of small displacement vibration to the dampers with minimum disturbance from the irregularities of the rail surface.

Design of Rigid Contact Tuned Mass Damper (RCTMD)

The design of a Rigid Contact Tuned Mass Damper (RCTMD) is presented in **Figure 3**. It comprises four metal discs and two mounting plates on the rail. Resilient materials are attached between the discs and the mounting plate. Inside the damper, the discs act as oscillators and are held together with the resilient material using a bolt passing through them and the mounting plate which is held by a nut at the other end. Dampers are located on either side of the rail

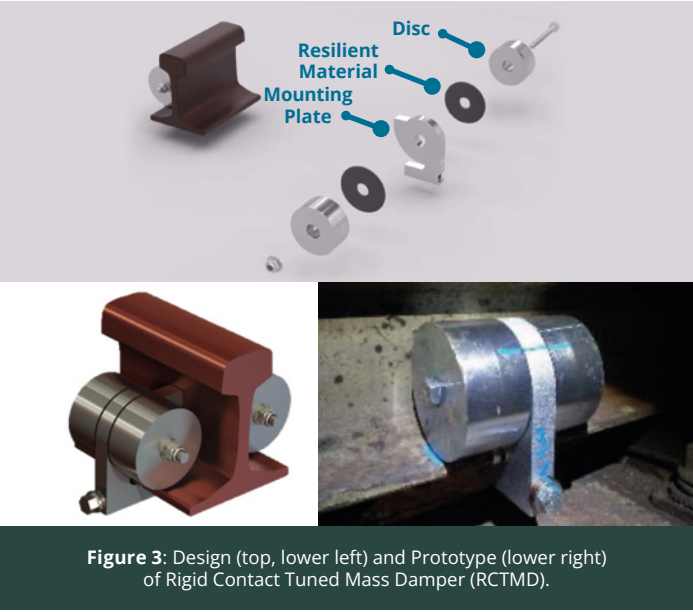


Figure 3: Design (top, lower left) and Prototype (lower right) of Rigid Contact Tuned Mass Damper (RCTMD).

web and are connected as a pair by a long bolt passing through the base of the mounting plates and below the rail foot. This arrangement greatly simplifies the mounting arrangement so that it can deliver its full mitigation performance in nearly all conditions and does not obstruct the rail inspection.

Reactive Amplification of Damping Force By TMD

The oscillators and the shear direction resilient layers amplify oscillation amplitude up to ten times for both lateral and vertical rail vibration, generating a strong damping force against the rail movement. The oscillation frequency of TMD can be tuned individually to specific resonance frequencies such as pinned-pinned resonance, P2 resonance and rail rotational resonance by tuning the mass of the oscillator and the properties of the resilient material.

Track Decay Rate Shortfall

The current Track Decay Rate (TDR) measurement standard, ISO standard BS EN 15461:2008+A1:2010 measures vibration responses to individual hammer impacts to obtain TDR. A single hammer impact in a track cannot fully excite the rail resonance modes. The reactive

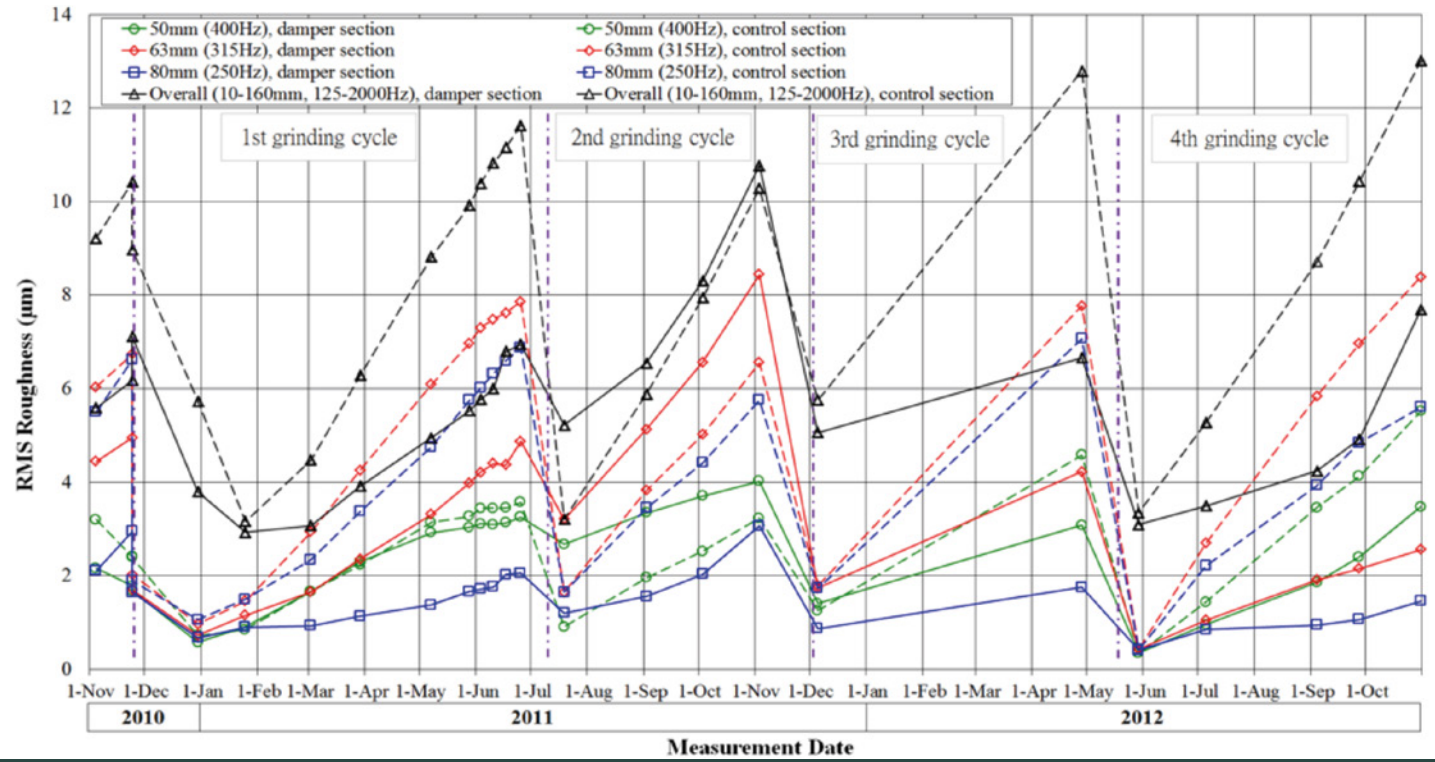


Figure 4: RMS Roughness Over Two-Year Period [7]. Solid Lines show section with damper; Dotted Lines show control section without damper.



Figure 5: Corrugation of Test Rail.



Figure 6: Installation of RCTMD on Testing Rails.

Dampers?	Grinding Cycle (GC)	Months after Grinding			
		1	2	3	4
No Dampers	1st			✓	✓
	2nd		✓	✓	
With Dampers	3rd	✓	✓	✓	✓

Table 2: Rail Roughness Measurement schedule and grinding cycles.

amplification by TMD needs time to react with 90-degree phase lag oscillations against rail resonance modes. The TMD damping effect may not be fully accounted for in the current TDR test. In contrast, continuous excitation may allow TMD to have enough time to respond and achieve better performance [5].

CASE STUDY

Previous Cases of Rail Corrugation Mitigations in 2012

Meehan et al. [6] recommended using a non-uniform train speed distribution to control the growth of rail corrugation. According to their prediction model, reducing train speeds can significantly diminish corrugation growth. They observed a 41% reduction from symmetric speed variation, with an additional 12% reduction in growth rate. Ho et al. [7] previously employed a rail tuned-mass-damper (TMD) to control rail corrugation in Hong Kong. Their approach successfully reduced the growth of short-pitch corrugation by around 40 to 70% for critical corrugation frequencies of 250Hz, 315Hz and 400Hz as shown in **Figure 4**. There were only three valid grinding cycles out of four grinding cycles in two years, as one of the four cycles was conducted by a malfunctioning grinding machine. The effectiveness of rail corrugation mitigation by TMDs is well-demonstrated within the three valid grinding cycles.

Testing Site in 2021

The present testing site is a 200m segment of curved track with a radius of 300m supported by a resilient baseplate with stiffness of about 14kN/mm. On this track segment, the rail head rotation and lateral pinned-pinned resonance are observed to dominate the

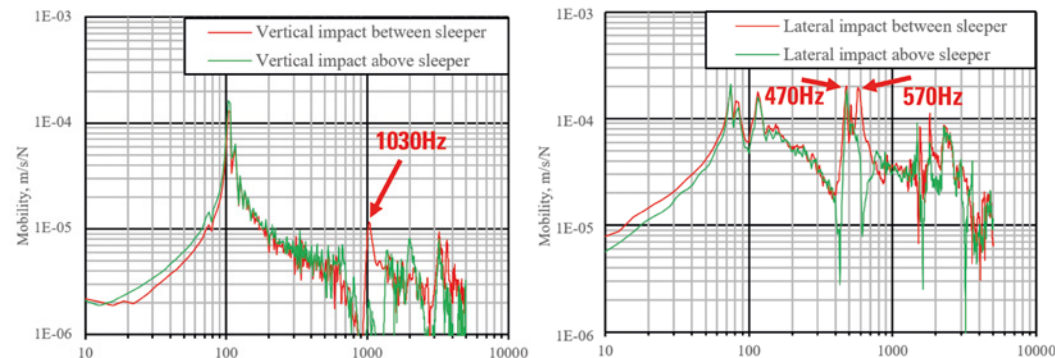


Figure 7: Results of point mobility test for Vertical (Left) and Lateral (Right) direction.

corrugation frequency fixing mechanism. In **Figure 5**, the corrugation depth is approximately 15µm RMS roughness. The TMDs were tuned to ~520Hz with a damping coverage ranging from 400Hz to 1200Hz.

Rail Corrugation Testing Procedures

Figure 6 illustrates the installation of the RCTMDs. Two configurations were used: a single damper installation between the fastenings, and a quarter installation (one damper for every four fastenings), on the low rail and high rail respectively. The test involved three types of measurements: rail vibration, Track Decay Rate (TDR) test, and rail surface roughness measurement using a corrugation-analysis trolley (CAT). Rail dynamic properties were assessed via a point mobility test. Additionally, TDR tests were conducted according to the ISO standard BS EN 15461:2008+A1:2010 using a single hammer impact. **Table 2** details the measurement schedule for the testing year. Data from the same 200-metre section was compared pre- and post-damper installation.

RESULTS AND DISCUSSION

Mobility of Rail

A measurement of rail mobility is conducted for the vertical and lateral direction of impact above the baseplates and at the mid-point between two baseplates. This is to find the resonance frequencies that could lead to corrugation growth. **Figure 7** shows the spectrum of rail mobility in both vertical and lateral directions to illustrate the rail dynamics. It is revealed that the vertical pinned-pinned resonance, lateral pinned-pinned resonance and rotation resonance occur at around 1030Hz, 570Hz and 470Hz respectively. It shows that lateral mobility is much higher than vertical mobility for this resonance in general. Another peak region is found around 100 Hz, which corresponds to the rail's natural resonance on the resilient baseplate and is unrelated to corrugation. When the wheel runs on the rail, this natural resonance shifts downward, transitioning to P2 resonance, where the oscillating mass consists of the combined mass of the rail and the wheel, which are considered as a single rigid body during P2 resonance.

Track Decay Rate Improvement of The Rail

The Track Decay Rate (TDR) (the decay of vibration level in dB per metre), test results are demonstrated in **Figure 8**. The presence of RCTMD increases the decay rate starting from 250Hz (Purple and red solid lines). The most significant improvement of decay rate occurs at 400Hz along lateral direction and 500Hz along vertical direction, where 520Hz was the tuned frequency of the present TMD.

It is noted that the TMD's damping effect is only partially captured in the TDR test. This is because the TMD dissipates rail vibrational energy that gradually amplifies oscillations within a few milliseconds after the initial vibration impulse. Therefore, measuring a single impulse amplitude does not fully account for the reduction in vibration amplitude that occurs after the initial impulse. However, the continuous excitation should be the excitation that is close to

the real case of wheel/rail interaction excitation. In this case, the TMD will have sufficient time to include reactive TMD force. Hence, the TMD can indeed achieve better performance under continuous excitation, such as when a train passes by [5].

CORRUGATION GROWTH RATE REDUCTION

Overall Corrugation Reduction Averaged over 200m Track

The important parameter about the rail surface condition is the root mean squared (RMS) roughness, as shown in **Figures 9** and **10**, presenting the low rail corrugation value average over 200m segment. Since the train generally travels at a speed $v=16.6\text{m/s}$ (60kph) on this rail, the corresponding corrugated wavelength can be calculated by $\lambda=v/f$. According to the 1/3 Octave spectrum of the measured roughness, the dominant corrugation wavelength λ is 31.5mm, followed by 50mm in the first two grinding cycles. These two wavelengths correspond to 528Hz and 332Hz respectively. The 528Hz can be considered as the combined frequency of two mobility peaks (470Hz and 570Hz) in the lateral direction as shown in **Figure 7**. After the installation of TMD, the two corrugation peaks (wavelength 31.5mm and 50mm) are both greatly reduced by 90%.

Individual Segment Corrugation Reduction at 31.5mm Wavelength

The rail corrugation growth rate reduction for each segment of 20m, was calculated in **Figure 11** at $f=528\text{Hz}$ ($\lambda=31.5\text{mm}$). The ISO 3095 roughness standard is provided for reference. This standard is designed for test tracks used in new train commissioning tests and is not intended for operational tracks. In practice, it is generally acceptable for running tracks to have corrugation slightly above the ISO 3095 roughness standard.

In **Figure 12**, the left and right images show the effect of rail dampers on the rail corrugation growth before and after damper installation, respectively. Both images were taken four months after the grinding process but during different grinding cycles. This figure shows that rail corrugation grows at a significantly slower rate after RCTMD installation.

Before Installation of RCTMD

Before the installation of RCTMD, corrugation was observed throughout the entire track section. Inconsistencies in rail roughness were noted between the first and second grinding cycles, particularly between 980-1060m and 920-940m. This indicates the

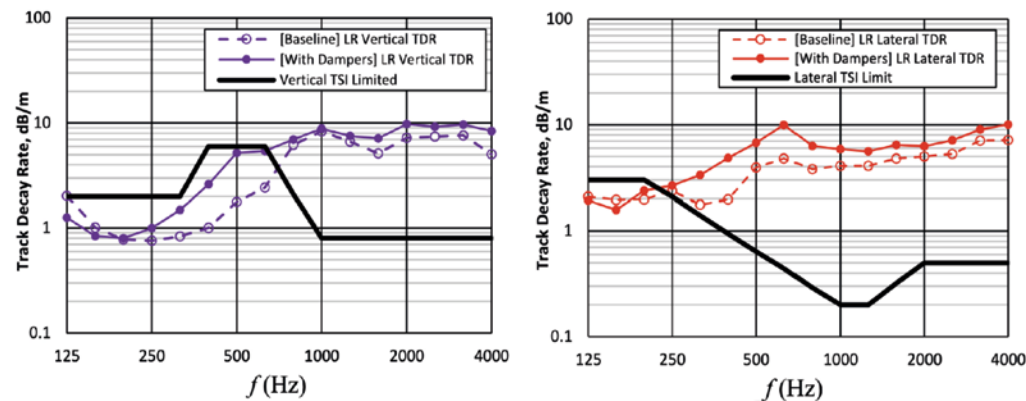


Figure 8: Results of TDR test for Vertical (Left) and Lateral (Right) direction.

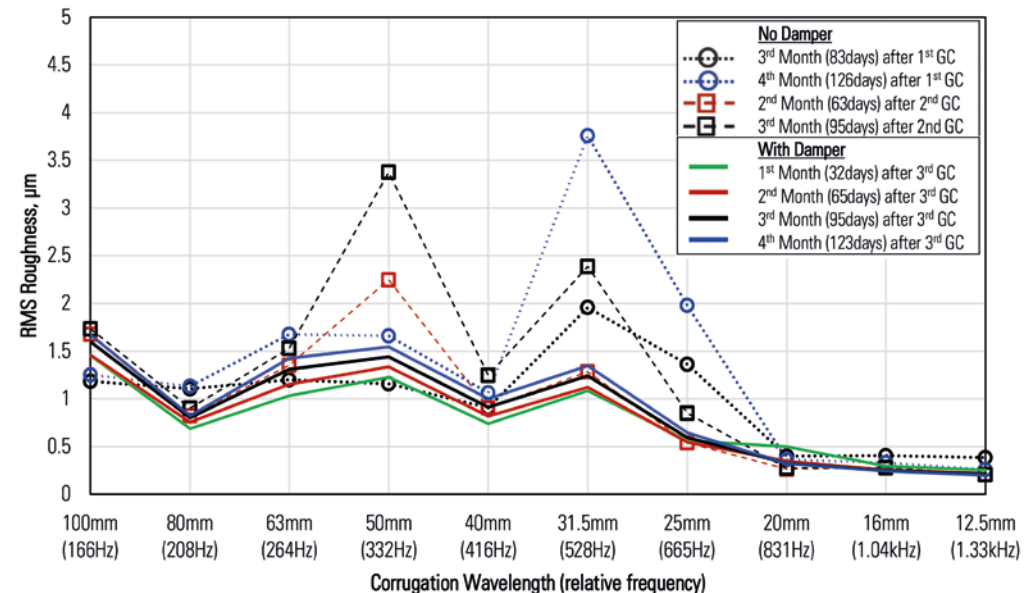


Figure 9: One-third octave spectrum of whole curved track surface roughness, $R_{rms}, 200\text{m}$.

