



THE PWI
THE INSTITUTION FOR RAIL
INFRASTRUCTURE ENGINEERING

PWI ANNUAL MEMBERSHIP £90
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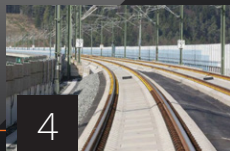
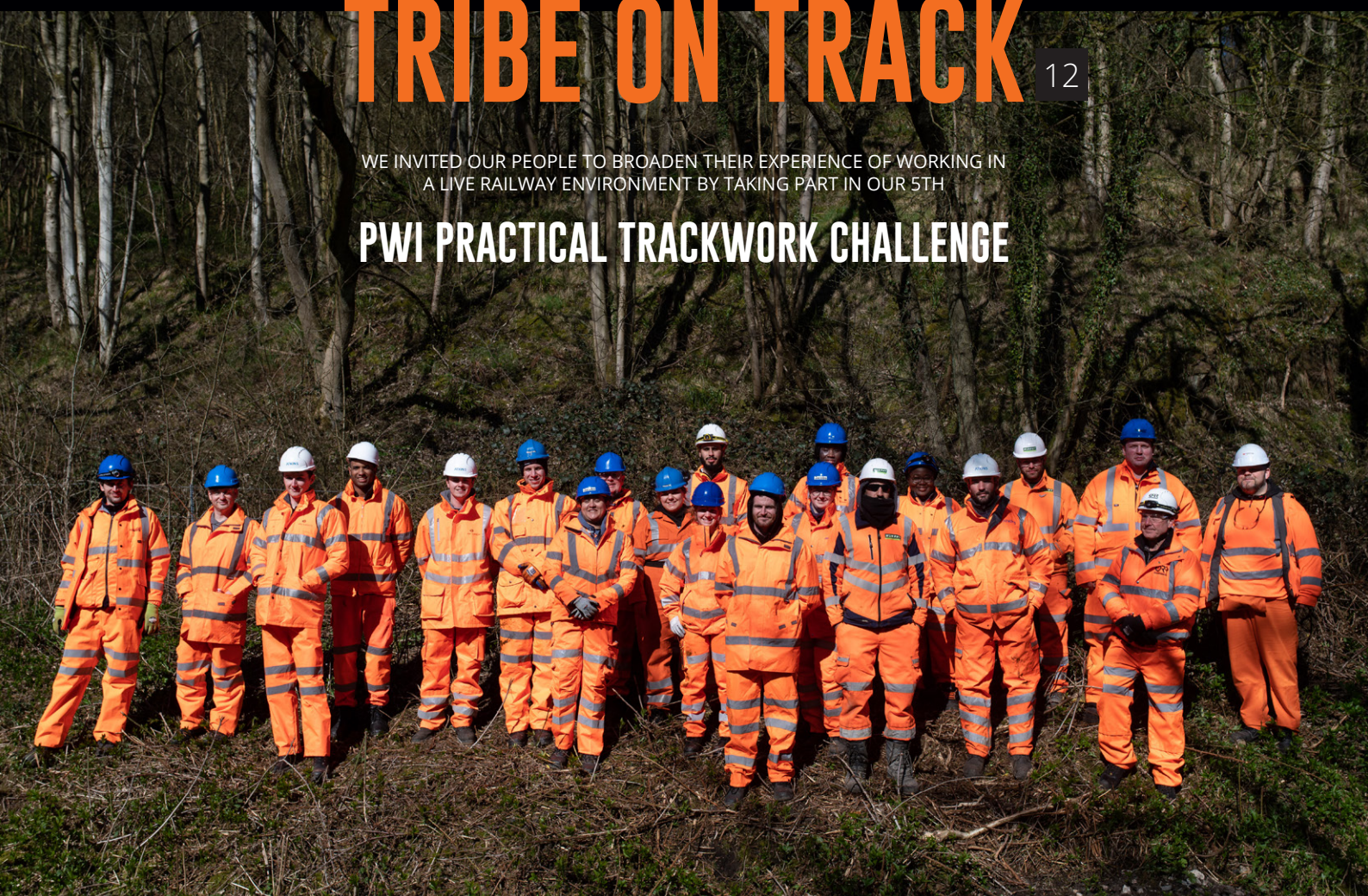
THE JOURNAL

JULY | VOL 140
2022 | PART 3

TRIBE ON TRACK 12

WE INVITED OUR PEOPLE TO BROADEN THEIR EXPERIENCE OF WORKING IN
A LIVE RAILWAY ENVIRONMENT BY TAKING PART IN OUR 5TH

PWI PRACTICAL TRACKWORK CHALLENGE



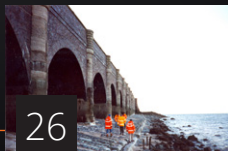
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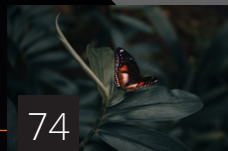
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BARBRO AWARD
PWI STAR OF THE YEAR



AWARD

OPEN TO ANYONE INVOLVED IN RAIL INFRASTRUCTURE ENGINEERING

THE PWI'S CLIMATE CHANGE ADAPTATION & DECARBONISATION AWARD

DESCRIPTION

The climate emergency and the absolute certainty that we need to both adapt and decarbonise global society is the largest and most important issue facing humanity. Engineering and engineers have a critical role to play in defining the policies and actions necessary to avert physical and societal collapse. Sponsored by WSP, this award will recognise an individual or team who, through their work, have made a positive contribution to climate change adaptation and / or decarbonisation within the boundaries of rail infrastructure.

ENTRY

Deadline 2 September 2022 to: secretary@thepwi.org
Please submit an original paper of 2000 - 2500 words on a relevant project or initiative, completed between 2019 - 2021. Papers will be judged against the following criteria; relevance to climate change adaptation and / or decarbonisation, benefits delivered and onward communication, quality of paper and demonstration of technical excellence. This award is open to anyone involved in rail infrastructure engineering.