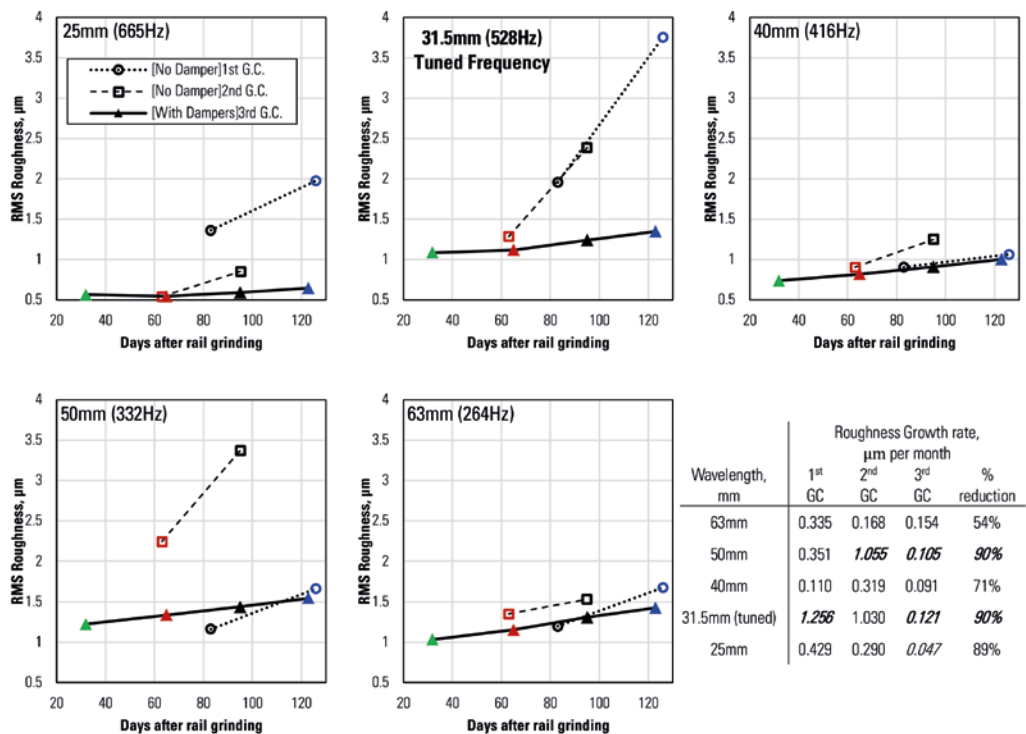
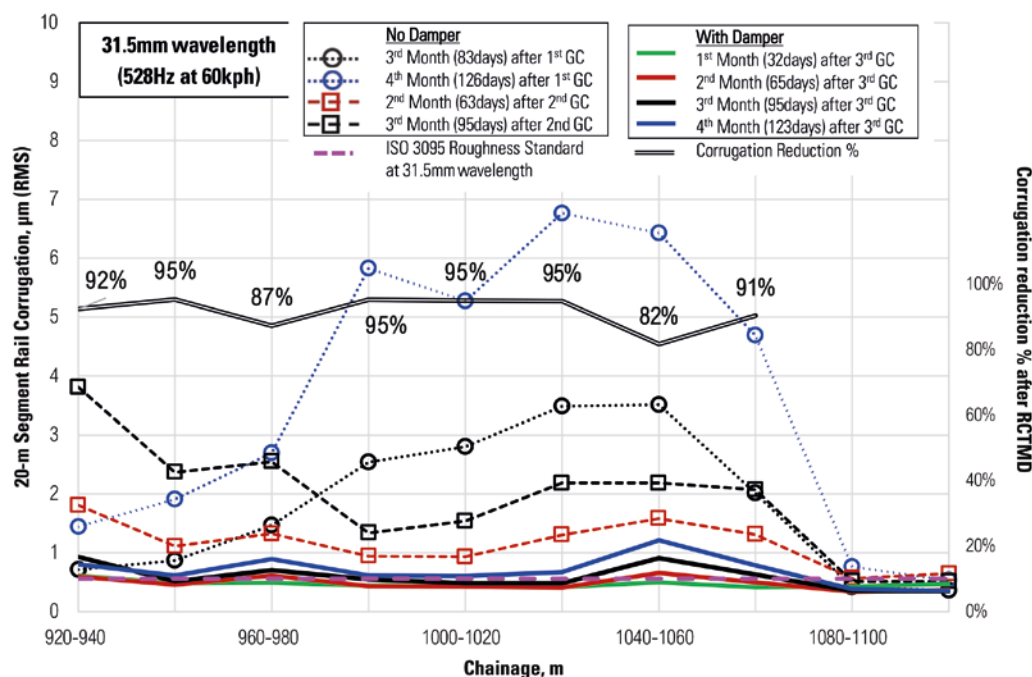


Figure 10: Average Corrugation Growth Rate Reduction for 200m from the wavelength of 25mm to 63mm.



31.5mm Wavelength Corrugation Growth rate, µm per month								
Chainage, m	920-940	940-960	960-980	980-1000	1000-1020	1020-1040	1040-1060	1060-1080
1 st GC (without damper)	0.506	0.728	0.861	2.297	1.726	2.289	2.033	1.868
2 nd GC (without damper)	1.879	1.178	1.148	0.371	0.569	0.826	0.561	0.710
Average of 1 st and 2 nd GC	1.193	0.953	1.005	1.334	1.147	1.558	1.297	1.289
3 rd GC (with damper)	0.090	0.044	0.126	0.061	0.057	0.080	0.237	0.122
Corrugation reduction %	92%	95%	87%	95%	95%	95%	82%	91%

Figure 11: Rail Corrugation reduction at every 20m segment f=528Hz (λ=31.5mm).

non-uniformity of corrugation development, as track conditions and irregularities change after each grinding. Despite these changes, the dominant corrugation wavelengths (31.5mm and 50mm) remained consistent as shown in **Figure 9**, although the locations of the corrugation varied as shown in **Figure 11**. Rapid growth of corrugation continued at chainages 980 – 1060 in the 1st GC, and 920 – 980 in the 2nd GC.

After Installation of RCTMD

In Figure 11, following the installation of the RCTMD, the overall corrugation growth rate along the track is significantly reduced by approximately 90%. As a result, it appears that corrugation does not grow, except in two localized segments: 960-980 m and 1040-1060 m, where the reductions in growth rate are 88% and 86%, respectively. While the average reduction in corrugation growth rate over 200 m is 90%, a few segments experienced reductions of 95%.



Figure 12: Rail Roughness immediately after damper installation - four months after grinding (Left) and one year after damper installation - four months after grinding (Right).

CONCLUSIONS

Short-pitch rail corrugation (20-80mm) frequently appears on the low rail of metro curves with resilient baseplates (stiffness < 25kN/mm), causing excessive noise with peak frequencies between 300 and 700Hz. In a 200-metre curved track section with a 300-metre radius, a corrugation that peaked at 31.5mm wavelength (1/3 octave) was measured, corresponding to approximately 528Hz when trains travel at 60kph. A comparative analysis between rail mobility and corrugation spectrum was conducted. The 528Hz corrugation frequency can be considered as the combined frequency of two mobility peaks in the lateral direction: the rail head rotation resonance at 470Hz and lateral pinned-pinned resonance at 570Hz. Following the installation of Rigid Contact Tuned Mass Dampers (RCTMDs), the overall corrugation growth rate along the track is significantly reduced by approximately 90%. As a result, it appears that corrugation does not grow, except in two localized segments: 960-980 m and 1040-1060 m, where the reductions in growth rate are still achieving 88% and 86%, respectively. While the average reduction in corrugation growth rate over 200 m is 90%, a few segments experienced reductions of 95%. For the railway industry, retrofitting the RCTMD offers a viable alternative for mitigating curve corrugation and its associated loud noise. This approach provides a significantly lower-cost

solution compared to frequent rail grinding, while also eliminating the need to reduce train speeds.

REFERENCES

- [1] S. L. Grassie, Wheel-Rail Interface Handbook, Elsevier, 2009.
- [2] S. L. Grassie, "Rail corrugation: characteristics, causes, and treatments," *Proceedings of the Institution of Mechanical Engineers, Part F: Journal of Rail and Rapid Transit*, vol. 226, no. 2, pp. 99-115, 2012.
- [3] T. X. Wu and D. J. Thompson, "Mechanisms of Short Pitch Rail Corrugation Growth," *Journal of Sound and Vibration*, 1999.
- [4] Z. Y. Shen and J. K. Hedrick, "A comparison of alternative creep force models for rail vehicle dynamic analysis," *Vehicle System Dynamics*, vol. 12, no. 1-3, pp. 79-93, 1983.
- [5] W. Ho, M. Ip and Y. Q. Ni, "Track Decay Rate (TDR) Measurement Method for Reactive Damping by Tuned Mass Damper (TMD)," in *Internoise 2022 - 51st International Congress and Exposition on Noise Control Engineering*, Glasgow, 2022.
- [6] P. Meehan, R. Batten and P. Bellette, "The effect of non-uniform train speed distribution on rail corrugation growth in curves/corners," *Wear*, Vols. 366-367, pp. 27-37, 2016.
- [7] W. Ho, B. Wong, D. Tsui and C. Kong, "Reducing rail corrugation growth by tuned mass damper," in *Proceedings of the 11th International Workshop of Railway Noise*, Uddevalla, Sweden, 2013.

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OVERSEAS SECTIONS – A BRIEF HISTORY

Through the 20th century PWI “Overseas” Sections were established in countries well beyond the British Isles. These Sections were part of the UK-based PWI with subscriptions payable to the UK organisation. Following restructuring of the UK’s railway industry in the mid 1990s and during the Institution’s struggle to survive in the UK, relationships with those Overseas Sections changed and in 2002 it was determined that overseas Sections would become self-standing organisations, wholly responsible for their own governance

and financially independent. Whilst a number of those organisations sadly proved unsustainable and were disbanded, others went on to flourish. The Australian Sections are happily in this latter group and, amongst them the Permanent Way Institution in New South Wales (PWI-NSW) has been particularly successful. 2024 saw that organisation celebrate 50 years since its initial establishment.

It gives us great pleasure to recognise the strong informal links that remain between the PWI and PWI-NSW and to reproduce below PWI-NSW’s report of its half-centenary year.

PWI-NSW CELEBRATES ITS 50TH ANNIVERSARY YEAR

PWI-NSW’S 51ST ANNUAL CONFERENCE: CELEBRATING INNOVATION, LEADERSHIP, AND ENGAGEMENT

On October 24 and 25, The Star in Sydney became the heart of Australia’s rail industry as the Permanent Way Institution NSW (PWI-NSW) celebrated its 50th anniversary and 51st annual conference. This celebration of our longevity was a tribute to the unwavering dedication, passion, and pioneering spirit that has driven the PWI-NSW since it was established as an independent section in February 1974.

With over 300 professionals attending daily, this milestone event showcased the strength and innovation within the rail sector with engaging presentations, panels, and invaluable networking opportunities. More than just a conference, this landmark gathering embodied PWI-NSW’s dedication to fostering professional growth and promoting industry-wide collaboration and excellence.

DAY 1 HIGHLIGHTS: HONOURING TRADITION AND EMBRACING SUSTAINABLE GROWTH

The conference began with an opening keynote from Jo Haylen, NSW Minister for Transport, who highlighted the state’s commitment to supporting local jobs and locally produced rolling stock. Minister Haylen’s speech acknowledged the long-standing relationship between PWI-NSW and the NSW Government Railways, reflecting on PWI-NSW’s deep roots in supporting New South Wales’ rail development. The first day focused on the past with insightful presentations, including the evolving rail standards, the Pilbara Railways’ historical development, and the progression of overhead wiring systems. Panels and breakout sessions dived into topics including new technologies and industry best practices.

A conference highlight was the Gala Dinner, attended by over 380 guests to celebrate PWI-NSW’s 50th anniversary. Yemi Penn, who served as MC and keynote speaker, brought an energy and inclusivity that left a lasting impression.

DAY 2 KEYNOTE: CAROLYN WALSH ON SAFETY AND FUTURE-FOCUSED INITIATIVES

The second day commenced with an inspiring keynote by Carolyn Walsh, Chair of the National Transport Commission, who outlined the National Action Plan for the interstate network, focusing on safety, interoperability, and standardisation across policies and processes. Carolyn emphasised that rail interoperability is an essential agenda item for the Federal Cabinet, pointing to a future where harmonised safety and regulatory standards are a priority. Further presentations included one by Tim Parker, CEO of the High-Speed Rail Authority, who discussed the transformative Sydney-Newcastle high-speed rail project, and Peter Monro of MTM, who shared developments on automated metros.

PWI-NSW LIFE MEMBERS, PRESIDENT AWARDS AND FELLOWSHIP

This year’s conference inducted five new Life Members: Mark White, Steve Naumovski, Stuart Sutherland, Stephen Fleck, and David Spiteri. This esteemed honour is bestowed upon individuals who have demonstrated exceptional dedication and leadership in the rail industry and as Committee members of PWI-NSW.

In recognition of their dedication and service to the rail industry, Mark White, Ian Prescott, and Dave Scealy were awarded the prestigious President’s Award, acknowledging their long-standing contributions to PWI-NSW and the rail sector.

Membership coupled with the grade of Fellow, the latter recently introduced in Australia, lies at the heart of our organisation. Members gain access to an invaluable network, continuous learning, and career advancement opportunities. The fellowship program honours individuals who have made distinguished contributions to the industry. This community provides support, mentorship, and resources that enable members to make meaningful impacts within the rail sector.

ACKNOWLEDGING OUR SPONSORS: BUILDING A STRONGER RAIL COMMUNITY TOGETHER

The conference’s success is due to the generous support of our sponsors. PWI-NSW extends its heartfelt thanks to our Conference Platinum sponsors - Laing O’Rourke, Acciona, JMDR, CPB Contractors, and John Holland - whose contributions were instrumental in bringing this event to life. Our conference sponsors, New Era Electrical Services, Brimble, RT Health, Degnan, and Lycopodium, played a vital role. Their consistent engagement underscores the collaborative spirit that drives PWI-NSW forward, creating a platform for open dialogue, knowledge-sharing, and professional development.

A CELEBRATION OF COMMUNITY AND ENGAGEMENT

This conference was more than a series of presentations; it celebrated the PWI-NSW community. Attendees actively participated in discussions, Q&A sessions, and networking opportunities, enriching every conversation with diverse perspectives and experiences. This engagement highlights the value of PWI-NSW’s commitment to fostering relationships beyond conference walls and building a network of support and innovation for all members.



MARK HARRIS
PRESIDENT PWI-NSW
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Mike Barlow
FPWI
PWI Technical Content Manager

THE PWI PRACTICAL ELECTRIFICATION CHALLENGE

OCTOBER 2024



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 is now working as one of the PWI Technical Managers, assisting with the production of the Journal and organisation of seminars. He has also continued his voluntary work for the London Section of the PWI, where he has previously held the positions of Chairman and Secretary.

The fourth week of October 2024 saw the second PWI Practical Electrification Challenge (PEC), with a return to the Network Rail (NR) Jane Austin Electrification Training School at Swindon for the site activities. The PEC grew out of the success of the PWI Practical Trackwork Challenges (PTCs), in that it offers a special opportunity for delegates from the PWI Corporate Members to experience some of the challenges of installing Overhead Line Equipment (OLE). The event is particularly valuable for people who are relatively new to the industry or those who do not usually have the chance to get on site for experience of electrification installation at close quarters.

The Training School provides excellent facilities and a secure and supportive setting as the site is physically and electrically segregated from the NR system. This allows briefings and explanations to be given to the delegates to enable them carry out the work, and have their questions answered without the deadlines of working on the railway. It would not be possible to do this on the national rail network due to the need for specialised training and the potentially hazardous nature of the work.

Once again, the delegates were based at the Leonardo Hotel, which is conveniently located for Swindon station and the Training School. The delegates stayed there on the Tuesday and Wednesday nights, allowing them to network and see presentations about the PEC and some aspects of railway electrification. The delegates came from across the rail industry including the Office of Rail and Road, the Railway Safety & Standards Board, Network Rail, Transport for Wales, AUS Ltd, Furrer+Frey, Volker, Babcock International Group, One Big Circle, AtkinsRéalis, SPL Powerlines UK, Systra, Balfour Beatty and Fugro.

Preparation for the PEC had taken place over many months and included development and review of the programme and safe systems of work, design reviews and risk identification and mitigation. Lessons learned from the first PEC were incorporated to improve and expand the event for the benefit of the delegates. Happily, this year even the weather was better!

After dinner on the Tuesday evening, Noel Dolphin Head of UK Projects for Furrer+Frey welcomed the delegates to the PEC and gave a brief introduction to the event. This was followed by a presentation by Phil Doughty, Chief Mechanical & Electrical Engineer of NR, on general electrical safety and the new NR isolation process. This was followed by a short talk from Joan Heery, the Technical Services Director of the PWI, and Mike Barlow, one of the PWI Technical Managers about the benefits of PWI Membership. Joan covered the range of education courses, textbooks, seminars and Section meetings which the PWI offer to support people with their Continuing Professional Development, and explained how the PWI can provide members with various routes to become professionally registered.

On Wednesday morning the delegates took the short walk from the hotel to the AtkinsRéalis office, where Garry Keenor, Professional Head for Electrification Transportation gave a detailed explanation of OLE, its components and design. This included a summary of conventional OLE installation and differences to what was used for the PEC. This was followed by a presentation by Rob Daffern, Director & Principal Engineer at Furrer+Frey, explaining how to read OLE design drawings and a review of the design for the PEC.

The delegates then walked to the NR Training School, and after booking in and changing into their Personal Protective Equipment (PPE), they moved out onto the training area where they were given a safety briefing by Craig Hall, Head of Operations E & W for SPL Powerlines. They were then separated into four groups led by Brian Gillespie and Liam Allport of SPL Powerlines, together with Martin Chesters and Andy Ward of NR OCR. The programme allowed for the groups to rotate between the different activities and briefings over the two days of the event to give them a wide experience of the work.

One important difference to working on OLE on the NR system is that all of the activities for the PEC were carried out at low-level, so that delegates did not need to be trained and licensed for working at height. Within this constraint, as far as possible the sitework was carried out in a similar way and to a similar standard as would be the case for work on the main line. Throughout the event the delegates were able to get 'hands-on' with most of the tasks and were encouraged to do so.

LESSONS LEARNED FROM THE FIRST PEC WERE INCORPORATED TO IMPROVE AND EXPAND THE EVENT FOR THE BENEFIT OF THE DELEGATES. HAPPILY, THIS YEAR EVEN THE WEATHER WAS BETTER!

As a new feature of the PEC for 2024 we were pleased to welcome Supporters to the event, namely Gripple, Mosdorfer and Cembre. The delegates had the opportunity to visit all of them on Wednesday and were given detailed explanations and demonstrations of various tools, equipment and components.

Following a visual familiarisation of the site and laying out of materials, Wednesday commenced with each group assembling and preparing a cantilever for installation. The groups then fitted the cantilevers onto the mast brackets and adjusted them to comply with the design drawings. This was followed by the installation of termination brackets. This created fully assembled cantilevers ready for the catenary wire to be run after lunch.

Following lunch, the groups rotated between various activities, including visits to the Supporters stands. The activities included –

- Fitting of bonds to rails
- A review of different types of droppers
- A briefing and demonstration by Rob Daffern of section insulators and neutral sections

Later that afternoon the groups combined to run-out and install the catenary wire, which required closely controlled teamwork. Once the catenary wire had been tensioned, (to a lower value than would normally be required), the delegates tidied the site and after changing out of their PPE the delegates booked out of the Training Centre and returned to the hotel.

Following dinner at the hotel there was a brief review of the day's activities, and a summary of those planned for tomorrow. Garry Keenor of AtkinsRéalis gave a presentation covering the role of

conductor whereas the contact wire is a solid and relatively inflexible bar. This makes it more of a challenge to handle and install than the catenary wire. Once it had been run out the delegates were shown how to remove twists in the contact wire and were able to try this for themselves.

Once the delegates had reformed into their groups the contact wire tension was then checked and adjusted, and the cantilevers and droppers were registered, with the contact wire being fitted into the dropper arms and the system height being checked. This was followed by a demonstration of the installation of in-span insulation.

Rob Daffern provided repeat and follow-up briefings on neutral sections and section insulators Garry Keenor showed each Delegate group examples of weights-based tensioning system and section isolators.

After lunch there was an exercise in carrying out quality checks and the collation of Handback information. It was then time for the delegates to dismantle the OLE which they had installed and leave the site tidy ready to be handed back to NR.



railway electrification in society and its benefits, and the need to convince decision-makers of these benefits. Garry included a brief history of UK rail electrification, and considered how specialisation of technical roles, (not just in electrification), risked creating a disconnect between designers and installation teams. This was followed by a presentation from Noel Dolphin on lessons learned from electrification projects. The delegates were then invited to give informal feedback on the first day, with their comments being noted for inclusion in lessons learned for future events.

Thursday morning commenced with a repeat visit to AtkinsRéalis offices for another briefing. The delegates then retraced their steps to the Training School to change into their PPE and be re-briefed on safety issues and the work plan.

The delegate groups again combined for the first action of the day which was to run out the contact wire. The latter is a stranded

After changing out of their PPE the Delegates returned to the AtkinsRéalis office for a brief review of the PEC, following which they were invited to give any feedback they wished to. This was followed up after the event by the opportunity to provide feedback online. The day concluded with the Delegates being presented with their certificates.

The PEC once again brought together volunteers, Supporters and experienced personnel to give the Delegates a greater appreciation of many of the practical challenges in the construction of OLE. In doing so it also demonstrated some of the very best aspects of working in the rail industry. Overall feedback has been very positive and the comments received will be fed into 'lessons learned' for future PECs.



Chris Belton
MPWI

THE DETAIL DESIGN AND MANUFACTURE OF LEWISHAM JUNCTION



Having started from humble beginnings as a Trainee Engineer with Henry Boot Railway Engineering (Sheffield) in 1984, Chris has been actively involved in S&C design and manufacture with a number of organizations over time including Edgar Allen and Balfour Beatty Rail where he became the Design Manager for the UK Permanent Way Design office in Derby with exposure to UK main line, Metro System design and Heavy Haul systems worldwide.

A subsequent move into the world of Design Consultancy with Jacobs provided further opportunity into UK alignment scheme designs and feasibility studies.

Over time, Chris has accrued a robust understanding of the full picture and life cycle of multi-disciplinary rail projects and railway operation. Now, having come back to his roots through Progress Rail Services, he is the Principal Engineer for Feasibility and Client Support where his experience feeds directly into PRS production and development.



Figure 2: Historic route map of the SECR in Lewisham's core position in the south east. (Image courtesy of Historic SECR Poster)

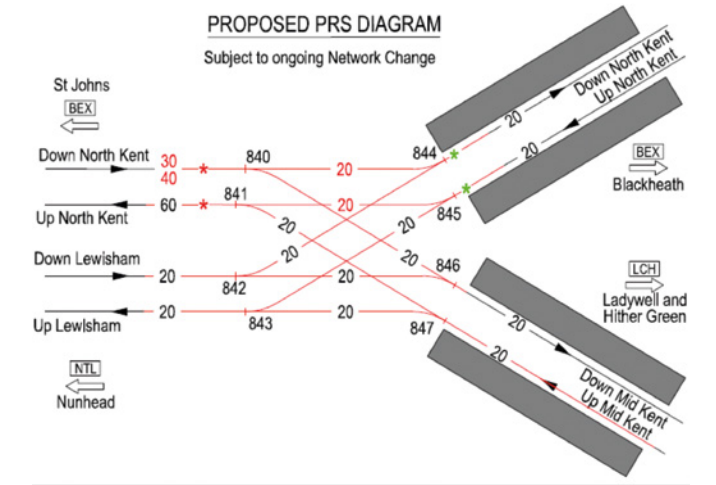


Figure 3: Lewisham Junction – operational layout (Image courtesy of AECOM Form A).

and intermediate manganese closure rails. Prior to that, the layout had survived as a full Bullhead layout from a 1949 renewal – a small picture of which is visible (in part) on the cover montage of the PWI Bullhead Design Part 3 supplementary book!

The GRIP 4 Form A scheme design was undertaken by AECOM within the South Rail Systems Alliance, as part of the CP6 Year 4 work bank, and was awarded to Progress Rail in mid-September 2021, with a planned installation date of December 2022. The existing junction condition prior to renewal was poor, and it had accrued a history of insulated joint failures and subsequent signal dropouts affecting the Lewisham area. These were partly due to a failure of the trackbed and formation, and there were a number of wet beds that had pumped up onto the track assembly. Allied to this, a particular area of embankment settlement had occurred, which heightened the risk of track twist (Figure 4).

From a detailed topographical survey of the junction and the approach tracks, the new design incorporated a number of fundamental design improvements over the earlier BR design. This included a co-planar arrangement and allowance for later plain line works within the Lewisham station platforms to improve alignment with the removal of excess cant and improvement of platform clearances and stepping profiles. The junction footprint width was reduced by 170mm to assist with embankment reinforcement works. There were considerable changes to the vertical profile designs to provide better minimum ballast depths where they were needed with due consideration for the considerable number of under-line structures, which resulted in the worsening of some approach gradients and vertical curves carrying the seven million annual gross tonnes on each through route. This was most certainly not the usual requirement, and there was no readily available solution in RE/PW standard drawings or NR standard 2049.

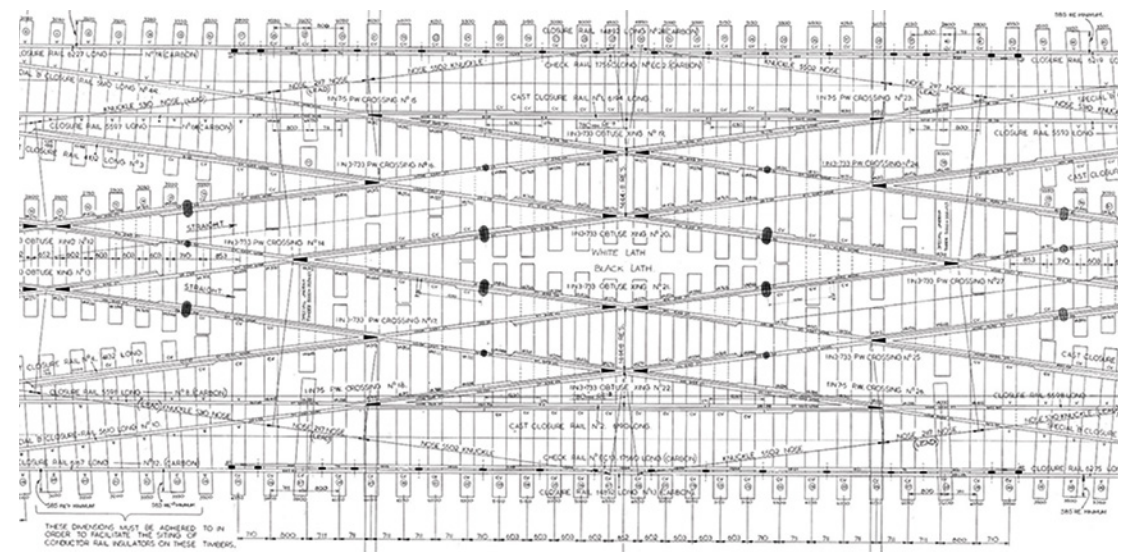


Figure 5: Excerpt from the original Edgar Allen 1977 manufacturing design for the core diamond crossings (Image courtesy of Progress Rail).



Figure 4: The former life expired Lewisham Junction showing signs of formation and Horizontal & Vertical alignment failure (Image courtesy of AECOM Form A).

As the GRIP 4 design was not initially available to Progress Rail at award, it was necessary to refer to the archives to enable a high-level rail take-off from the 1978 design. The project specification called for a heat-treated rail of 350BHN throughout without intermediate manganese rails. Network Rail were duly notified of the specific quantities required to enable this special free issue rail to be allocated to Progress Rail. (Figure 5).

Figure 1: Aerial view of the close proximity of cast manganese crossings and resultant bearer support positions. (Image courtesy of Progress Rail)

INTRODUCTION

This article has been compiled from the original Progress Rail presentation given at the Summer Technical Seminar in Birmingham in July 2023. It aims to provide a window into the complex UK detail design and manufacturing stages of the process to make scheme designs workable and, ultimately, provide switch and crossing (S&C) layouts that meet the very specific requirements of the project installation team.

Progress Rail, a Caterpillar company, is one of the key manufacturers of S&C for Network Rail (NR) in the UK. Our in-house cast manganese detail design and manufacture capability complements our portfolio and helped make our company the preferred supplier for the intensive requirements of the Lewisham Junction renewal programme. Historically, it was an earlier incarnation of Progress Rail as Edgar Allen Engineering (Sheffield) that provided British Rail with the preceding junction design and supply back in 1978. Figure 1 (above) shows the complexity of the new nomenclature and sets the scene for the challenges that were faced in bringing together the components within the core section of the junction.

BACKGROUND AND HISTORY

Lewisham Junction is located six miles southeast from London Charing Cross station and was originally the convergence point of the historic South Eastern Railway and the London Chatham & Dover Railway. It was not until 1857 that a physical junction was constructed between the two rival companies when they became the South Eastern & Chatham Railway Company (SECR) with shared operating rights (Figure 2). The junction is unique in format, as it is restrained considerably both horizontally and vertically on a four metre high embankment with all operational flexibility provided within one compact footprint. This is a legacy of the original alignment of the two separate companies, who wanted to serve the fledgling town of Lewisham and their subsequent different approaches from separate London termini. It forms the principal junction of route divergence from London, serving north and mid-Kent, the Medway towns and the south-eastern reaches of Kent and the south east coast (Figure 3). There have been a number of desk-top feasibility studies undertaken over the years, but none have concluded an economical split to allow a more conventional layout.

The layout that was to be replaced was designed and installed by British Rail (BR) in 1978 as a fully jointed BS113A vertical arrangement and, for the first time then, with cast manganese monobloc crossings

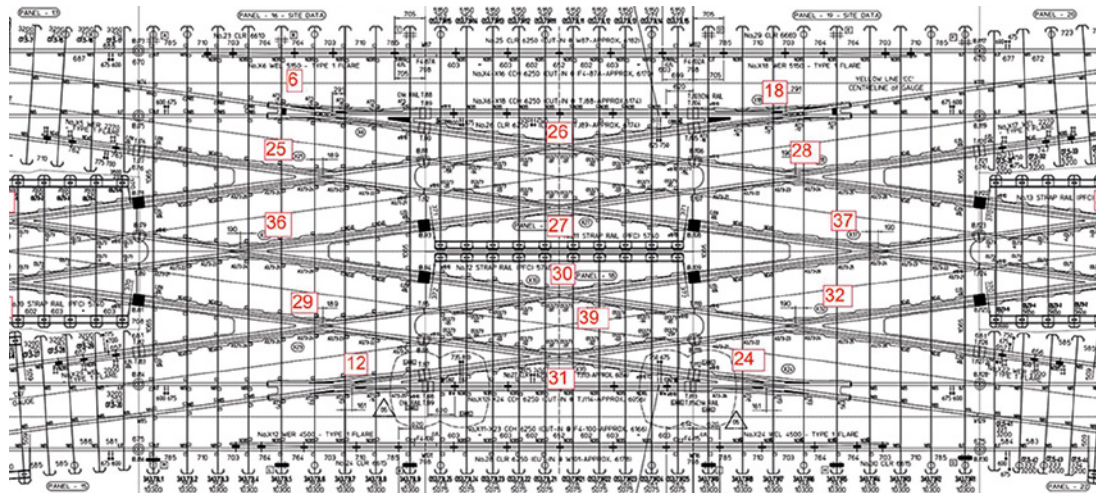


Figure 6: Excerpt of final 1:50 detailed production design with all parameters fixed. (Image courtesy of Progress Rail).

EARLY DESIGN CONSIDERATIONS

Geometrically, the new junction arrangement was again to be a NR56V vertical design, as was installed for the first time back in 1978. This proposal best suited the footprint geometry and approach alignments available, given the junction had a relatively low speed requirement of 20mph on both the through-lines and over the crossover portions through the diamond crossings. The resultant arrangement was a four double junction scissor crossover modular design, comprising three DVs 10.75/9.25/3.733/7.5 junctions and a BVs 8/8/3.733/7.5 junction, which was a slight change to the former array of 2xDV, 1xCV and 1xBV double junction. The primary gain in making this change was to assist in the alignment design to support the reduced track intervals and to maintain a straight over straight alignment through the core of the junction. This was effectively tied together in the centre with four - 1 in 3.733 diamond crossings. In high level terms, this amounted to 16 obtuse and 24 common cast manganese crossing units with support provided by 529 concrete bearers.

From the onset, it was clear that the detailed production design of Lewisham Junction would require a highly experienced senior level designer to decipher the internal technicalities and understand the pending interface issues between design disciplines. It was also foreseen that the complexity would require more than a single design check representative, and to overcome this and the copious amounts of data concerned, the engineering and production team split the design into four separate double junctions with boundaries. These were allocated to four checking engineers with each checker allocated a common theme throughout the entire design, such as, bearer allocations, modular split, insulated rail joints, adoption of the through alignment and crossing specifics (**Figure 6**). These were brought together internally for comparison and compilation in a similar manner to a GRIP scheme Interdisciplinary Design Check (IDC).

To minimize risk to any project and ensure early technical engagement with the design and engineering teams, Progress Rail have developed a 'skeleton' or 'skinny' drawing output form for complex junctions which can be turned around within the first few weeks of the detailed design programme. This is a Progress Rail development of an outline design incorporating all suitable key information for the scheme designer to overlay onto the geometrical design requirement for review with the project team as part of the IDC process. This is key to ensuring confidence from an early stage - that all primary alignment has been achieved and the fit of the footprint meets the parameters of the scheme design. Needless to say, Lewisham Junction warranted this approach and both the AECOM design team and the Colas site engineering team were able to efficiently provide feedback in relation to minor design tweaks and installation-specific requirements that required further development. The detailed design also included considerations for the modular split of the layout, with due consideration for safe lifting and loading and

early consultation with the nominated haulier. This would also be the first time the new Parallel Flange Channel (PFC) restraining straps would be used on the diamond crossing units of such an arrangement - a development undertaken by Progress Rail and NR to replace the original bullhead rail types and now in place on the new RE/PW designs where appropriate.