AWARD EVENT

November 2022, London



THE JOURNAL

JULY 2022
VOL 140 PT 3

THE COPY SUBMISSION
DEADLINE FOR THE
NEXT JOURNAL IS
1 MAY 2022

FRONT COVER IMAGE:

**PWI Practical Trackwork Challenge
Churnet Valley Railway**

COPY / ADVERTISING

DEADLINES & ENQUIRIES

July 2022	DEADLINE - 1 May 2022
October 2022	DEADLINE - 1 August 2022
January 2023	DEADLINE - 1 November 2022
April 2023	DEADLINE - 1 February 2023

Kerrie Illsley, Creative Manager, journaleditor@thepwi.org

THE PERMANENT WAY INSTITUTION

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2022 PWI ANNUAL SUBSCRIPTIONS

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Member	£90.00
Member (66.5 or older at 01.01.22)	£37.00
EngTech Member*	£90.00
IEng/CEng Member*	£143.00
Fellow	£122.00
Fellow (66.5 or older at 01.01.22)	£48.00
EngTech Fellow*	£122.00
IEng/CEng Fellow*	£191.00

CORPORATE MEMBERSHIP

Sml enterprise (Turnover up to £17.5m pa)	£2,200
Med enterprise (Turnover £17.5m - £200m pa)	£5,500
Lrg enterprise (Turnover above £200m pa)	£11,000
Heritage railway	£150

PROFESSIONAL REGISTRATION

APPLICATION FEE: New Registrant** EngTech £60 / IEng £225 / CEng £225
APPLICATION FEE: Additional Membership EngTech £40 / IEng £90 / CEng £90
EngCouncil Fee* EngTech £20.30 / IEng £35.40 / CEng £41.72

* If you are professionally registered through the PWI the annual Engineering Council Registration fee will be collected in addition to your PWI subscription and will be paid to the Engineering Council on your behalf. ** Includes the Engineering Council Registration Entry fee.



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SHARE YOUR KNOWLEDGE

Whether you come from an academic or industry background, or a combination of both, if you are an expert in your field then we would love to hear from you.

Share your idea with us for a new technical article and our Technical Content Manager will get in touch to start the process.

Email journaleditor@thepwi.org

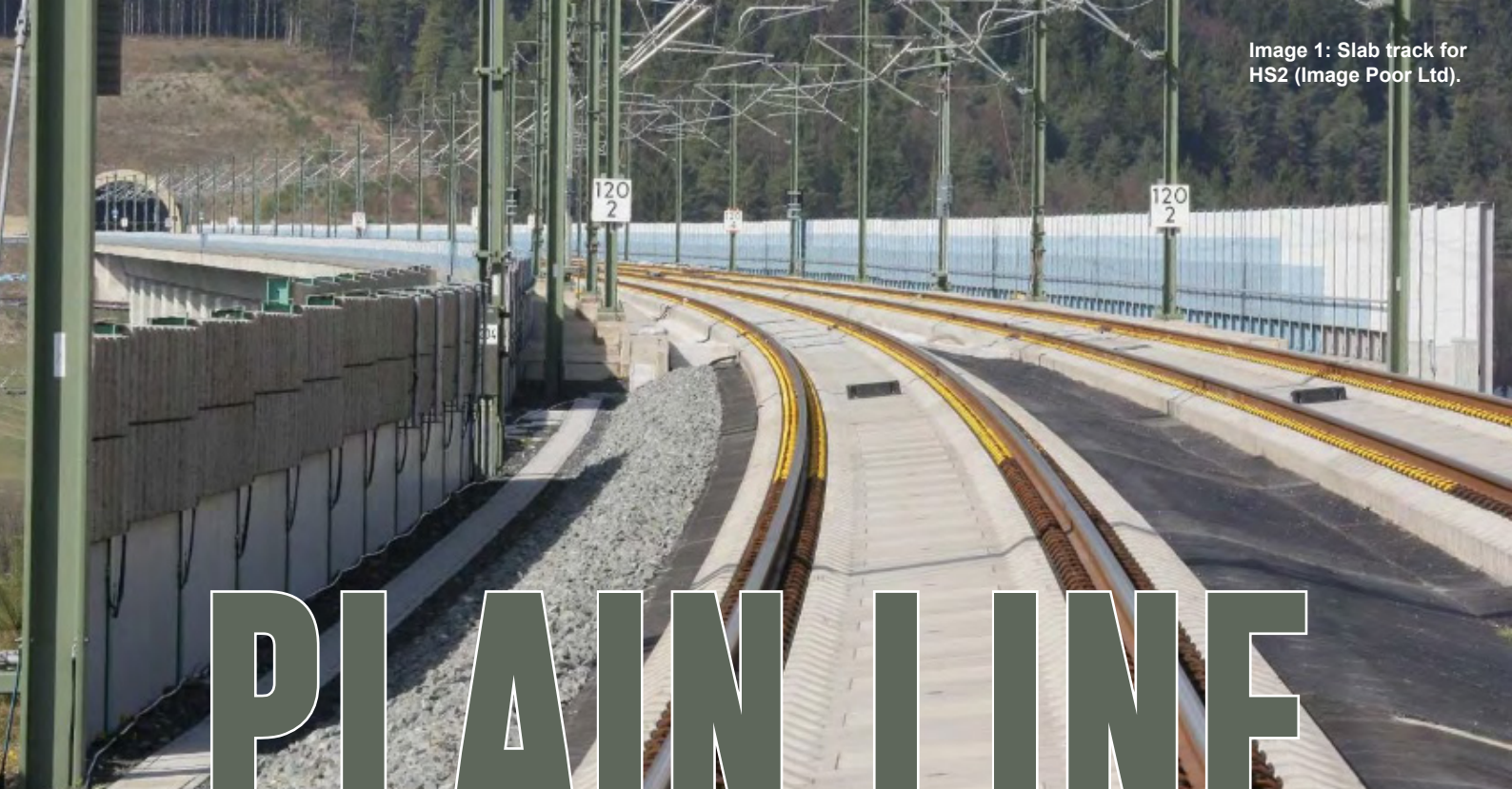
JOURNAL CATALOGUE

Did you know that there's a Journal catalogue on the PWI Website?

It holds a comprehensive list of every technical article published in the last few years. This chronological list links directly to the article over in the Knowledge Hub.