APPLICATION OF THE DETAILED DESIGN

The new junction design occupied a narrower footprint width and brought the track

centres parallel from the existing slightly diverging arrangement but had been developed non-symmetrically in the horizontal plane. The two pairs of through lines were not equally positioned about the junction centreline, and as a result, had a direct effect on the positioning of the through bearers supporting the core of the junction diamond crossings with 11 separate positions where a non-standard crossing nose position was seated relative to a bearer centreline. The worst of these was 171mm greater than the nominal 127mm dimension and this warranted a progressive approval from the project. Each of the four double junctions was designed in outline form with standard third rail provision as per RE/PW standard allocation. All adjustments and additional site requirements for the Electrical Traction Equipment (ETE) third rail were advised to Progress Rail as part of the Form C comments, which allowed them to be incorporated in one hit. As if the sheer complexity of the junction and the requirement for a fully weldable layout was not enough, the prohibition of a concrete bearer split in the fourfoot meant a 10.3m through bearer to support the diamond crossings across the full width of the core was required. The quantity of such bearers was of course kept to a minimum but still totalled eighteen in number - and was an industry first, the longest length previously being 8.5 metres. The concrete bearers were manufactured by CEMEX on their

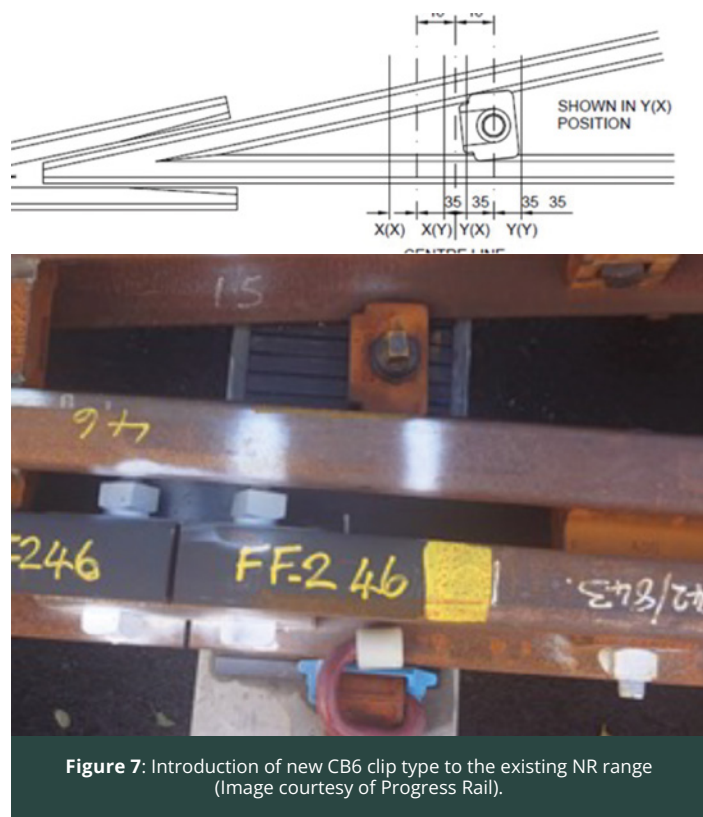


Figure 7: Introduction of new CB6 clip type to the existing NR range (Image courtesy of Progress Rail).



Figure 8: Close proximity of bolts warranted interlacing and head to tail reverse assembly and, in some cases, the adoption of flat fishplate profiles. (Image courtesy of Progress Rail).

long line process in Derbyshire, and the new longer length required brought a number of issues that needed careful consideration. The most demanding of these was the positioning and relative tolerances of the clip housing, which put dependency on the manufacturing management of concrete workability, such as consistent elastic creep and control of camber and bowing. Bearer handling was also a significant issue, and Progress Rail worked closely with CEMEX to reach a workable solution to permit safe handling arrangements and suitable storage methods.

With the application of rail and crossings on the concrete bearers, very specific and localised design issues had to be addressed at all levels, and there were a number of such instances - particularly at crossings and rail joints. These required a detailed review, with due consideration for the maintainer who would be responsible for their upkeep, plus a robust record of such within the As-Built detail of new components so the non-standard elements were captured. One such requirement was at a non-standard intersection of bearer and saddle crossing where a conventional rail clip or an existing gauge stop clip could not be accommodated from the available range. In this instance, Progress Rail developed an additional gauge stop 'CB6' clip to address the dimensional requirements, which was subsequently adopted into the NR catalogue and RE/PW standard designs (**Figure 7**). A new clip for a tight fit you might say! Again, the very nature of the close proximity of all the switch and crossing hardware and ancillary components brought a number of complications at rail joint positions, a problem compounded where insulated rail joints were required. These were resolved with bespoke re-configuration solutions such as bolt re-orientation and the adoption of flat fishplate profiles in special locations (**Figure 8**) - all which were needed to maintain NR compliance in their performance. It was by no means a pick and mix solution.

CAST MANGANESE CROSSINGS

On complex junctions like Lewisham, it is imperative the crossing requirements are frozen as early in the design process as possible to allow adequate time for their manufacturing process. Lewisham was certainly no exception and required a number of standard pattern modifications and new patterns to align to the new junction geometry and meet the new requirements over the old design. Many of these change requirements stemmed from the need for non-standard bearer support positions and shorter than standard crossing leg lengths, as the end-on-end nature of a number of these in the core of the junction warranted such - with no cut-in available. This is due to the very nature of manganese steel prohibiting it being cut down, drilled and finished with on-site tools, so rail ends are workshop finished and utilize a tight joint bolted fishplate arrangement to secure them to the follow-on manganese crossing. All crossings were to adopt the latest 'M' series thickened wall design and would be Explosive Depth Hardened (EDH), and all bonding drilling would



Figure 9: Flash butt welding of rail legs onto cast manganese crossing bodies in the Sheffield facility (Image courtesy of Progress Rail).

be location specific - not universal. These were cast in the Progress Rail state-of-the-art foundry in South Queensferry in Scotland. As the crossings were utilized within a fully weldable layout, the position of some required weldable rail ends be applied, and this was done by insertion of an intermediate tri-metallic stainless steel weld in the Progress Rail welding and finishing facility in Sheffield (**Figure 9**). This is undertaken as conventional site welds are not suitable for welding dissimilar manganese and rail steel types. Foundry planning was paramount as a requirement, as this would consume over two weeks continuous foundry time, which could potentially prohibit other work from being processed. Likewise, the sequencing of pattern production and modification needed to interlace fully with the casting plan.

ASSEMBLY AND LAYOUT

The Lewisham Junction layout was required to be laid out and proved as one single entity, just as it would be reconstructed on site and was no different than other complex layouts Progress Rail encounter in this respect. This would bring together all elements and prove the overall fit, such that it could be fine-tuned and marked-up and disassembled in readiness for dispatch by road and rail. The build plan was four weeks and the layout was planned-in and positioned at the south west end of the Progress Rail Beeston 8200m² assembly facility. The layout measured 132m in length by 23m in width and consumed approximately one third of the working surface including all-round plant access. Careful yard planning permitted a number of other NR layouts to be assembled for dispatch in readiness for Christmas works. It was a big job, but it was manageable amongst other projects with similar timescales.

All layout projects that pass through the Beeston facility are accurately planned using robotic control GPS positioning for the layout footprint. Additionally, Beeston has a local survey control where conventional EDM equipment can be used for setting-out purposes if required. The advance planning of all the steel work and concrete bearer deliveries came together and the long concrete bearers were delivered first to ease and minimize on movement. These bearers required a four-point lift and were the first to be positioned on the ground. The initial build sequence plan was to work from the inside of the junction outwards allowing for all close tolerance and close fit issues of the cast crossing nomenclatures to be achieved first. However, this was superseded by reversing the plan because of cast crossing deliveries, which required close management of the subsequent concrete bearer deliveries and liaison with the Beeston team. The accumulative tolerances of so many sub-assemblies required a skilled assembler to manage, and from the onset, the installation site team were actively encouraged to visit Beeston to familiarize themselves with the layout to de-risk the project.



Figure 10: End-to-end manganese crossings in two planes required absolute length accuracy (Image courtesy of Progress Rail).

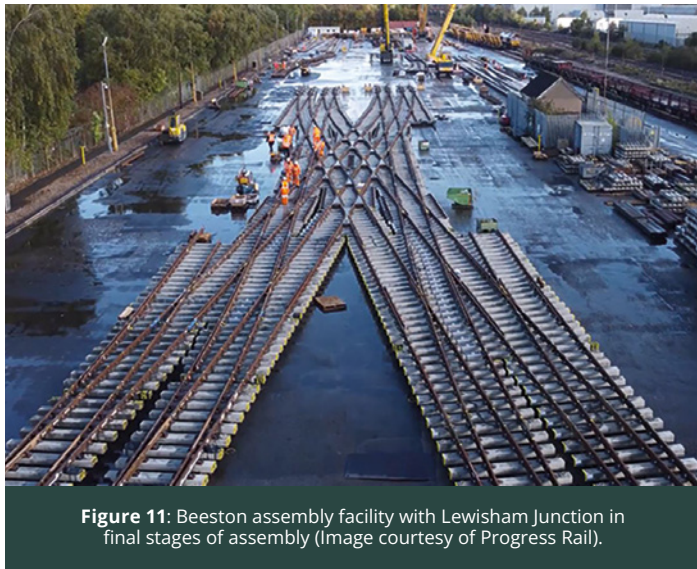


Figure 11: Beeston assembly facility with Lewisham Junction in final stages of assembly (Image courtesy of Progress Rail).

No layout as intricate as Lewisham would be without its complications. Perhaps the biggest assembly issue through the build sequence was the interface of the end-on-end fit and subsequent accumulative tolerances through five cast manganese crossings within the diamond crossings at the core of the junction, which was a straight line issue. However, to complicate further, this issue was compounded by the same scenario through the run of seven cast crossings positioned end-on-end through the central diamond profile. With no blank rail elements able to cut-in, an absolute fit was required to achieve the geometrical linear dimensions of the assembly. This was a difficult task given ambient temperature fluctuations affected the 'close tolerance bolts' in the insulated rail joints, and the fixed clip housings on the concrete bearers offered no latitude for adjustment (**Figure 10**).

The layout was completed in full, four days ahead of the programme schedule, and the inspection was carried out internally and by a NR representative over a three-day period in late October. The layout passed release inspection first time and with no snags, which is indeed a testament to the Progress Rail engineering and manufacturing team, considering the industry average of four snags per layout.

There were in fact sixteen iterations of the delivery plan before the final one locked down on a split delivery method. From a modular perspective, there were nineteen panels delivered on five works trains, with the balance of all smaller units and long deliveries on 40-foot tilting road lorries. Deliveries took place over a three-week period to pre-planned specific delivery points including Blackheath station car park and a storage compound adjacent to Lewisham station, both with restrictive available hours. This was all in the run-up to Christmas and warranted road closures both in the mornings and evenings and the suspension of parking on a number of feeder roads close to some schools. It also required the removal of traffic bollards, a road sign, a lamp post and the demolition of a small brick structure. As a result, the ten-day Christmas programme of the junction area in Lewisham was a success story and resulted in

on-time full delivery for the key blockade works for Colas Rail and their client, NR.

In 2022, there were 141 layouts that passed through the Beeston facility. Of these, it is most likely that Lewisham Junction had the highest profile and quickly became a celebrity with its fly-through drone footage making it onto social media across the industry. Its 14,240 separate components brought together and processed by a highly skilled workforce and turned into a success story by ongoing close collaboration and early engagement at the design and construction stages (**Figure 11**).

THE LAYOUT PASSED RELEASE INSPECTION FIRST TIME AND WITH NO SNAGS, WHICH IS INDEED A TESTAMENT TO THE PROGRESS RAIL ENGINEERING AND MANUFACTURING TEAM, CONSIDERING THE INDUSTRY AVERAGE OF FOUR SNAGS PER LAYOUT.

The Colas and NR installation during the Christmas blockade in 2022 was completed successfully within the time frame and with no issues reported back to Progress Rail. To-date, feedback from the local maintainer based at Hither Green has been positive and the layout is performing as it should with the usual maintenance regime in place.

This approach is a practice that Progress Rail sees driving success, particularly with heightened complexity both from a manufacturing and a delivery perspective and should serve as a blueprint for successful project delivery.

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Hakan joined Bentley Systems in 2005 and is a Senior Product Manager, Civil Engineering.

Hakan previously served as a Senior Consultant. Before joining Bentley, Hakan worked at the Head office of the Swedish National Rail Administration, an EPC company and at an IT consultant company. Throughout his career, Hakan has focused on Railway designs, with a particular interest in high-/low voltage electrical and Signalling. He holds a degree in Mechanical/Electrical Engineering.

Dan has spent his career helping advance the engineering practice through technology and innovation using Bentley's civil design software.

He works with departments of transportation and engineering firms around the world to discover areas of need, guides development of Bentley's Road and Rail design software, and educates software users to leverage technological advancements to become more efficient and produce advanced project models that have value beyond a set of construction documents.

EFFICIENT RAILWAY INFRASTRUCTURE THROUGH DIGITAL INNOVATION



Throughout history, the rail sector has played an important role in the advancements of technology and civilization. The earliest railroads shrunk the world as it became possible to move people and goods across great distances at previously unheard-of speed and accessibility. Railways were at the forefront of new technology throughout the steam, diesel, and electrical eras. They were at the core of engineering advancement and growth of society through bridges, tunnels, metros, and even standardized time zones.

Today, railroads continue to be part of important advancements in engineering, technology, and society. New projects like the east-west Elizabeth Line through London and future north-south HS2 corridor certainly provide substantial increased mobility and efficiency for their riders. But these projects also usher in the need for significant advancements in how modern-day railroads are designed, constructed, and maintained. In 2018, Bentley Systems introduced OpenRail Designer to replace its existing Bentley Rail Track design software. OpenRail Designer enables detailed engineering and 3D design of track that supports digital workflows, where engineering deliverables are meant to be reused throughout the asset lifecycle, playing a vital role in delivering safe and reliable operations.

Safety is a key responsibility of rail infrastructure owners and operators. In the United Kingdom alone, there are 20,000 miles of track, 30,000 bridges, tunnels, and viaducts, and thousands of signals, level crossings, and stations that must be thoroughly inspected, repaired and maintained. With infrastructure under constant stress from weather and increased capacity demands, the scale of

the challenge facing the industry is clear. Railway owners and operators must balance public and employee safety obligations with economic pressure to maximize efficiency and minimize costs related to maintenance.

When working on new or legacy rail systems planned for expansion or modernization, early adoption of intelligent modeling and digital delivery is essential to lay the foundation for successful rail operations and maintenance.

The traditional design process is labour intensive, requiring multiple draftspersons to do manual CAD work to create drawings. That process makes change management difficult, with any change to the track design requiring significant rework of the drawings. These 2D-centric workflows also lack 3D modeling for design checks, clash detection, and BIM requirements. Automation is limited, and is often driven by spreadsheets and custom macros, which are prone to human error.

Adopting OpenRail Designer's intelligent 3D modeling and a connected data environment to improve workflows, optimize project delivery, and improve overall service, safety, and reliability is a first step to preventing failures and unplanned downtime.

BETTER UNDERSTAND EXISTING CONDITIONS

Regular inspections and preventative repairs are a fundamental component of railway maintenance. Today, manual track inspections

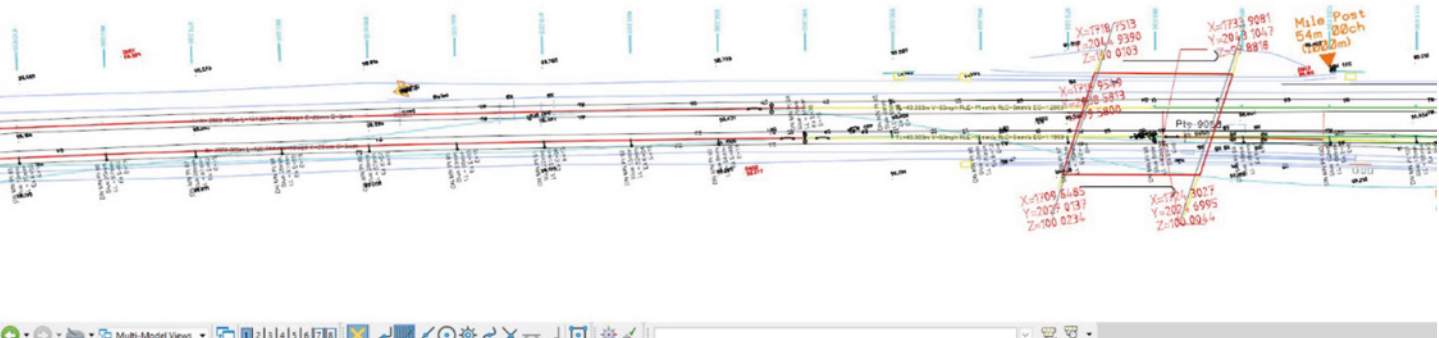


Figure 1: Understanding existing conditions.

by rail professionals are still a common form of data acquisition. Technology plays an important role in facilitating and supporting experienced personnel to increase the frequency and accuracy of track monitoring activities, helping them to better understand existing conditions. Combining technology with industry knowledge and experience enables engineers to prioritize critical maintenance. Leveraging drones and Internet of Things (IoT) sensors can enable large sections of the railway to be surveyed quickly and cost effectively. AI and machine learning can support the analysis of large volumes of track imagery and data to identify maintenance needs, proactively addressing potential issues.

Periodically surveying the rail positions provides inputs for calculating rail parameters, such as rail gauge, Cant, and curve radii used to analyse the condition of the railway geometry. The amount of survey data generated is massive and virtually impossible to manually analyse. The ability to compare and analyse multiple surveys conducted over time improves decision-making.

For example, consider a survey, such as in **Figure 1**, showing the elevation of one of the rails is decreasing resulting in an unwanted twist of the rails. This condition not only decreases passenger ride comfort but could potentially develop into an unsafe situation. Comparing surveys done over time can provide crucial information for understanding the development of the issue and predicting how quickly it might progress. If the decrease of the rail elevation has not changed in recent surveys and the elevation difference is within tolerance, this issue will need to be monitored in future surveys but may not require immediate maintenance. However, if the rail elevation difference is increasing in recent surveys, maintenance may be needed. Periodically surveying the same railway and comparing the survey data provides information to predict when a fault will reach its threshold value, and the situation may become unsafe. Using modern technology, such IoT, to monitor rail conditions in real time can expedite the analysis and prediction of required railway maintenance.

USE DATA TO INFORM DESIGN

The survey data normally consists of 3D points—horizontal location and an elevation—along the inside of the railhead, or it could include calculated points from the rails forming the centreline of railway.

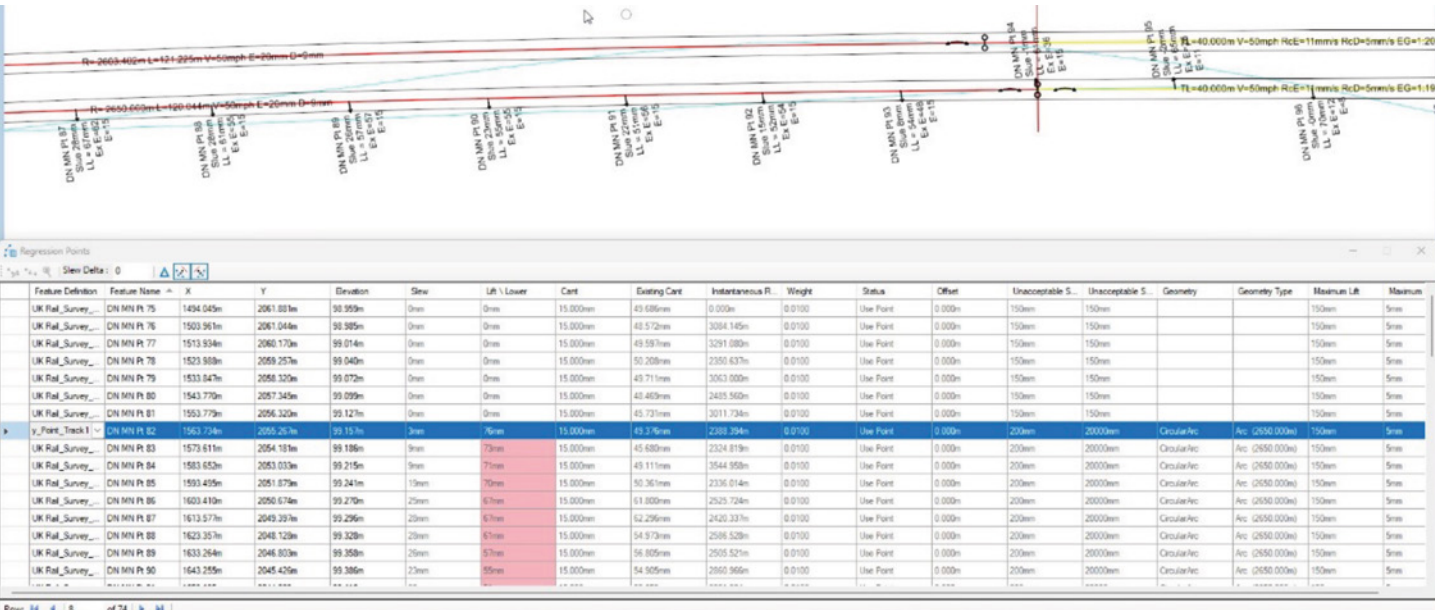


Figure 2: Survey and design review.

There are many ways to collect data points, such as extracting the points from point clouds and photogrammetry, specialized track surveying equipment, or IoT track sensors. No matter how the data is collected, it is important to understand the age of the survey, the accuracy of the data, and the coordinate system in which the points are aligned.

REGRESSION DESIGN, AN ITERATIVE APPROACH FOR BETTER OUTCOMES

OpenRail Designer provides the common data environment to view, analyse, and compare current survey data with historic models from previous maintenance or renewal surveys.

When an area requiring work is identified, the railway geometry is modeled describing the corrections that need to be made to the railway. This work is called regression design.

The survey data is handed over to a track designer, who regresses or re-creates a suitable railway centreline geometry that fits through the survey points. It is not possible to create the geometry exactly matching the survey data, since the survey is the current position of the railway, which has moved from its desired or optimal position. The track designer will regress the railway both horizontally and vertically while also taking into consideration the Cant, which is directly related to the route speed, rail gauge, and curvature. The track designer's knowledge and experience are crucial in the iterative regression design process to create a desirable track geometry with suitable Cant and provide minimal physical impact to the neighbouring tracks, equipment, and infrastructure. Both graphical and tabular feedback as shown in **Figure 2** aid the track designer when regressing the geometry. The model-based environment of OpenRail Designer provides both the engineering toolsets for track alignment regression and the 3D models for efficient design review and clash detection.

Before construction begins, a new track survey may be collected and the initial regression design compared against the new survey to validate that the proposed solution is within the appropriate design standards. Any design adjustments and revalidation are easily performed at this stage before the final approval.

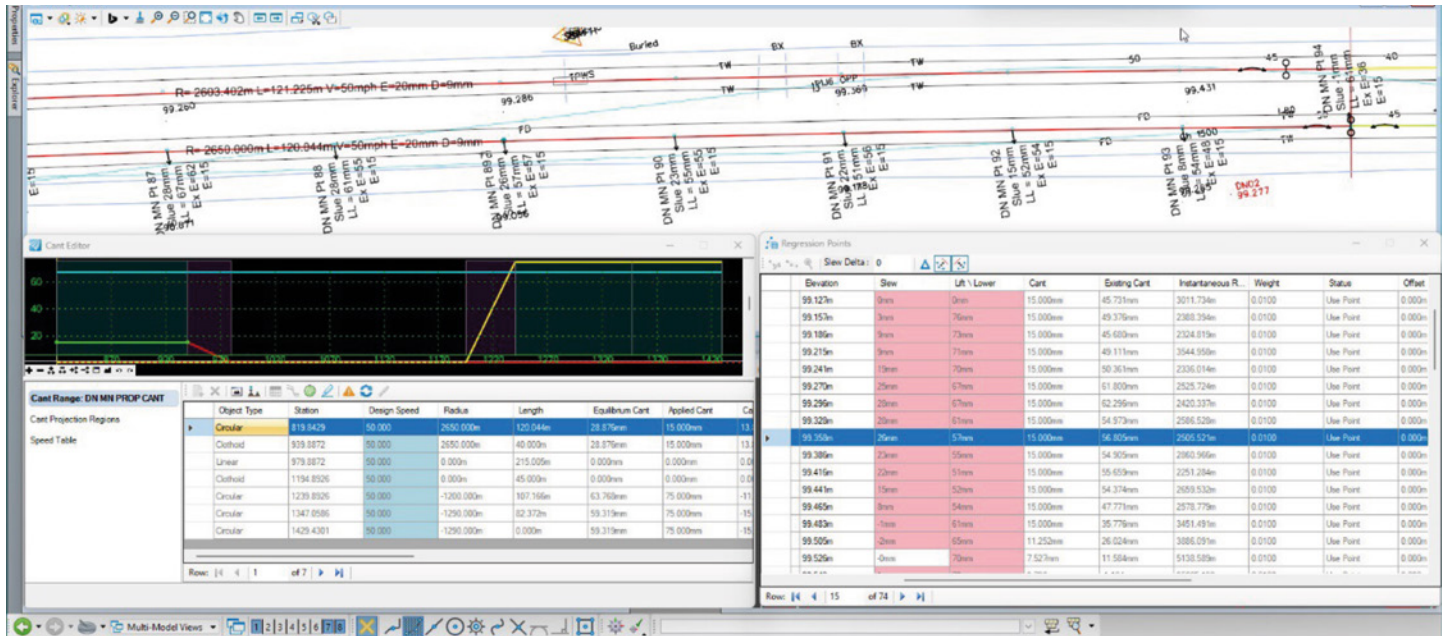


Figure 3: Geometry Model.

MORE EFFICIENCY AND LESS REDUNDANCY, GAINING VALUE FROM THE GEOMETRY MODEL

OpenRail Designer provides both graphical and tabular tools as shown in **Figure 3** for designers to quickly and efficiently evaluate multiple regression scenarios using geometry models. The geometry model is constructed using tangents (straight railway) and curve sets (combinations of transition curves and circular curves), both horizontally and vertically. While designers work in the familiar horizontal and vertical layouts, the software automatically combines them into a 3D geometric model of the track. Cant, the difference in elevation between the two rails, is applied to the geometric model so one rail is higher than the other through curves. Cant, a function of the curve radius, railway gauge, and speed, improves ride comfort and the distribution of loads across both rails. Railways trafficked by both faster and slower trains have mixed Cant requirements. For example, the required Cant for a freight train will likely result in poor riding comfort for a faster passenger train. This is where design of applied Cant and Cant Deficiency achieves a compromise to both accommodate the freight train and provide the riding comfort for the passenger train.

Geometry is also defined with chainage (or stationing), which is the distance from the start of the geometry. The chainage, elevation, perpendicular offset, and rotation relative to the bearing of the geometry is widely used to describe locations of trackside objects.

The geometry model is also fundamental for other railway engineering disciplines such as roadways, earthwork volumes, bridge and tunnel structures, signalling, and electrification. The OpenRail Designer geometry model is the single source of truth referenced by everyone. Because all disciplines are using the same geometric model, the risk of not having the latest changes is virtually eliminated allowing work to progress in parallel.

DRIVE COLLABORATION AND INFORMED DECISION-MAKING

Gain insights throughout the asset lifecycle

The railway geometry model is crucial to an efficient, modern, collaborative design environment. The renewal design will apply changes to the original design. Even if the changes are small, they may have a negative impact on other railway equipment. Any railway geometry changes may impact clearance tolerances, which need to be checked, and, in the worst case, need to be adjusted. A clearance issue found reviewing the model overlaid with trackside equipment is much easier and less costly to correct than if this issue is not found until construction.

The model can contain all the data. In addition to the railway geometry elements, it can contain related trackside equipment, asset identification, metadata, and much more. It becomes a true representation of the real world, otherwise known as a digital twin. In this case, a digital twin is a virtual representation of the railway, which can be composed of data from many different sources.

Traditionally, railway projects are delivered to construction as plan, long section, and cross section drawings as well as reports, schedules, and bills of materials. Uses of the deliverables are limited to the information the designer or drafter choose to include. Model-based or digital twin-based deliverables, on the other hand, empower the user to query the data they need when they need it. These can be traditional queries such as plan, long section, and cross section drawings or reports, but now the user can choose exactly what data to include in what area and interval.

Share the source model across disciplines and phases

Other railway engineering disciplines, such as signalling and electrification, are dependent on the geometry model. Any changes in the geometry model can result in changes to signalling and electrification that need to be reviewed and checked. For example, the location of the overhead line catenary wire in a curve needs to consider changes to the applied Cant in that curve. Any changes to the Cant will have three and a half to four times the radial effect on the contact wire, dependent on the contact wire height.

The design of the signalling system's pre-signalling point positions need to be calculated based on the line speed, vertical geometry gradients, and operating train's breaking characteristics. This is one of many design challenges where the geometry model directly constrains design outputs.

The renewal geometry model is also used for constructibility simulations, where the construction phases are planned and evaluated to determine the most efficient implementation as well as analysis of any challenges. Status information of the geometry model elements, what should be replaced, and what should be modified are fundamental information to the planning of construction phases.

Sharing the original source geometry model within the project is one of the most important aspects of a collaborative multidisciplinary design environment. To further support sharing the geometry model, project participants need to know what the latest version is and what changes are made between versions. Secure data governance of today's engineering work-in-process documents including federated models, references, and versions, along with digital twins, is critical to efficiently managing these powerful data rich environments.



Figure 4: Visualize designs in real world context.

Turn data to insights with a railway digital twin

Since digital twins are computer software agnostic, different data can contribute to enhancing them. As different models, processes and systems are fed into the digital twin over time, it becomes a true virtual representation of the current, and past, conditions suitable for operational monitoring, maintenance, and future development.

Reviewing a digital twin usually does not require any specialist software, which makes it easy and quick to access. For example, the Bentley Infrastructure Cloud is a cloud based digital twin environment fed from OpenRail Designer where users can project models and plan sheets from anywhere with internet access.

Plan, profile, and cross section views, supported with reports and visualizations such as shown in **Figure 4**, can be extracted at any position from the 3D model-based digital twin as needed. Digital twins are scalable to serve the lifecycle of an asset, so a railway digital twin can start with rail geometry, related track corridor equipment, and a terrain model, and can grow over time as the railway is constructed, put into service, and maintained.

DELIVERING SAFE, RESILIENT RAIL NETWORKS

The way we design and deliver contracts, as well as the way we plan our infrastructure, needs to change so that we can deliver the kind of modern, sustainable, and safe transportation systems that our communities need.

The rail industry stands to gain immense benefits from digital innovation throughout the asset lifecycle. Data is the foundation of infrastructure intelligence, and digital twins are the key to unlocking engineering data from files to be analysed and reused across the lifecycle. OpenRail Designer creates models that are easily fed into a digital twin.

Digital innovation can support the achievement of sustainability targets and provide a better service to infrastructure end users, including increased passenger and freight services. Embracing technologies, such as big data, the Internet of Things, and digital twins, together with artificial intelligence and machine learning techniques, enable engineers to collaborate in real time, evaluate the impact of changes more seamlessly, and significantly reduce rework and errors to deliver safer and more resilient projects in less time.

TEAMWORK IS MAKING THE DIGITAL RAIL INDUSTRY A REALITY TODAY

The PWI, several PWI member organizations, and Bentley have been working together for the past 18 months improving the efficiency of track design, regression, and review workflows using OpenRail Designer. Thanks to this fantastic partnership, the rail industry is better prepared to deliver the traditional project deliverables of today and digital deliverables of tomorrow at the same time with a single effort.



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The PWI Technical Board is our forum for all Corporate Members, to facilitate the sharing of the latest developments and knowledge in railway engineering.

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BRIDGING GENERATIONS A VOLUNTEER'S JOURNEY IN HERITAGE RAIL RESTORATION

The world of heritage railways is one of passion, ingenuity, and dedication. For John Hewlett, an experienced railway professional and volunteer, this world represents an opportunity to apply his skills in a meaningful way while supporting a community-focused project. His volunteer work at Llanelli And Mynydd Mawr Railway, a heritage railway in South Wales, exemplifies the vital role of technical expertise in preserving railway history.

FROM NETWORK RAIL TO HERITAGE RAIL

John Hewlett's career began with a mechanical engineering degree from Durham, leading to his role as Assistant Engineer for Network Rail in Swansea. Accustomed to maintaining and managing older track infrastructure with limited resources, his professional background prepared him for the challenges of heritage rail.

When the opportunity arose to volunteer, John initially hesitated, doubting the appeal of more railway work in his free time. However, encouragement from Nick Millington, then PWI President, and a desire to give back changed his perspective. "The heritage railway needed someone with formal track training," he explains. "I realised my experience could make a real difference."

REVIVING THE TRACKS

The railway John supports once served as a colliery freight line and retains much of its original track. However, years of wear had left the infrastructure in disrepair, culminating in a derailment that prompted a call for expert help. "Our first task was to assess the track," John recalls. "Unfortunately, most of it was in poor condition. We condemned sections and began scoping the work needed to restore safe operations."

Over the next year and a half, John and a rotating team of Network Rail volunteers tackled the daunting restoration. "We replaced old timbers with concrete sleepers, refurbished sections, and focused on creating a safe standard for slow-speed trains," he says. Their efforts culminated in reopening the railway, an achievement celebrated with the return of passenger trains just before Christmas.

THE IMPACT OF VOLUNTEERING

John's involvement has yielded benefits beyond track restoration. "For me, volunteering has been a way to keep my skills sharp," he explains. "I get hands-on experience I don't often have in my day job, and it's satisfying to see the immediate impact of our work."

The project has also strengthened community ties. From employing local residents to building a café using a repurposed rail carriage, the railway serves as a hub for education, preservation, and local engagement. "The railway is more than just trains - it's a vital part of the community," John says proudly.

EVEN IF IT'S JUST A FEW DAYS A YEAR, YOUR KNOWLEDGE CAN MAKE AN INVALUABLE DIFFERENCE ... HERITAGE RAILWAYS OFFER A UNIQUE OPPORTUNITY TO APPLY YOUR SKILLS AND EXPERIENCE IN A REWARDING WAY.

ENCOURAGING OTHERS TO GET INVOLVED

Heritage railways across the UK rely on volunteers with a wide range of expertise, from engineering to safety and management. John encourages others to consider lending their time. "Even if it's just a few days a year, your knowledge can make an invaluable difference," he says. "Heritage railways offer a unique opportunity to apply your skills and experience in a rewarding way."

John's story highlights the importance of skilled volunteering in preserving the past and inspiring the future. As he continues to support the railway's plans for expansion and development, his commitment stands as a testament to the power of collaboration and community spirit.