Find it towards the bottom of this page: www.thepwi.org/the-journal/





PLAIN LINE NOW AND IN THE FUTURE

I will continue with a focus on plain line in this Journal with areas that I have picked up on my rounds and involvement with technical stuff. The future is exciting with the Elizabeth line now open in London. I had many British Rail colleagues working on Crossrail (as it was originally called in the 1980-90's) and it was always going to be an essential and much needed improvement in East-West travel across London. My congratulations go to all those involved, it does seem a long time since I went down onto the track at Canary Wharf with David Packer.

HS2 is the largest infrastructure project in Europe and is continuing with great progress and it is good to work with many engineers from both the client and the supplier's organisations. The PWI is fortunate to be a conduit for knowledge in high speed rail construction thanks to Gherghe Nicoara, Head of Track Engineering, HS2 Ltd. It will not be long before we see track being installed.

The next subject for me is about a relatively new concept, intelligent tamping! We, as an industry, spend millions of pounds providing the most up to date machines and delivering a maintenance service with our experienced band of operators and technicians. We were pleased to welcome Bernhard Antony, Head of Technology Centre, Plasser & Theurer, Purkersdorf, in Austria to both the PWI Plant and Machinery Seminar in Newcastle last autumn and again at the PWI Technical Board in April. There is also a full article from him in this Journal on page 32.

I make no excuses for supporting the advances in tamping technology which produce higher quality through digitalisation and enhance our sustainability focus on ballasted track. Since the introduction of mechanised maintenance 70 years ago, there have been few strategic developments except for the recent use of alternative hybrid and all-electric propulsion systems for machines.

We now have the answer to the future of mechanised maintenance - the introduction of smart tamping machines. Digitalisation and advanced automation of machine operation will reduce human intervention. The system enables a tamping machine to undertake in-situ measurements of the track and ballast prior to any intervention. It was found that clean ballast required less force to be applied than dirty ballast, highlighting the need to treat them differently. The system can analyse the compaction effort required and also determine the ballast condition, before treating the track as required. Once completed, it is possible to provide a data log of the work undertaken including a visualisation of the area treated. There is also increased quality of the trackwork through dynamic compaction control, the ability to monitor the ballast condition and, therefore, predict the intervals required for cleaning.

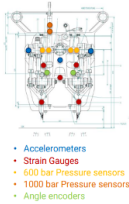
I see this introduction complements well our plans for new PWI technical courses to enhance the knowledge of technicians, re-introduce absolute design tamping everywhere and do a proper job of maximising the life of ballast for cost efficiency and sustainability reasons.

TAMP – From Research to Product

Basic-Research as foundation

What are the benefits?

- Continuous monitoring of ballast condition and optimization of the tamping process.
- Detection of the level of deterioration of the ballast.
- Determination of the perfect timing for ballast bed cleaning or renewal.
- Identification of the influence of each tamping parameter and definition of the optimum values.
- Continuous improvement of the system through post-analysis of the collected data.




SENSOR SETUP used on TCP-Machine 09-4x4 4S Dynamic

Image 2: The intelligent tamber (Image Plasser and Theurer).

Optimising the main work

AI reduces human intervention



A logical next step in the digitalisation of track maintenance

Technology increasingly replaces the operating staff's practical experience

This leads to

- down-time-efficiency
- better quality
- fewer mistakes

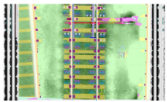
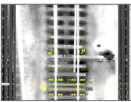



Image 3: The benefits of an intelligent tamber (Image Plasser and Theurer).



Image 4: Churnet Valley PWI Track Challenge Personnel carrier (Image Brian Counter).



Left & below images show David Godley talking to NR Graduates followed by a real match between track and electrification! (Image Brian Counter).



Image 6.



TECHNICAL

This Journal offers a broad mixture of technical articles and it is good to acknowledge the excellent work of Mike Barlow again as PWI Technical Manager for collating the content. I mentioned "Lunch and Learn" last time and having had such a successful start we will continue this into the autumn and include some professional registration workshops.

The April Electrification Seminar in Glasgow was a highlight for me with as usual many outstanding contributions. I must have hit a nerve when I reminded delegates of the next round of courses for Overhead Line as we started the next OLE Module 1 at Derby with 22 delegates. It was great to see people from all over the country and from different backgrounds many who were engineers but especially those supervisors from Sandwell and Dudley OLE depot!

Our Practical Trackwork Challenge went ahead at Churnet valley and is reported upon in this Journal on page 12. This was an exceptional event and to make it real, we even had snow! Everyone had to travel to site by a rail staff transporter so here is a picture of a delegate enjoying the ride, (image 4).

REFLECTION

It comes as no surprise that a return to face-to-face events brings us to the core of the PWI activities and makes being a member so worthwhile. The "double act" where we ran courses concurrently for new Network Rail graduates in Track & Civils and Electrification & Plant was such an example and we could not have had a better open discussion session with them all than the kind attendance of David Godley and John Edgley.

However, the virtual Track Module 2 (design) with 30 Hong Kong MTR track engineers stands out as an experience for our trainers as well. Thanks go to Bob Langford for pulling this together. They approached us and said that they are now looking forward to Module 3... who knows, we could reinstate a vibrant PWI Section!

AND FINALLY...

In April, I included this picture which was an amazing landscape of iron (image 6) and asked for comments as to where it was located. Thanks go to the following for getting back to me: **Sean McCarthy** said "At the entrance to Zurich Hauptbahnhof (Main station)." **Chris Chitty** said, "Zurich, as the loco appears to be Swiss and the signal numbers commence with a letter Z. The impressive line of double slips / crossovers also replicated in the background, would also indicate Zurich. I always enjoy the mystery pictures, so hope to see more in future Journals." **Roger Bastin** said "Every Operators dream - a layout with full flexibility:- Zurich Hbf." We'll leave the final comment for debate with our trainers in track design!



Brian Counter

TECHNICAL DIRECTOR
technicaldirector@thepwi.org



PROFESSIONAL AND CONTINUOUSLY DEVELOPING

As I scanned the proof of this edition of the Journal, I was struck by the wide range of technical topics covered, albeit all within the scope of railway infrastructure engineering.

This quarter's articles go to the heart of the PWI's mission of supporting our members as they work to develop and maintain informed and up to date professional competence. And, in due course, those articles will join the ever expanding body of learning within the PWI's Knowledge Hub. If you haven't tried out the Hub, I recommend a visit to the PWI website to access and search its decades' worth of accumulated railway technical knowledge and experience, and to see how others have solved the myriad of technical problems posed by railway infrastructure.

CRITICAL INTERFACES

I'm particularly pleased to see the focus on climate change and weather, and their potential impact on railway networks and infrastructure assets, in this edition of the Journal. The accelerating pace of world climate change has exposed new vulnerabilities in our infrastructure.

The realisation that some railway route sections will be exposed to unprecedented extreme weather events and that many of our earthwork structures are at a critical point in their fatigue life mean that the balance of risks associated with railway infrastructure is changing: and will continue to do so. Safe operation of the railway requires these changes to be understood and reflected in corresponding adjustments to the management regimes that control those risks.

As the tragedy at Carmont in 2020 well illustrated, the interface between track, and earthworks and drainage assets is a critical area where mutual understanding and knowledge sharing between engineering disciplines is key to railway system safety. So, it's good to see this interface forming the topic of a new PWI technical course. The course provides the detailed knowledge, understanding, and insights necessary to manage safety risks effectively, within the context of the whole railway "system of systems".

Railway infrastructure is characterised by its multiplicity of interfaces between engineering disciplines, and it is imperative that engineers from one discipline understand the potential impact the work and asset condition for which they're responsible can have on assets managed by other disciplines. A track engineer doesn't have to be an expert in electrification or signalling, nor vice versa, but a good appreciation of interfacing disciplines and assets is an important element of competence for all railway engineers.

SUPPORTING PERSONAL DEVELOPMENT

Technical courses are only one of the ways in which the Institution promotes learning, and PWI events in Spring and early Summer provide a clear illustration of this. As reported later in this Journal, our seminar in Manchester in early March brought those attending up to speed with the significant challenges presented to the railway industry by climate change and the decarbonisation imperative.

At the end of March, the Practical Trackwork Challenge (PTC) introduced another cohort of early career engineers to hands-on trackwork. This event, held on the Churnet Valley Railway in Staffordshire, used single line track renewal (with added snow flurries) to illustrate the importance of logistics and planning in track renewal work (and the importance of all-weather PPE). My thanks go to the PWI corporate members and experienced volunteers who supported this task-focussed event by providing plant and a core of expert practitioners to demonstrate how such work is delivered. All being well a further PTC will take place in November, where participants will engage with another, different, set of trackwork tasks.

Our April and May seminars, respectively in Glasgow exploring developments in electrification, and in Birmingham looking at how technology has been harnessed to deliver step changes in staff safety, gave those attending an unparalleled opportunity to meet technical experts in these fields, and a very welcome chance to catch up on face-to-face networking. The positive combination of learning and networking was also clearly evident at the April PWI Technical Board, attended by corporate members, and at the PWI's stand at Rail Live in June.

Rail Live has made a name for itself as the UK's premier railway infrastructure event. The range of infrastructure equipment, components, and services on show was impressive, as was the stream of visitors at the PWI stand. Friends old and new sought answers to questions on education, professional development, and technical matters: others just popped by to say "hello". Several interesting technical developments were evident, and I trust these will be the subject of future Journal articles.

FOR THE FUTURE?

The PWI was represented at the general assembly meeting of the UEEIV (the umbrella organisation for railway engineering institutions across Europe) in Münster, Germany at the beginning of June.

In recent years the UEEIV has been somewhat "low profile", but the general assembly endorsed a new mission, to connect those engaged in railway engineering across Europe and share technical knowledge, particularly amongst those in the early stages of their railway careers. The PWI strongly supports this new direction and I look forward to the UEEIV's facilitation of new development opportunities for our members: hopefully including technical exchange visits. The UEEIV meeting was held alongside the IAF (international exhibition for track technology) railway infrastructure engineering show. This international event, normally held every 4 years, is Rail Live's "big brother", showing off the latest railway infrastructure plant and equipment, and technological developments from across Europe. I enjoyed a full day touring the event, my only regret being the very small number of UK engineers and exhibitors I encountered. The next IAF show is in 2025 and I'm wondering how the PWI can encourage greater UK participation: members ideas on this would be welcome...

OUR PEOPLE

As I write, the PWI team is preparing for the Institution's July AGM. This meeting always involves some comings and goings, and this year is no exception. After many years of valued service to the Institution, Andy Cooper stands down as a non-executive director. I must place on record my thanks for Andy's help and support to the wider Institution, and to its CEOs. In the same breath I welcome Simon Blanchflower as a new non-exec. Fresh from his recent Chief Executive role at East West Rail, Simon brings long and wide-ranging railway industry experience to the Board which I'm sure will help keep the PWI "on the straight and narrow".

This year also sees the departure of several Vice Presidents, and new arrivals in those positions. Again, I thank the retiring VPs for their tireless efforts in promoting the Institution: and I extend a hearty welcome to those who've elected to take on our VP roles (and the associated tasks!).

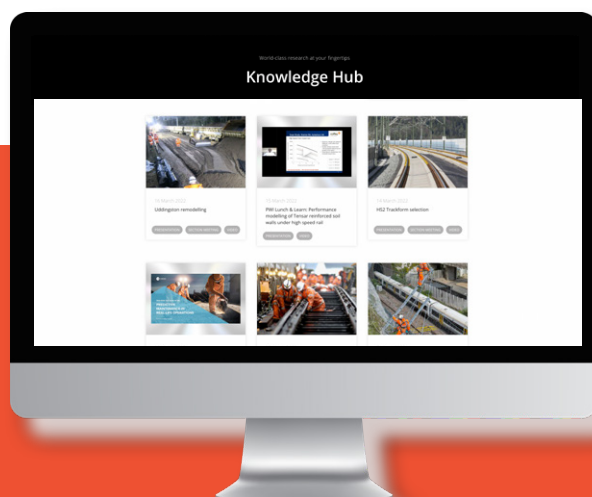
Whilst Joan Heery leaves the Presidential chain this year after completing her four-year term, I'm very pleased that she's chosen to remain with the PWI, as an outstanding Membership Director.