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BOOKSTORE: A LIFETIME OF RAILWAY ADVENTURES



Title: Railwayman – Engineer-Diver *Memories of a Lifelong Railway Engineer*
Author: Brian Maddison

For many of us, our career paths take unexpected turns, and few could claim a journey as varied and rewarding as Brian Maddison's. His book, *Railwayman – Engineer-Diver: Memories of a Lifelong Railway Engineer*, offers a fascinating insight into a profession that spanned over five decades and included groundbreaking engineering, underwater explorations, and a legacy of stories that celebrate the railway industry's rich heritage.

Brian's fascination with railways began in childhood, sparked by visits to watch trains with his father. One particular trip, where he witnessed heavy engineering work along the tracks, planted the seed for a lifelong passion.

However, his route to railway engineering wasn't direct. "I left school at 15 and drifted through a few dead-end jobs," Brian recalls. "At 17, I applied for a railway position, and that's when it all began."

Growing up near Peterborough, Brian's family had no direct connection to the railway - his father was a motor mechanic. But once Brian found his footing in the industry, he quickly realised the collaborative and supportive spirit of railway life. It was this sense of camaraderie that fuelled many of the anecdotes he recounts in his book.

One of the most intriguing chapters in Brian's career came during his time as part of British Rail's diving team. In the 1960s, scuba diving was a new frontier for underwater inspections, and British Rail pioneered the use of this technology for examining submerged bridges and harbour walls. "A railway engineer in Derby had the idea to train railway staff as scuba divers," Brian explains. "It was a novel approach, replacing traditional hard-hat divers with a more versatile method."

When Brian moved to Leicester, a colleague on the diving team encouraged him to join. After a brief training course, he was diving into murky rivers and harbours, inspecting structures that were vital to railway safety. But not all of his underwater experiences were grim. "One of the highlights was a contract in Greece to inspect the Corinth Canal. The clear blue water was a stark contrast to what we usually worked in," he shares.

While the book includes captivating tales of diving, it also delves into other aspects of Brian's career, including bridge works, station construction, and even the peculiar characters he encountered.

A standout story involves Lady Elton, a landowner who attended a site meeting on horseback, resplendent in formal riding gear. "She refused to dismount, and it was clear that her word was law," Brian laughs. "Eventually, we reached a compromise, but it was a surreal moment."

The decision to write the book was born out of a sense of gratitude. Reflecting on his career during the COVID-19 lockdown, Brian realised how fortunate he was to have enjoyed his work for over 50 years. "There were only two very short periods when I didn't enjoy my job. That's a privilege not many people can claim," he says.

Through the pages of his book, Brian hopes to inspire and entertain readers. "I've had colleagues tell me the book brought back their own memories, and that's been wonderful to hear," he says.

Notably, all proceeds from the book are donated to the Railway Children Charity, an organisation close to Brian's heart. Founded by a British Railways manager after witnessing the plight of children living on railway platforms in India, the charity has been a focus of support for Bridgeway Consulting, the company Brian co-founded after British Rail's privatisation. "Even after retirement, I wanted to continue supporting their work," he says.

Brian's book is not just a memoir but a celebration of the railway industry's history, its resilience, and the people who make it thrive. Available on Amazon for £17.99, *Railwayman – Engineer-Diver* is a must-read for anyone interested in the railways, engineering, or simply a good story.



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The equipment used when Brian first started diving (left) and the equipment used today (right). (Image courtesy of Brian Maddison).

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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.

Collaboration, leadership and innovation are the expected norms in today's working environment. This Seminar explores how we can further embrace these attributes to deliver more efficient ways of working.

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

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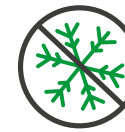
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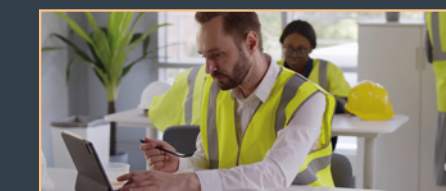
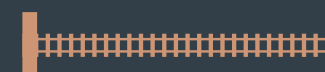
Crewe BHIL re-signalling,
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Presenter: Jon Hayes
Date: 18 March 2025

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Presenter: Julian Staden
Date: 1 April 2025

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

CPD



BRIAN PARKINSON
PROFESSIONAL REGISTRATION
DEVELOPMENT OFFICER
profeng@thepwi.org

LESSONS LEARNT FROM 2024'S CPD AUDIT

Achieving PWI Professional Registration is a very proud moment because it confirms recognition from your peers of your skills, knowledge and experience but it is equally important we maintain these competences in the future.

Like other professions, we do this by carrying out Continuous Professional Development (CPD), and the PWI carries out a yearly audit of 5% of members' CPD records. The audit results are not just an Engineering Council requirement but also help us to advise and guide our members on the benefits of CPD.

This year's audit found CPD records contained a very broad selection of activities and subjects. These included attendance at seminars, online Lunch and Learns, reading technical reports, and attending employer in-house training. The records usually included specific lessons learnt and reflective thoughts indicating future actions, but we did note some activities did not link to a Personal Development Plan (PDP) objective, and some records did not link to any associated Plan at all! We also felt that some objectives in PDPs were perhaps too high level for members to usefully measure progress.

Overall, we felt many activities recorded were likely to be training needs agreed at annual reviews with the member's line manager. These requirements are clearly important to maintaining engineering competence in your current post, but in a changing industry with regular reorganisations, we would recommend your PDP is an opportunity to develop some personal actions for your future career.

For example, you could set an objective to gain a more detailed understanding of embankment instability, rail wear degradation or the risks associated with managing critical rail temperatures.

Perhaps you think in the future it would help to have a better understanding of how work programmes or projects are initiated. All the above topics are covered in the rail media, PWI Journal, our excellent Lunch & Learn programme, and local Section meetings.

Many years ago, I remember hearing my soccer coach shouting from the side "somebody put your foot on the ball." The game was very frantic, and players were just reacting without a plan of the next move. Eventually, a player stopped the ball to think, and passes were then better controlled... until I got the ball! You may recognise the situation in your daily work on occasions. Perhaps we should all make time to "put our foot on the ball" and consider how we will prepare personally for inevitable changes.

The industry faces a great deal of change: the establishment of Great British Railways, a rapidly changing climate, and vast amounts of industry and engineering data being produced, to name a few. So we recommend you also include some specific personal aims in your PDP which can help you develop your future career aspirations alongside your current role requirements.

Your CPD record should then include reflection on what you have learnt, to assess whether you are heading in the right direction. Future changes can be challenging but from my own experience they also provide opportunities. If you would like to discuss your Development Plan, then please do not hesitate to contact the PWI Registration team (profeng@thepwi.org).



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MORE ABOUT
WHAT GOOD CPD
LOOKS LIKE.



DID YOU KNOW...

As a Member of the PWI when you attend a **Section Meeting, Lunch & Learn** presentation or other training event this is automatically logged on your online CPD record?

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USEFUL RESOURCES

TO SUPPORT YOU IN PUTTING TOGETHER YOUR CPD AND PDP RECORDS

Some of the current PWI Professional Registrants have kindly agreed for us to share examples of their submissions to support fellow Members undertaking their applications. You can view these online along with other useful resources such as historical annual CPD audit learnings, and a list of examples of what counts as CPD.



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MONTHLY PROFESSIONAL REGISTRATION SUPPORT

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!

PWI GUIDANCE ON ENGINEERING COUNCIL COMPETENCE REQUIREMENT E4: CARRY OUT AND RECORD YOUR CONTINUING PROFESSIONAL DEVELOPMENT (CPD)

INTRODUCTION

The Engineering Council requires engineers seeking or holding professional registration at each of its three registration levels, to carry out and record the continuing professional development (CPD) necessary to maintain and enhance competence in their own area of practice. This requirement is described as competence "E4". The competence sits within the "E" group of competences which set out expected levels of personal and professional commitment.

PURPOSE

But what does that requirement mean in practice for professional engineers and for those seeking registration? What does it mean for you? This note sets out our Institution's view of what you, as an individual engineer, should do to satisfy the Engineering Council requirement.

SATISFYING THE REQUIREMENT

Competence E4 is intended to ensure that engineers maintain and enhance their competence in their own area of practice. This will not happen by accident or by default: it requires forethought and planning, active learning through a range of activities, and consideration of both the value of the learning experienced and how that learning can be applied in your role as an engineer. This can be summarised as PLAN – DO – REFLECT.

THE ENGINEERING COUNCIL REQUIRES ENGINEERS SEEKING OR HOLDING PROFESSIONAL REGISTRATION AT EACH OF ITS THREE REGISTRATION LEVELS, TO CARRY OUT AND RECORD THE CONTINUING PROFESSIONAL DEVELOPMENT (CPD) NECESSARY TO MAINTAIN AND ENHANCE COMPETENCE IN THEIR OWN AREA OF PRACTICE.

PLAN...

Your Personal Development Plan (PDP) sits at the heart of your continuing professional development. It should:

- describe 5-7 personal focuses for the next 12 months
- summarise your longer-term development aims for the next 4 or 5 years
- contain a mixed variety of intended CPD activities e.g. formal education and training, seminars and lectures, site visits, study tours, reading, online learning, and other personal study
- cover a range of competences e.g. technical, production, safety, sustainable development, and managing and developing others in the context of your role
- over time, relate to the full range of Engineering Council competences from A1 to E5.

DO...

The Engineering Council requires that you record your CPD activities. For each activity you should record:

- a summary of each learning activity, cross referenced to your PDP
- the date(s) on which the activity was undertaken, and the time spent on it (generally the number of hours)
- the key aspects of the learning you took away from the activity
- a description of, and reflection on, how that learning will affect what you do and your outlook on your work (and personal) environment in the future.

The Institution expects members to spend a minimum of 30 hours engaged in CPD activities in a 12-month period.

REFLECT...

As noted above, your CPD record *must* include personal reflection on each CPD activity. Examples of reflection include:

- what significant things you learnt, how those things are applicable to your current or future roles, and how they broadened your experience
- whether the activity supported a PDP objective in the way you expected
- an evaluation of the activity itself, e.g. was it well organised and well presented, was it directly or indirectly helpful to you now or in the future, did it represent value for the time spent
- how you intend to apply the learning achieved
- whether and how the learning changed your broader attitudes or approaches
- whether you can pass on all or some aspects of the learning to others with whom you work, and the value that might deliver
- whether and how the learning affects your ongoing PDP.

As well as reflecting on each CPD activity, it's beneficial to consider doing an annual personal review, reflecting on how well, in overall terms, your CPD matches the aims set out in your annual PDP and future development plans.

MY CPD

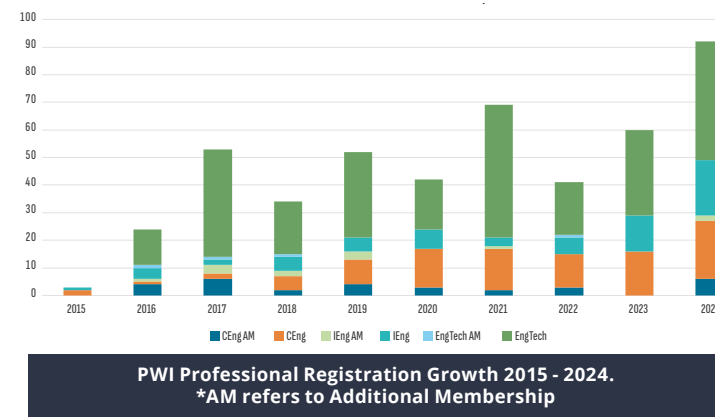
Did you know of our exclusive member benefit? Accessed through your portal on our website, you can create PDPs and log CPD activity. All activity booked directly through the website is automatically logged, so all you need do is add your reflection!



THE 140 CHALLENGE: A JOURNEY OF PROFESSIONAL GROWTH

In the bustling world of railway engineering, 2024 marked a pivotal year for the PWI as we celebrated the Institution's 140th anniversary.

**"NOW THAT I AM A
CHARTERED ENGINEER
WITH THE PWI...
I FEEL MORE CONFIDENT
IN MY CURRENT ROLE
WHEN WORKING
ALONGSIDE MY PEERS."**



The "140 Campaign: The Challenge Awaits You!" was more than just a call to action - it was an invitation to professional growth. 92 engineers answered that call, each stepping forward to achieve Professional Registration. From seasoned professionals to emerging talents, they represented the diverse spirit of railway engineering.

Chris Fuller, a CEng applicant, reflects that for him, achieving Chartered Engineer status was more about "self-confidence through credibility" than career progression. "Now that I am a Chartered Engineer with the PWI," he explains, "I feel more confident in my current role when working alongside my peers." His journey, like those of his fellow challenge participants, was marked by determination and support.

Behind the scenes, mentors, sponsors, and supporters worked tirelessly. Drop-in surgeries, co-working sessions, and targeted support also became pivotal. Whether through an interest form, a personal email, or an inspirational session, each touchpoint brought engineers closer to us and their professional goals.

The numbers told a powerful story: 27 achieved Chartered Engineer status, 22 reached Incorporated Engineer level, and 42 gained EngTech recognition. More than statistics, these were individual triumphs - each representing countless hours of study, reflection, and professional development.

As the year drew to a close, 18 more applications stood ready, promising continued momentum into the new year. This campaign did more than help reach a numerical target - it ignited a movement of professional growth.

Looking ahead, the Knowledge 200 campaign promises to build on this momentum, continuing the PWI's mission of supporting and elevating railway engineering professionals.

In celebrating 140 years, with the support of our wonderful community, the Institution has been able to not only honour its history but also write a new chapter of inspiration and achievement.



#CHARTEREDWEEK

24 to 28 February | Celebrating Trusted Professionals

2025 is the first year of this new, national initiative #Chartered Week. This year's theme is Celebrating Trusted Professionals.

It's a great opportunity to recognise the Chartered heroes whose work and commitment help to strengthen public confidence in the sector. It's an opportunity to celebrate Chartered practice and the people, organisations and registrations that are raising standards of competence and ethics across society today.

This awareness campaign aims to:

CELEBRATE

The enduring power of Chartered practice in the modern world, and the registered professionals and teams who are making a difference.

EDUCATE

On the vital role Chartership plays in setting high standards of competence, conduct and leadership on our key industries and professions.

ADVOCATE

The value of being Chartered and encourage others to explore their own Chartered potential and other registration pathways.

Information shared from www.charteredweek.uk website

THE POWER OF CPD: HOW THE PWI SUPPORTS CAREER GROWTH



An Interview with recent EngTech awardee Hannah Thomson

Continuous Professional Development (CPD) plays a vital role in shaping the careers of railway professionals, offering opportunities for growth, confidence-building, and staying ahead in a fast-evolving industry. In an interview with PWI Marketing Manager Jade Dover, Site Engineer and PWI Member Hannah Thomson shares her personal CPD journey and how the PWI has supported her every step of the way.

NAME: HANNAH THOMSON JOB TITLE: SITE ENGINEER EMPLOYER: AMCO GRIFFEN

Hannah, can you start by sharing why you think Continuous Professional Development (CPD) is so important for professionals in the railway industry?

Absolutely. For me, CPD is not only a professional requirement; it's a way to constantly keep learning and growing as an Engineer. The railway industry is always evolving - new technologies, updated standards, and fresh challenges are constant. CPD ensures we stay relevant and can tackle whatever comes next with confidence.

That's a great point. You've been incredibly proactive in your CPD journey. Can you tell us how you got started and what motivated you to stay consistent?

It started during my Civil Engineering graduate apprenticeship, where I was required to keep a weekly log of my learning as part of one of my University modules. This got me into the habit of regularly keeping a record of whatever I was working on. When I looked back at the end of the year, I realised how much I had learned and what I had been capable of. Seeing my progress documented was a real confidence boost, especially when I could look back and think, "Wow, I've achieved so much this year." I wanted to continue the habit of recording and reflecting on what I had learned from different projects to make sure that all my work challenges and achievements were counting towards something.

That's inspiring. How did the PWI support you along the way?

The PWI was instrumental, particularly with the EngTech Accountability Workshop. The structure and regular sessions kept me on track and focused. Honestly, I don't think I would have pursued my EngTech registration without it. The support and guidance made the whole process far less daunting, and I was able to attend the sessions in between working and studying full time.

Many professionals struggle with keeping up their CPD records. What advice would you give to them?

My main piece of advice is to record little and often. Don't wait until the last minute to compile everything. Even though I have graduated now, I still treat my CPD like a mini module and make sure to set aside regular time to update my records. And reflection is key. It's not just

about listing activities but taking time to understand the value of what you've learned and where that knowledge might have a place in my toolkit in the future.

Speaking of reflection, the PWI has been introducing tools to make CPD easier, like automatic logging and reminders. How do you think these tools can help Members?

They're brilliant, having something that automatically logs your attendance or prompts you to reflect after an event is so helpful. Reflection is 50% of the process, so anything that nudges you to do that is beneficial.

How has CPD impacted your career so far?

It's been a game changer. CPD has helped me stay up to date with the industry, and it's boosted my confidence in my abilities. It's also made me more competitive in the job market. Employers value professional registration and see it as a sign of dedication. For me, CPD is about ensuring I'm a relevant and capable engineer, both now and into the future.

Finally, what would you say to someone considering joining the PWI to support their CPD?

Do it! The PWI offers so much - from workshops and webinars to a supportive community. It's a fantastic resource for staying on top of your professional development, connecting with others in the industry and showcasing different projects. Whether you're just starting out or looking to advance your career, the PWI can help you achieve your goals.