Finally, I'm very pleased to welcome Chrisma Jain to the Presidential Chain. I was fortunate to work with her at Transport for London and I have no doubt that the Institution will benefit hugely from her considerable leadership skills, knowledge of railway infrastructure, familiarity with professional engineering institutions, and boundless energy.



Stephen Barber

CEO
stephen.barber@thepwi.org



Visit our Knowledge Hub
www.thepwi.org/knowledge-hub/

THE PWI'S CLIMATE CHANGE & DECARBONISATION COMMITTEE

VISION

A RAIL INFRASTRUCTURE COMMUNITY THAT INSTINCTIVELY DELIVERS A ZERO-CARBON SUSTAINABLE RAILWAY

MISSION

RECOGNISING CLIMATE CHANGE AND DECARBONISATION CHALLENGES IN RAILWAY INFRASTRUCTURE, SHARING SOLUTIONS AND BEST PRACTICE, AND FOSTERING THEIR ADOPTION THROUGH COLLABORATION TO ENABLE POSITIVE CHANGE.

Our successful Climate Emergency Technical seminar is now some months behind us and if you missed it, all the presentations are available in the PWI knowledge hub. Aside from the excellent speakers, we were particularly delighted to welcome a high number of younger people to the event, working in a variety of roles across the Rail industry.

At around about the same time as our seminar took place, the Intergovernmental Panel on Climate Change (IPCC) issued the latest element of their Sixth Assessment Report. The IPCC prepares comprehensive assessment reports about the state of scientific, technical and socio-economic knowledge on climate change, its impacts and future risks and options for reducing the rate at which climate change is taking place. Their work has been ongoing for many years and there are multiple reports available on the IPCC website dating back to 1990 if you are interested in broadening your knowledge:

<https://www.ipcc.ch>

I have spent some time reading the latest report and understanding the context of how the assessments are carried out. Within the overall sixth assessment report there are series of documents which have been compiled by a number of working groups:

- AR6 Climate Change 2021: The Physical Science Basis
- AR6 Climate Change 2022: Impacts, Adaptation and Vulnerability
- AR6 Climate Change 2022: Mitigation of Climate Change
- AR6 Synthesis Report – due for publication in September this year.

The synthesis report will give an overall summary and co-ordinated view of the information contained within individual reports, so a very important piece of work. The Impacts, Adaptation and Vulnerability report was the one issued around the same time as our conference in March and I set some time aside to read this. The report identifies 127 key risk areas and considers these over different timescales; near term (2021-2040), midterm (2041 – 2060) and long term (2061-2100). Although the report is written at a global level, I could see linkage to a number of presentations that were discussed at our technical conference in March. For example, we received a presentation by colleagues from Mott MacDonald on the Leeds Flood Alleviation Scheme and another on Improving Weather Warning Systems to better understand the impact on the Rail network and I can certainly see how they sit alongside global reporting initiatives. The report reinforced to me the importance of the work we are doing as an industry to combat and manage the risks we are facing.

As part of the recent conferences on the Climate Emergency and Electrification, I met Richard Hill, a PWI member who holds a real passion for the environment, climate change and decarbonisation. In his day job Richard is part of Network Rail's Asset Protection team based in Derby looking after outside parties working alongside the rail corridor in the East Midlands area. His interest in environmental matters started in 2013 when he embarked on a part time Open University Degree in Natural Sciences. Richard's interest and passion was further reinforced by COP 26 activity and the views presented by Sir David Attenborough, Greta Thunberg and even Her Majesty the Queen.

Richard loves the railway and the fact we have the chance to make a real difference on decarbonisation through electrification and other mechanisms is a value he holds dear. At the climate emergency conference in Manchester

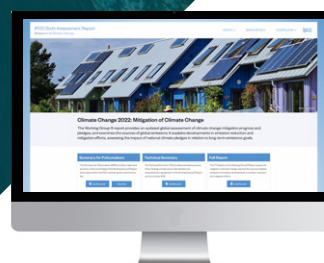
Richard set a challenge for the delegates, asking them if they understood their own personal carbon footprint and what steps they could take to reduce it. Richard also provided a number of links for individuals to access various carbon calculators (see below):

- <https://footprint.wwf.org.uk/>
- <https://www.carbonfootprint.com/calculator.aspx>
- <https://www.gov.uk/guidance/carbon-calculator#the-mackay-carbon-calculator>
- <https://zero.giki.earth/>

At the electrification conference in Glasgow, Richard again spoke to the audience about understanding their own carbon footprint, so his message is spreading. Richard's aspiration is to inspire people to make small changes, a method he calls "planetary gains". As an engineering community we all appreciate the importance of understanding the baseline position as part of the process of improvement and innovation so on Richard's behalf, I would encourage everyone who reads this article to take a few minutes to calculate their own carbon footprint and decide if they would like to take action to reduce it.

Joan Heery Chair of the Advisory Committee on Climate Change & Decarbonisation, Membership Director and Past President

WWW.IPCC.CH



Earning and Learning



Nick Millington
PRESIDENT
Permanent Way Institution

Time flies and before you know it, mid-summer has passed. And for me, my year as your PWI President has certainly flown by and is now coming to an end.

It has been a very rewarding experience being your President this year. It is brilliant to see the PWI flourishing and growing. The Institution provides a strong sense of 'community' and one that transcends those at the very start of their career (apprentices and graduates), those that are in active service now and those experienced members that have (and some only recently) retired. I call it 'Sustainable Professional Development', with the key thread being support and sharing of railway infrastructure knowledge, professionalism and friendship.

My year as your President started (in July 2021) whilst Covid restrictions were still having a serious impact on rail industry revenue. Covid was also impacting our ability to have PWI meetings in person. But through the autumn, and except for the 'Omicron' blip in December and January, I am pleased to say that I have been able to attend many of our local PWI Section meetings in person. It is also encouraging to see that rail industry revenue has climbed from 40% of pre-pandemic levels (at July 2021) to 90% over the same period. But, the rail industry has suffered a major financial shock and the gap between revenue and industry cost must stay at the forefront of our minds in the PWI. I will be attending more Section meetings through the autumn and, again, would ask that you all act as rail ambassadors: use the network to attend PWI meetings and conferences and really pay attention to our customers' experience (safety, punctuality, cost, service, etc).

Through the year, the PWI has embraced the new 'hybrid' normal. We have relaunched our website (a huge thank you to those in the PWI that delivered this) and 'Knowledge Hub'. We continue to be very active on virtually every social media channel, and our 'followership' is growing significantly and sustainably. We have run a very beneficial series of online 'Lunch & Learn' meetings, with many relevant topics covered and great speakers (fantastic CPD opportunities, by the way).

We have delivered a number of great conferences this year: plant, decarbonisation, electrification, safety, and of course, track and have experimented with a hybrid approach (joint in person and online attendance) at both our major seminars and a number of our local Section meetings. All of this is targeted at

giving as many of you as possible the ability to meet in person, attend virtually or catch up with the learning opportunities (via recordings) at a time of your choosing. CPD, you have no excuses!

Track worker and asset safety is a key focus for the PWI and it was a pleasure to attend and chair the morning session of our recent Safety Conference in Birmingham. From my substantive position in Network Rail, I still observe colleagues believing that we must put colleagues at risk on or near the line in order to undertake activities to keep our railway safe. The reality now is that technology, sophisticated monitoring, artificial intelligence, collaborative planning and high integrity protection / warning systems are available – and these provide a paradigm shift: a safer environment for track workers (no contact with moving trains), whilst monitoring our assets perpetually and keeping them even safer. Our safety conference demonstrated that a new, safer approach is available now. A key challenge for the PWI, looking forward, is to be at the forefront of driving the use of trainborne data collection to take this approach to another level: Perpetually monitored assets, utterly reliable and always safe.

Another great step forward this year is our PWI 'Diversity and Inclusion' strategy and the creation of our D&I Committee. The Institution has a proud heritage (and one for which we should be very proud), but it is heavily orientated towards 'white males' through our history since 1884. We are absolutely committed to creating opportunities for everyone and am very grateful to members and colleagues who have come forward to help fulfil this aim on our D&I Committee. When I reflect on my own personal thoughts on this, I have daughters, a sister, friends from various parts of society, I would not feel at all comfortable if for some reason, they were not given the same opportunities as me. A diverse Institution will inevitably be a safer and a more intellectually effective Institution.

Throughout my career, I have lived by a principle of 'Earning and Learning'. In my Presidential year, I have seen this principle in action everywhere I look. One of the most fulfilling parts of leading the PWI this year has been to see the amount of people that are using the PWI professional development frameworks to develop themselves whilst working in substantive roles in the industry. It was particularly rewarding for me to present professional certification (Engineering Technician, Incorporated Engineer and Chartered Engineer) to c.30 members who were able to attend the annual Celebration Event before Christmas. In addition, it has been a pleasure to present Diplomas and other Awards throughout the year. The PWI now provides professional development pathways from Apprenticeship to Chartered Engineer to Fellow and for Track and Electrification colleagues alike. And this year, our Electrification Diploma has been launched and joins our popular Track Diploma. Another popular addition this year has been our 'Lunch & Learn' series and I must pass my thanks to the many presenters for the wide range of topics that have been covered so far.

I'd like to pass my thanks to a number of people in the PWI. The core team do a remarkable job. It is a small team, but every base is covered very professionally. Membership, conference organisation, training, corporate administration, stakeholder management and much more is all handled seamlessly and everyone in the PWI owes you a huge debt of gratitude. I'd like to thank the Non-Executive Directors who continue to support the PWI with their sensible challenge and sage insight. I'd like to also thank all of the Vice Presidents and the committees of all of the local Sections for everything you do bringing the PWI to life locally and regularly for our members. Finally, I'd like to thank Richard Spoors who has recently retired from representing the PWI at the Union of European Railway Engineering Associations (UIEEV) for many years. The group is a great place to share railway engineering ideas across Europe and I know that Maddie Coyle, who is our new representative will serve us all very well. Thank you Maddie and good luck!

I have two final thoughts before I check out: Of late, the word 'Modernisation' is being used a lot in the industry. It is a word that is feared by many and it shouldn't be. My father (who had no interest in railways) asked me what treat I wanted after a brief stay in hospital when I was a 4 year old in 1978. For some reason (which I do not recall) I asked to go and see a new 'Intercity 125' train. The photo below is the station where my father took me at that time and the train that probably saved the railway industry in this country. When I reflect on this photo, everything has changed, *everything*. And it is all OK - change is inevitable. We cannot afford for the railway industry to go into decline and we must all embrace modernisation to make our railway safer, more efficient and more attractive to customers. Thank you to David Hardy for this photo – it is where my railway career started!

Finally, cast your mind back to the Millenium – the year 2000. If you cast your mind forward the same amount of time, our railway must be a zero carbon network. Ask yourself, are we going fast enough to meet this challenge? It should be on everybody's mind, and we should be pulling out every possible stop to complete this challenge. And with this in mind, it is no better time for me to hand over to your next PWI President, Peter Dearman. Peter has been championing the decarbonisation agenda and I would like you all to provide Peter (and our industry) all the support possible to decarbonise quicker.

Stay safe everyone and thanks for a great year.



LEO COPLEY MPWI

We sat down with one of our young members, Leo Copley, an Undergraduate Engineer at WSP, to talk about his experiences working in the rail industry.

Degree apprenticeships can set you up for a career full of possibilities and allow you to play your part in delivering projects while studying.

WHY DID YOU WANT TO WORK IN THE RAIL SECTOR?

Initially I was more focused on some type of mechanical engineering career. However, having seen WSP's advert for the rail engineering degree apprenticeship this drew me in and reignited my childhood interest in railways. Although the degree pathways offered were primarily of an office-based design nature, I realised that this would be the ideal introduction into the industry and allow me to build up my technical knowledge and skills that would be used throughout the rest of my career, wherever and whatever this may be doing in the industry.

WHEN AND WHY DID YOU JOIN THE PWI?

I joined the PWI 20 days after starting my job with WSP. It was a happy coincidence as it was the easiest way to book onto one of the upcoming seminars my team had recommended I attend. Attending this was an eye-opening experience about the possibilities in rail and the vast wealth of knowledge and experience the PWI has and shares between its members.