Hannah's journey demonstrates how CPD can transform a career, providing both personal growth and professional opportunities. With the PWI's tailored support, maintaining your CPD doesn't have to be daunting. As Hannah said, "It's about recognising your progress and ensuring your skills stay sharp for the future." For railway professionals, investing in CPD with the PWI's help is an investment in a fulfilling and resilient career.

2025 DATES FOR YOUR DIARY

INTERVIEW DATES

If you are going for IEng or CEng, use the submission deadlines - linked to our quarterly Professional Review Interview dates - to set your progress milestones.

SUBMISSION DEADLINE

(at least six weeks prior to interview)

20 January 2025
28 April 2025
28 July 2025
20 October 2025

INTERVIEWS IN W/C

(to be held remotely)

3 March 2025
9 June 2025
15 September 2025
8 December 2025

ED&I COMMITTEE REFLECTION

A REFLECTION: NEURODIVERSITY IN THE WORKPLACE



ED&I MOMENT

The ED&I Committee continues its commitment to fostering inclusivity through engaging and thought-provoking discussions. In the latest ED&I Moment, Martin Davies delivered an informative presentation on hearing loss and deafness, aligning with the International Week of Deaf People, held annually in September.

This highlights the experiences of deaf and hard-of-hearing people and the importance of sign language as means of communication.

PROMOTING INCLUSIVITY FOR HEARING DISABILITIES

Hearing loss is more common than many might realise. In the UK, one in five people, 12 million individuals, are deaf or hard of hearing. By 2035, this figure is projected to rise to 14.2 million, according to the Royal National Institute for Deaf People (RNID). These statistics underscore the urgent need for awareness and inclusive practices to support this growing demographic.

Martin highlighted that British Sign Language (BSL) is not simply a signed version of spoken or written English. Instead, it has a unique syntax and structure, meaning that subtitling or written English is often inadequate as an alternative for communication.

Recognised as an official language on 18 March 2003, BSL gained further legislative support with the BSL Act 2022. This Act builds on the Equality Act 2010 and requires government departments to report on their use of BSL, including how many publications are available in this format. Despite this progress, 50% of government publications remain inaccessible in BSL, emphasising the need for continued advocacy and action.

FOSTERING INCLUSIVITY IN COMMUNICATION

To create inclusive environments for individuals with hearing disabilities, Martin shared practical communication tips from the RNID:

- Rephrase and simplify messages
- Engage in face-to-face communication

- Use a BSL interpreter
- Provide written alternatives:
- Minimise background noise
- Give undivided attention

These strategies are invaluable not only in day-to-day interactions but also in professional settings, such as meetings and events, ensuring everyone feels included and valued.

REFLECTIONS FOR THE PWI COMMUNITY

This presentation served as a timely reminder of the importance of considering hearing disabilities in our practices and inspired further reflection on how we can support the International Week of Deaf People's mission to create a more inclusive and accessible society.

Whether it is through the use of BSL interpreters at events, reducing background noise during seminars, or ensuring written resources are readily available, these small changes can make a meaningful difference. By embracing inclusivity and supporting the use of BSL, the PWI community can contribute to breaking down barriers for those with hearing disabilities.



FIND OUT
MORE ABOUT
INTERNATIONAL
WEEK OF DEAF
PEOPLE

**1 IN 5, 12 MILLION INDIVIDUALS IN THE
UK ARE DEAF OR HARD OF HEARING.
BY 2035 THIS IS PROJECTED TO
INCREASE TO 14.2 MILLION.**

Royal National Institute for Deaf People (RNID)

At the age of 51 I was diagnosed as being autistic. This did not come as a shock but it did raise a lot of questions and took some time to process my new label. Most people are aware of autism but what does it actually mean?

Autism is not an illness or disease, it means your brain is wired to work in a slightly different way to the majority of people. You don't 'catch' autism or develop it, you are simply born that way. There is no 'cure' for it and there's no need for it to be cured but it does need greater awareness so that the autistic person and the people around them are able to understand how seemingly everyday situations can affect them in unexpected ways.

The autistic spectrum is very wide and no two people are the same. Someone with so-called 'classic autism' may be unable to communicate and need constant care and supervision while someone with 'high-functioning autism' (formerly known as Asperger's Syndrome) might be an inventor, scientist or even a railway engineer.

**"I CAN COME ACROSS AS BLUNT AND
TO-TO-POINT IN MY COMMUNICATIONS
WITHOUT REALISING.
ONE LINE MANAGER DESCRIBED ME AS 'MASTER
OF THE BLUNT EMAIL', WHEN I THOUGHT I WAS
BEING UNNECESSARILY CHATTY!"**

The latter type of autism can be less obvious, with friends and colleagues perhaps regarding you as a bit quirky or slightly odd but nothing more serious. So why is it an issue? A common trait amongst autistic people is a heightened sense of anxiety. This is a form of stress that can be triggered by obvious situations such as accident or financial problems but the autistic person can also get anxiety from issues that might seem very minor to most other people.

Working in an office environment can be challenging for an autistic person. Background noise can be very distracting to me and that's unavoidable in a large open plan office. Artificial lighting can literally be a headache. Then there's interaction with colleagues - I tend to take things that people say too literally. If someone says, "I'll be there in 5 minutes", after 6 minutes I have to remind myself they probably didn't mean exactly 5 minutes! A minor issue, perhaps, but an indication of the way the autistic mind can misinterpret other people's meanings or intentions. Failing to 'read between the lines' can lead to much bigger misunderstandings.

I can come across as blunt and to-the-point in my communications without realising. One line manager described me as 'master of the blunt email', when I thought I was being unnecessarily chatty! I asked other colleagues and friends if they thought my messages were blunt. The response was a resounding Yes! ('curt', was also mentioned!).

On a positive note, I am able to remember countless numbers and codes which comes in handy in a railway environment where everything is labelled in routes, miles and chains. I'm in my element when dealing with fixed assets that have been measured, labelled, tested, assessed and organised.

A major change in organisational structure put a lot more responsibility on me. As the months went on the volume of work increased and then crisis hit my family. Both of my parents became ill, my father had terminal cancer, and I was the sole carer for them. Added to this was my own family to care for, a mortgage to pay and not enough hours in the day to cope with it all. I had my own crisis, I went completely off the rails and could no longer think straight or find any balance in my life. My anxiety went sky high, I had no energy but could hardly sleep.

A friend suggested I try mindfulness. I had never heard of it but I was curious and desperate enough to try it. That was a real turning point for me. I found an excellent teacher and slowly but surely I got to learn how to use these subtle yet effective techniques for calming the mind. It helped to reduce anxiety, it helped to give me focus and it helped me to cope with stressful situations. It restored a balance to my life which had been missing for so long.

Autistic people can thrive in the right environment but finding the best conditions can be a challenge. My own situation went undiagnosed for over 50 years but luckily my employers were supportive when I discussed my condition with them. Minor adjustments to methods and patterns of working can have a significant benefit to the mental health of employees which in turn benefits the employer in the form of increased productivity. A flexible approach can reap rewards.

I don't speak for all autistic people because as stated earlier, no two people are the same. However, if someone has been identified as being on the spectrum and is willing to discuss it then take a few moments to listen to them and understand what small changes could make their working lives better. It may be minor, seemingly trivial issues that could be changed but it could mean a significant improvement to that person's peace of mind which, ultimately, is in everyone's best interest.



LEE HOLLAND
SOUTH AND WEST WALES
SECTION SECRETARY
southandwestwales@thepwi.org

SHARE YOUR STORY

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



LIZ TURNER
REGISTRATION MANAGER
liz.turner@thepwi.org

CONGRATULATIONS

OUR ANNUAL CELEBRATION EVENT TOOK PLACE ON 14 NOVEMBER IN NOTTINGHAM; A FITTING LOCATION AS IT WAS IN NOTTINGHAM THAT THE PWI WAS FORMED, 140 YEARS AGO.



We came together to collectively celebrate the individual effort by those in our community who have gained a professional title, a PWI Diploma, or were recognised for their technical paper, published in our quarterly Journal.

We were also delighted to present a number of Honorary Life Memberships to some exceptional individuals who have each made significant contributions to our Institution, in recognition of their impact and dedication.

OUR PRESIDENT MONA SIHOTA, CALLED ON ALL AWARDEES TO BE PROUD OF THEIR ACHIEVEMENT - SOMETHING HARD GAINED BUT WHICH NOW CAN NEVER BE TAKEN AWAY.

Our president Mona Sihota, called on all awardees to be proud of their achievement - something hard gained but which now can never be taken away; to keep pushing to make things better in an industry for which they are the future; and to carry on with their own journey and be a role model, supporter and champion.

Russell Jackson CEng FICE FPWI, EVP Global Transit at AECOM gave the keynote address. Russell is a civil engineer with over 30 years' experience in executive business management, major project design management and multi-disciplinary engineering of infrastructure projects mostly within the rail sector.

Russell spoke of his pride in being a Fellow of the PWI, noting the journey we have been on in expanding our remit with the vision to embrace railway engineering as a whole, and driving technical leadership and training, diversity of membership, and the careers of members.

Russell told of his career experiences via three drinks: goat milk with blood in Tanzania, mango daiquiris in Bangalore and thick vanilla milkshakes in Dallas. There are clear and progressive steps to CEng, but then what? You're then through the door into an open world and have to make your own next step.

- Find a great mentor, value them, and keep in touch with them.
- Master a role and then make way for someone else ready to take over, bringing new ideas and energy.
- Step up to new opportunities and challenges: 'give it a go, and see what happens'.

"PERSONAL AND PROFESSIONAL GROWTH IS AT THE HEART OF OUR CULTURE, AND WE ARE IMMENSELY PROUD OF THE ACHIEVEMENTS OF OUR MEMBERS." STEPHEN BARBER, PWI CEO

THIS YEAR'S AWARDS:

- ▶ EngTech
- ▶ IEng
- ▶ CEng
- ▶ PWI Diploma
- ▶ Journal Awards
- ▶ Honorary Life Membership



Scan to view more photos from the PWI Celebration Event 2024

Congratulations to those in attendance:

ENGINEERING TECHNICIAN: Dominic Meakin, Daoud Hamdani, James Rusbridge, Jamie Bell, Lewis Baird, Mateusz Krzemien, Matthew Evans, Neil Wightman, Ross Clark, Simon Wu.

INCORPORATED ENGINEER: Christopher Bench, Daniel Rogers, Lewis Kenyon, Marisa Bajerski, Mark Jackson, Martin Dewhurst, Michael Goodwin, Robert Tait, Zara McLoone.

CHARTERED ENGINEER: Adam Batson, Andrew Mulholland, Andrew Jones, Ben Cuthbertson, Chris Fuller, Dave Speakman, Eamonn Maloney, Graham Penfold, John Hewlett, Matthew Frost, Philip Dooner, Tony Morgani.

JOURNAL AWARDS

Gold Journal Award: (Co-authors) Koohyar Faizi, Maria Gallou, Matthew

Brough 'Rail trackbed stabilisation using micro-piling'

Silver Journal Award: Peter Heubeck, 'Resurrecting Railways: Lessons from two Scottish projects'

PWI DIPLOMA IN TRACK ENGINEERING: Chukwudumeje Oddie-Okeke, David Smith, Edgar Hayward-Fitch, Isobel Catt, Jamie Bell, Jamie McMahon, Jamie Shakespeare, Liam White, Nayab Siddique, Paul Granger, Paul Miller, Thomas Minards.

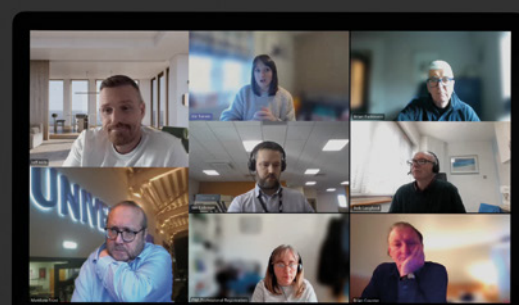
PWI DIPLOMA IN ELECTRIFICATION ENGINEERING: Anthony Asagba, Sam Hayes, Steve Davies, Tom Wong, Zamaan Lophi.

HONORARY LIFE MEMBERSHIP: Andy Franklin, Bob Langford, Chris Parker, Jonathan Bray, Phil Ransom.



PWI VOLUNTEERS – WHAT A TEAM!

Our Institution is undoubtedly proud of every Member who pursues and attains a professional title, and we are always pleased to recognise the time and effort required from them to achieve that. But, in addition, it is right that we recognise the extraordinary volunteer effort that sits behind every election.



This small army of dedicated volunteers – Scrutineers, Reviewers, and those who sit on our Membership Committee, Academic Panel, and Professional Development Committee - are committed to supporting the development of others, and the professionalisation of the industry. Without them, we could not offer Professional Registration to our Members. And without them, our newly registered Members could not wear their celebratory smiles!

“I EXTEND MY HEARTFELT THANKS TO ALL THOSE MEMBERS WHO PROVIDE THIS CRITICAL SUPPORT, AND TO THOSE EMPLOYERS WHO ENABLE IT.”

I extend my heartfelt thanks to all those Members who provide this critical support, and to those employers who enable it: be in no doubt that your efforts and commitment are recognised and very much appreciated.

Martin McMullen, one of our Reviewers who focuses on the track engineering discipline has written of his volunteer work as follows.

It is an honour and a privilege to aid and assist the PWI as an EngTech Reviewer, but more importantly to help and support my fellow engineers of varying experience and background. The reviews I have undertaken have opened my eyes to the vast spectrum of talented people within our industry and introduced me to many different methods and techniques of problem solving, delivering tasks and meeting challenges head-on. (I'll happily borrow others' solutions with pride to use with my own team!)

It's hugely encouraging for all track staff to be given an opportunity to be recognised not only for the hard work and dedication they give to our industry but for what they have achieved. Taking the knowledge and experience they have gained, presenting it to an illustrious organisation such as the PWI and gaining the honour of EngTech, registering with the Engineering Council as a bona fide engineer and having letters after their name. The fact that I get to play a part in their journey is satisfying, rewarding and exciting especially when I hear of different projects and parts of the business and what's happening in other areas of the UK.

All in all, I find the process of undertaking the EngTech reviews a real benefit to myself - and it's a pleasure to assist my peers and the PWI.



STEPHEN BARBER
CEO
stephen.barber@thepwi.org



SCAN HERE
TO VIEW CURRENT
OPPORTUNITIES

SECTION UPDATES

JOIN OTHER PWI MEMBERS AND RAIL PROFESSIONALS IN YOUR REGION

By attending your local Section meetings, you can listen to expert talks and discuss different aspects of rail infrastructure engineering. Section meetings are open to all PWI Members, so you can dip into other regions whenever you want. Non-members are also welcome as a taster.

NORTH EAST SECTION VISIT: BRITISH STEEL, SCUNTHORPE



BEN BROOKS
VICE PRESIDENT
North-East England

17 LOCAL
SECTIONS

200+ MEETINGS
PER YEAR

LOCAL TECHNICAL
SITE VISITS

FACE TO FACE
AND ONLINE MEETINGS



Twelve of us had the pleasure of a guided tour around the Rod mill and Rail & Section mill on the afternoon and evening of Tuesday 15 October.

The British Steel team explained rail manufacture from blast furnace through the continuous casting and milling processes to a final rail product. It was fascinating to see the huge production facilities first hand and better understand all the quality controls that go into assuring the rail we install in the network.

ATTENDING A SITE VISIT WITH YOUR LOCAL SECTION IS A GREAT OPPORTUNITY TO GAIN FIRST-HAND EXPERIENCE ON-SITE AND SEE HOW OTHER PROJECTS HAVE COME TOGETHER.

We want to hear from you! Share your Section's experiences, stories, and successes with us. Whether it's a memorable meeting, a unique project, or an insightful discussion, your contributions can benefit the wider PWI community and inspire others to get involved. Help us showcase the incredible work happening across our Sections – together, we can amplify the value of knowledge-sharing. Send your stories to marketing@thepwi.org today!

OBITUARIES



SCAN TO READ
THE FULL VERSION OF
THESE OBITUARIES ON
THE PWI WEBSITE.



**Tribute to
Peter Roy Yarlett**
1943 - 2025

PWI Member Peter was devoted to his community through his love of brass bands, real ale, and steam engines. A former civil servant and active member of several groups, his hobbies brought him friends and adventures, from playing the cornet to exploring industrial heritage sites. Despite health challenges, he remained passionate and resourceful, connecting with enthusiasts online. Our thoughts are with his family at this time.



**Tribute to
Rodney Smith**
1932 - 2024

Our former long-standing Thames Valley Section member and committee member, Rodney Smith, passed away peacefully at home on Friday 15 December at the age of 92. Rodney was a regular attendee at Section meetings up until 2019, when travel from home from Witney became difficult for him. He will be well remembered by colleagues from WRCE offices in London, Reading and Oxford. We send our condolences to his wife Vera and family.