TELL US A LITTLE ABOUT YOURSELF.

I joined WSP's apprenticeship program in the Manchester track team straight after leaving sixth form. As part of this I spend one in every six weeks on block release to London South Bank University where I am studying for my BEng in rail and rail systems engineering. In the office my role is very varied to give me the opportunity to supplement and apply my learning from Uni, as well as allowing me to explore other disciplines outside of track and see how they interface.

WHAT DOES AN AVERAGE DAY LOOK LIKE FOR YOU?

An average day for me revolves around the computer, either being based in the office or working from home. With this I am generally setting up and populating drawing files, assisting with producing cross sections and setting up and populating reports. I have also started being involved in reviewing documents so that I have the chance to learn what makes a 'good' document by asking questions about the processes and thinking behind them.

ARE YOU INTERESTED IN BECOMING PROFESSIONALLY REGISTERED?

Yes, my degree is structured so that upon completion I will have met all the criteria for IEng registration. Once I've achieved this, I plan to find a Level 7 Apprenticeship to top up my degree to master's level and meet the criteria for CEng registration. I will have to review this closer to completion of my current apprenticeship though as undoubtedly factors and circumstances will change in the interim period.



WHAT CONTINUING PROFESSIONAL DEVELOPMENT (CPD) ACTIVITIES DO YOU DO? WHAT'S YOUR APPROACH TO CPD?

Due to the apprenticeship, my current approach to CPD is very conservative, taking part in the occasional Manchester and Liverpool Section meeting and seminar. As my course progresses and the lectures become more specialised, I plan to pay particular attention and take part in seminars and meetings that I can relate back to my course to support my learning and provide a different take on the subjects, rather than just being classroom based.

WHAT'S THE BIGGEST BENEFIT OF BEING A PWI MEMBER?

The biggest benefit of the PWI is that all its resources are geared towards railways and rail engineering. Compared to some of the other professional institutions, it is obvious how PWI lectures and resources relate to my everyday job. I also believe that the PWI can capture and showcase railway specific innovations and knowledge that would likely get overlooked by other institutions which encompass a wide range of engineering types and disciplines.

WHAT WOULD YOU SAY TO SOMEONE WHO WAS THINKING ABOUT A CAREER IN THE RAIL INDUSTRY?

It always used to be said that a job in the railway was a job for life. In my opinion this is relevant now more than ever before as opportunities through innovation and development mean the railways are set to take on a leading role in the UK's transport infrastructure and economy to provide decarbonised, quick and efficient mass transport for both passengers and freight. This is equally true on a worldwide basis, meaning that a job in the sector could lead to you working for any number of companies in any number of countries.

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Practical Trackwork Challenge Churnet Valley Railway

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It seems such a long time ago that we last held a Practical Trackwork Challenge (PTC) event and indeed it was, October 9 - 10 2019 to be precise and you don't need me to remind you what happened in the intervening two and a half years.

But here we were again on the evening of the 29 March 2022 in the Borough Arms Hotel, Newcastle Under Lyme, welcoming our delegates to the fourth Practical Trackwork Challenge event, the location of which was the Churnet Valley Railway (CVR).

The Borough Arms Hotel acted as a base for the event for two nights and provided an opportunity for both the PWI to explain the event and for delegates to mix and share experiences.

The PTC is essentially a training course that allows people who work in the industry, but who have little or no site knowledge to experience working in a live railway environment in a safe and controlled manner.

After the evening meal at the hotel Roy Hickman led the Construction & Design Management 2015 (CDM2015) briefing to all the delegates, and he explained along with Tony Hancock of the CVR the history of the area, the safety arrangements and the work to be undertaken over the next two days.

The event was organised by the PWI under the control of experienced track engineers, Roy Hickman, Kevin Percival and Andy Steele. The plan was to renew 183 metres of 1961 flat bottom wooden sleepers track one and half miles northwest of Froghall station. Here the single line railway lies on a

shelf in a narrow valley flanked by the river Churnet to one side and the Caldon canal on the other. This makes the site narrow and difficult for machine and personnel access and as a worksite. The new materials were provided by the CVR and had been taken to site in advance. These were serviceable F27 concrete sleepers at 24 per length, new cropped 50ft (15.25m) 113lb (56kg) rails and approximately 650 tons of reclaimed ballast.

The site had been chosen by the CVR because of the high number of broken and rotten timber sleepers in the area and the high number of rail metallurgical defects in the existing track. Logistically the site would prove problematic as it was one and half miles from the nearest station access at Froghall and was heavily overgrown.