UPCOMING SECTION MEETINGS

WINTER/SPRING 2025

FEBRUARY 2025

PELAW JUNCTION RELAY
4 Feb 16:30 - 18:30
Lee Stevens and Gareth Hudson
IN-PERSON **NORTH EAST SECTION**

HOW WATER AFFECTS THE RAILWAY: KNOW YOUR ENEMY!
10 Feb 17:15 - 18:15
Iain Fox
HYBRID **SOUTH & WEST WALES SECTION**

TRU: HUDDERSFIELD TO LEEDS – DELIVERING ON THE GROUND
11 Feb 16:30 - 18:00
Stuart Witts
IN-PERSON **LANCASTER, BARROW & CARLISLE SECTION**

BEAULIEU STATION TRACKBED DESIGN
12 Feb 17:30 - 18:30
Dr Maria Gallou
IN-PERSON **NOTTINGHAM & DERBY SECTION**

MANAGING HIGH SPEED PERMANENT WAY
12 Feb 17:30 - 18:30
Andy Vickerstaff
HYBRID **LONDON SECTION**

A CHALLENGE TO THE VIRTUAL TRANSITION PRINCIPLE
19 Feb 12:45 - 14:00
Constantin Ciobanu
HYBRID **WEST OF ENGLAND SECTION**

TRACKBED INVESTIGATIONS AND DESIGNS 2025 UPDATE
19 Feb 17:30 - 19:00
Levente Nagy
HYBRID **GLASGOW SECTION**

RAIL 200: OR IS IT?
20 Feb 17:00 - 19:00
Gareth Dennis
HYBRID **YORKSHIRE SECTION**

MARCH 2025

AIRPORT METRO
4 March 16:30 - 18:30
TBC
IN-PERSON **NORTH EAST SECTION**

DEVELOPMENTS IN CAST MANGANESE CROSSINGS
4 Mar 17:00 - 19:00
Hannah Persson
HYBRID **YORKSHIRE SECTION**

OPERATIONS PERFORMANCE
10 March 17:15 - 18:15
Craig Fisher
HYBRID **SOUTH & WEST WALES SECTION**

TRILINK: THE INTELLIGENT RENEWAL OF WEST COAST MAIN LINE NORTH
11 March 16:30 - 18:00
David Gordon
IN-PERSON **LANCASTER, BARROW & CARLISLE SECTION**

WEST LONDON ORBITAL
12 March 17:30 - 18:30
David Mansfield
HYBRID **LONDON SECTION**

MONIRAIL – ADVANCES IN RAILWAY CONDITION MONITORING
19 March 17:30 - 19:00
Mani Entemazi
HYBRID **GLASGOW SECTION**

OPERATIONAL PRINCIPLES OF TAMPING MACHINES
20 March 17:00 - 18:30
Andy Batters
IN-PERSON **NOTTINGHAM & DERBY SECTION**

SCAN HERE TO RESERVE YOUR PLACE



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

APRIL 2025

BROWNEY CURVE WORKS
1 April 16:30 - 18:30
TBC
IN-PERSON **NORTH EAST SECTION**

PWI PRESIDENTIAL ADDRESS THAMES VALLEY
2 April 17:45 - 19:00
Mona Sihota
HYBRID **THAMES VALLEY SECTION**

TRACK RENEWALS ON ESKMEALS VIADUCT
8 April 16:30 - 18:00
Christopher Littler
IN-PERSON **LANCASTER, BARROW & CARLISLE SECTION**

TECHS FACTOR COMPETITION 2025
9 April 17:30 - 18:30
HYBRID **LONDON SECTION**

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**

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

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



FURTHER YOUR KNOWLEDGE WITH OUR RANGE OF TECHNICAL EDUCATION & TRAINING PROGRAMMES

Choosing to build upon your knowledge and expertise by enrolling on a PWI technical education and training programme is a great next step for your career. The PWI is a specialist in railway engineering and our expert tutors have years of practical experience working on the railway. This means that not only will you improve your technical knowledge but you will also benefit from individual and group coaching, receiving specific feedback in relation to your own next steps and career progression.

WHAT ARE THE BENEFITS OF UNDERTAKING FURTHER EDUCATION AND TRAINING?

- Enhanced knowledge in a specialist technical area
- Make your CV stand out
- Demonstrate a commitment to your professional development
- Career progression and opportunities
- Journey towards Professional Registration

WHY CHOOSE TO TRAIN WITH THE PWI?

- Industry recognised qualification
- Specialist tutors with real railway engineering experience
- Unique range of courses adapted to current railway requirements
- All courses are linked towards Professional Registration
- Courses validated with nationally recognised credits
- Competitively priced courses
- All courses are assessed and certificates awarded from a recognised licensed railway Institution

EARTHWORKS, DRAINAGE & OFF-TRACK ENGINEERING COURSE ONE COURSE, ONE WEEK

LEVEL 5 IN-PERSON DERBY

DATES: 12-16 May 2025 / 10-14 November 2025
IDEAL FOR: Engineers who want to develop their knowledge, understanding, and insights necessary to manage the risks presented by earthworks, drainage and associated off-track railway infrastructure assets.

- PROGRAMME:**
- Earthworks, slopes, cuttings and retaining structures
 - Drainage systems and water management
 - Level crossings and other infrastructure interfaces
 - Vegetation and lineside management
 - Third party interfaces
 - Good practice asset management.

ACHIEVEMENT: PWI Earthworks, Drainage and Off-Track Engineering Certificate
NEXT STEPS: Join the PWI as a Member. This is an advanced course in a complex subject area and involves interfaces with all other rail infrastructure. Look at other PWI courses and review your qualifications and experience which can lead you to Professional Registration at all levels.



SCAN TO
BOOK YOUR
PLACE

ADVANCED TRACK TECHNICIAN COURSE

LEVEL 4 IN-PERSON DERBY

DATES:
MODULE 1: 30 June-3 July 2025
MODULE 2: 17-20 March 2025 / 1-4 September 2025
MODULE 3: 28 April-1 May 2025 / 20-23 October 2025
IDEAL FOR: Newly qualified and experienced engineers who want to gain the knowledge and skills required for all technical staff involved in track maintenance, renewals or project activities on the railway.

- PROGRAMME:**
- Track theory, practice and surveying
 - Advanced surveying, design and switches and crossings
 - Asset management planning, CDM, quality assurance, report writing and on-track machinery supervision.

ACHIEVEMENT: PWI Advanced Track Technician Certificate
NEXT STEPS: You will be supported to make a formal application for Professional Registration to be awarded PWI EngTech.



Delegates on the Advanced Track Technician Course. (Photo courtesy of Andy Steele).

S&C REFURBISHMENT COURSE

LEVEL 5 IN-PERSON DERBY

DATES: 24-28 March 2025 / 13-17 October 2025
IDEAL FOR: Engineers who want to gain the knowledge and skills needed to plan and deliver safe and effective S&C refurbishment.
PROGRAMME:

- S&C components design and analysis
- Site survey and measurement
- Scoping and planning
- Practical sessions and a site visit to survey and prepare a plan.

ACHIEVEMENT: PWI S&C Refurbishment Certificate
NEXT STEPS: Join the PWI as a Member. This course is advanced level as it covers a full review of S&C types in the UK. It is essential that Engineers are fully aware of the design and maintenance aspects of layouts when proposing major repairs and refurbishments. Alongside other PWI courses, this certificate can be used towards Professional Registration at Incorporated Engineer level.

3RD/4TH RAIL ELECTRIFICATION COURSE

LEVEL 6 IN-PERSON LONDON

DATES: 7-10 July 2025
IDEAL FOR: Newly qualified and experienced engineers who want to gain the knowledge and skills needed for electrification engineering.
PROGRAMME:

- Electrification principles, application and safe practices
- Principal elements of DC electrification system
- Legislation, standards and codes.

ACHIEVEMENT: PWI Certificate in DC 3rd/4th Rail Electrification Engineering
NEXT STEPS: Join the PWI as a Member. This is an advanced course in DC electrification and equivalent to a module on the PWI Electrification Diploma and can be used towards Professional Registration at Incorporated Engineer level. Systems Engineers are recommended to undertake courses in other disciplines.



SCAN TO BOOK YOUR PLACE
ON ONE OF OUR TECHNICAL
TRAINING COURSES

“

THE COURSE PROVIDED ME WITH PRACTICAL KNOWLEDGE ABOUT THE DIFFERENT TYPES OF SWITCHES AND CROSSINGS ACROSS THE NETWORK,

(PERSPECTIVE WE FONDLY REFER TO AS ‘ON THE OTHER SIDE OF THE FENCE’ OUTSIDE NETWORK RAIL HIGH SPEED 1).

 **Wioletta Ciszewska,**
Asset Engineer (Track),
Network Rail High Speed

”



TAKE THE NEXT STEP IN YOUR CAREER: UNDERTAKE A PWI DIPLOMA

TRACK ENGINEERING DIPLOMA

LEVEL 6 IN-PERSON DERBY ONLINE

DATES:

MODULE 1: 9–12 June 2025 / 3–6 November 2025

MODULE 2: 10–13 February 2025 / 12–15 May 2025 / 29 September–2 October 2025

MODULE 3: 28 April–1 May 2025 / 15–18 September 2025 / 8–11 December 2025

IDEAL FOR: Newly qualified graduates, technicians, supervisors, track managers with some academic qualifications or seasoned track experience, who wish to develop their knowledge and skills at a higher level.

PROGRAMME:

- Track engineering
- Track design
- Advanced track asset engineering and renewals

ACHIEVEMENT: PWI Track Engineering Diploma

NEXT STEPS: Join the PWI as a Member. This is a nationally recognised railway diploma which will advance the holder's career. Formal credit equivalence at level 6 leading to potential Incorporated Engineer status.

ELECTRIFICATION ENGINEERING DIPLOMA

LEVEL 6 IN-PERSON DERBY LONDON

DATES:

MODULE 1: 19–22 May / 1–4 December 2025

MODULE 2: 14–17 July 2025

MODULE 3: 7–10 April / 20–23 October 2025

MODULE 4: 7–10 July 2025

IDEAL FOR: Newly qualified graduates, technicians, supervisors, track managers with some academic qualifications or seasoned track experience, who wish to develop their knowledge and skills at a higher level.

PROGRAMME:

- Systems and maintenance
- Design
- Advanced asset engineering, construction and renewals

ACHIEVEMENT: PWI Electrification Engineering Diploma

NEXT STEPS: Join the PWI as a Member. This is a nationally recognised railway diploma which will advance the holder's career. Formal credit equivalence at level 6 leading to potential Incorporated Engineer status.

“THE PROCESS ITSELF WAS DEMANDING BUT HIGHLY REWARDING. THE IN-DEPTH EXPLORATION OF TRACK MAINTENANCE, DESIGN, AND ASSET MANAGEMENT OFFERED A THOROUGH UNDERSTANDING OF THE COMPLEXITIES INVOLVED IN TRACK ENGINEERING.”



Zakaria Sejdani
Track Engineer & Vibroacoustic Systems Design, Infrastructure Team, MM SPA

“THIS DIPLOMA HAS EQUIPPED ME WITH THE TECHNICAL KNOWLEDGE NEEDED TO WORK CONFIDENTLY IN REAL-WORLD ENVIRONMENTS. I'VE GAINED A GREATER APPRECIATION FOR THE ROLE OF INNOVATION IN SHAPING THE FUTURE OF THE INDUSTRY AND HOW IT CAN DRIVE EFFICIENCY AND SUSTAINABILITY.”



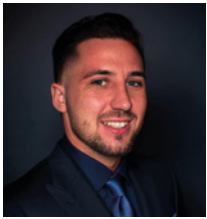
Denzel Maumbe
Graduate Design Engineer, Keltbray



ACHIEVE PROFESSIONAL REGISTRATION TOP-UP QUALIFICATION TO IENG

The PWI Track Engineering Diploma and Electrification Engineering Diploma are both 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 CASE STUDY



Towards the end of 2024, we caught up with Danny Whitworth, a PWI Member who has recently undertaken the Electrification Engineering Diploma, to find out about how his continuing professional development (CPD) is supporting him to further his career.

Danny kindly shared with us his experience of studying with the PWI and why he recommends that other railway engineers continue their education and technical training with the PWI.

NAME: DANNY WHITWORTH JOB TITLE: ELECTRIFICATION PLANT MAINTENANCE ENGINEER EMPLOYER: NETWORK RAIL

Can you tell us a little about your role and background?

I've just recently changed roles. Up until this week, I was a Senior Asset Engineer on the Anglia route, focusing on renewals and enhancements for electrification and plant. Now, I'm the Electrification Plant Maintenance Engineer for the high-speed line, based in Singlewell.

My career has always been centred around electrification and plant. I started with Network Rail around 2016, and before that, I was in supply chain project delivery. I began my journey in the technical drawing office in Ashford, working on electrical diagrams for Kent. By 2019, I transitioned into the Southern RAM team as an Asset Engineer, covering Kent, Wessex, and Sussex.

How has further education, particularly with the PWI, supported your career development?

In 2019, Network Rail began sponsoring me for university, which was a huge step forward. I completed two years of an HNC in Railway Engineering at Sheffield Hallam, covering all the disciplines. I was initially meant to go into signalling and telecoms, but when no one was available for electrification and plant, I switched paths. That led me to my master's in Railway Systems Engineering and Integration at the University of Birmingham, paired with a Level 7 apprenticeship.

Throughout this journey, the PWI courses have been invaluable.

What PWI courses have you studied, and how did you find them?

I've completed modules one through four of the Electrification Engineering Diploma. I actually booked myself and a colleague onto the course to deepen our understanding of OLE. The course was extremely valuable for helping me gain a broader technical knowledge, especially as I transitioned into OLE (Overhead Line Equipment) from a DC background.

One of the major benefits is that each of the three OLE modules contributed 20 credits towards my professional registration, which was significant for me. Altogether, those 60 credits at Level 6 were key in helping me meet the academic requirements to move forward with my Incorporated Engineer (IEng) registration. For someone like me who had already completed a foundation degree (HND) but needed further learning, this course filled that gap perfectly.

Have you been involved in other aspects of the PWI membership that has benefited your electrification career?

I've taken part in several activities with the PWI, all of which have been instrumental in advancing my career in electrification. One of the most memorable experiences was attending the PWI Electrification Challenge. It was an unbelievable, hands-on opportunity where we worked in teams to assemble a cantilever, run contact wires, and fit droppers and insulators. I even worked with a team from Transport for Wales. For someone like me, moving from a DC background into OLE, this kind of practical learning was invaluable - it gave me the confidence to apply what I'd learned in a real-world setting.

I've also attended PWI seminars, including one focused on DC systems, which was vital for refreshing my skills. These events not only help you brush up on your knowledge, but they also provide incredible networking opportunities. I've met people from all over the industry through PWI events and courses, and those connections have opened up new career opportunities for me. If I hadn't attended the course, I wouldn't have had access to some of the contacts and opportunities I've been able to pursue since.

Is there anything that you found challenging?

The course was certainly demanding at times, especially the travel. I attended the residential modules, so it required travelling to Derby and London for a week at a time. That was difficult, particularly because I'm based in Kent, but it was worth it for the hands-on learning. Studying while balancing work commitments was also a challenge, but I think that's common when you're pursuing higher education while working full-time. Overall, it was manageable and the benefits far outweighed the challenges.

How has the Electrification Engineering Diploma helped you in your current role?

It's been a massive help. The course has filled gaps in my knowledge and boosted my confidence, especially in my new role as Electrification Plant Maintenance Engineer. Beyond the technical knowledge, the diploma also counts towards professional registration, which is crucial for someone like me working towards chartered status. The modules contribute to the academic requirements needed for professional registration, which is a huge plus.

What advice would you give to someone considering the Electrification Engineering Diploma?

My advice would be to keep your notes and refer back to them, especially if your role doesn't involve using the course material every day. It's also great for CPD (Continuing Professional Development), so make sure to log those hours. Finally, the networking opportunities are brilliant - you meet people from all over the industry, and those connections can lead to future opportunities.

Thank you Danny for taking the time to share your career journey with us. We have no doubt other PWI Members will be inspired by your story.



STANDING OUT FROM THE CROWD

VolkerRail is a leading multidisciplinary railway infrastructure contractor.

With our sector focus solely on rail, we are uniquely placed to support our clients from design through to commission.

Having supported the development of most of the UK's light rail systems across the UK, we understand the challenges our clients face when maintaining, renewing or enhancing light rail infrastructure. We have a unique ability to adapt our services to work across varying track forms, undertaking annual maintenance and renewals through to full turnkey projects, which have transformed cities.

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THE PWI

PWI TECHNICAL SEMINAR

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

7 MAY 2025



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.

BOOKING NOW OPEN:
www.thepwi.org

£97 MEMBER
£177 NON-MEMBER
£20 STUDENTS

Sponsorship and exhibition spaces available. Please contact events@thepwi.org

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THE PWI

TECHNICAL SEMINARS

Route to Change: Navigating technology, infrastructure and behaviour

10 April 2025 | University of Manchester

Water Management on the Railway... what does it mean to me?

7 May 2025 | London

Electrification and Innovation: Rail's path to decarbonisation

2 July 2025 | Hilton, Cardiff

Track Renewals

5 November 2025 | University of Birmingham



SCAN TO
RESERVE
YOUR PLACE



TECHNICAL EDUCATION AND TRAINING PROGRAMME

DUE TO HIGH DEMAND, BOOK EARLY TO AVOID DISAPPOINTMENT

ADVANCED TRACK TECHNICIAN COURSE

LEVEL 4 IN-PERSON DERBY

Module 1

30 June-3 July 2025

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ELECTRIFICATION ENGINEERING DIPLOMA

LEVEL 6 IN-PERSON DERBY LONDON

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1-4 December 2025

Module 2

14-17 July 2025

Module 3

7-10 April 2025

20-23 October 2025

Module 4

7 - 10 July 2025 ●

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ONE COURSE, ONE WEEK

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TRACK ENGINEERING DIPLOMA

LEVEL 6 IN-PERSON DERBY ONLINE

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S&C REFURBISHMENT COURSE

ONE COURSE, ONE WEEK

LEVEL 5 IN-PERSON DERBY

24-28 March 2025

13-17 October 2025