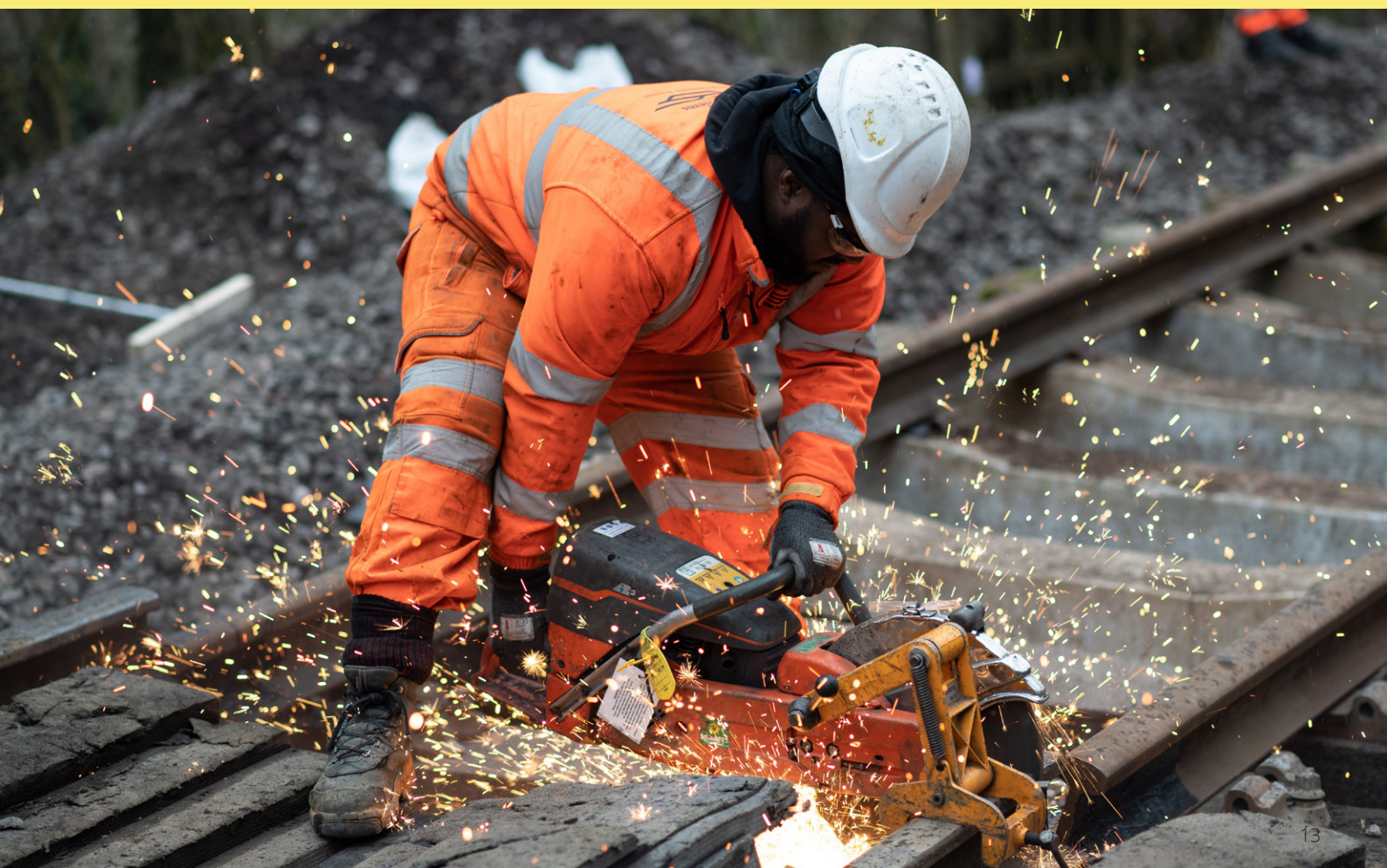
“

A fantastic event!

Quite an achievement to bring together such a large and diverse group and introduce to them a wide range of processes, technology, and equipment.

Great to meet hugely knowledgeable and experienced professionals, and the chance to observe and contribute to an actual track replacement project - all in two days! Thanks again to all those involved, especially Richard our team leader.

DELEGATE FEEDBACK





It is important to state that the renewal although on a Heritage Rail site was still a live site, which carries the same inherent safety risks to our colleagues as when delivering a job on the open network. Operationally however the risks are far less, and this allows us to demonstrate the process and procedures used and also to allow delegates to get involved in the site works themselves, in a safe and controlled manner. Therefore, we planned to deliver this job as we are required to under law under the CDM 2015 regulations. That meant that the CVR acted as Client, and PWI corporate members Balfour Beatty and Mott MacDonald acted as Principal Contractor and Principal Designer respectively. The PWI were effectively the Scheme Project Managers.

Richard Spoors and Malcolm Pearce of the PWI acted as independent assessors of the event and also as "guides" to the groups moving around the site.

Balfour Beatty supplied site staff including, a track gang of 10 personnel together with a very experienced supervisor, Eugene Landells. They also provided Lewis Hattersley who was the Engineer in overall technical charge of the site. All staff going onto site had to register with the site access cabin provided by Sunbelt Rentals with on-site welfare provided by High Motive through James Read. Balfour Beatty also supplied the fantastic site installation technicians via TfL James Field, Amandip Singh Samra and James Lock.

To give the reader an idea of the logistics of this event, on the first day we had more than 70 staff, visitors and delegates on site in the

afternoon, with a similar amount on day two. Mott MacDonald provided design services and Sulaiman Bah and Noye Isahmah supplied the design drawings that we would work to over the course of the event.

Our plant was provided by ProRail Services, and Quattro, Cleshars and Robel were on hand to provide small tools and tuition under the expert gaze of super trainers Jon Winborne of Cleshars and Chris Dines of Robel. All machines were accompanied by Machine Controllers and POS representatives supplied by their parent companies.

KOREC provided surveying services and special thanks must be given to Matt Barwell, who repeatedly went out on site to just pick up a little more detail, and to add in some extra survey control as we planned the event along the way.

Nobody would have got to the site at all if it were not for ProRail Services providing the project with a Kubota Rail Personnel Carrier, and the genial Tudor Popescu who frequently ferried groups of up to 17 staff at a time between Froghall station and the worksite over the two days.

This event relies heavily on our Corporate Members very generously providing services free of charge, which is a substantial financial commitment in terms of both skilled personnel or machinery, and for that the PWI are very grateful indeed. The CVR were once again excellent hosts and their volunteer staff provided all the site staff and delegates with free food and drink over the course of the event.





Being able to ask questions in a site environment is rare. This was a great chance to gain a deeper insight.

I particularly enjoyed the variety of speakers when on site. There was a good mix of practical and theory across the two days.

It was clear the speakers were passionate about their work and helped everyone to stay engaged. Also, the track taxi/shuttle was really cool!





Being able to see things in real life which I design, will help me to visualise and understand more when designing.

DELEGATE FEEDBACK



Our plan for day one was to remove the track panels, with the RRV placing reusable top stone to the cess on the canal side, (before closure the cess had been the second track). Next, a laser-controlled dozer pushed the remaining spoil down the bank towards the river, leaving a 175mm ballast bed below new rail level and a crossfall towards the canal. It had been hoped to commence laying sleepers before the end of the day, however the work had taken a little longer than planned, so that was left for day two. The Balfour Beatty team provided an explanation of laser control of excavating machines and how the site beacon laser is set up from the design drawings. The track survey had been undertaken using a GEDO survey trolley kindly supplied by KOREC and operated by Matt Barwell with TfL technical staff providing the onsite design alignment delivery for installation and post tamp. The delegates were given the opportunity to take part in the work with hand tools when it was safe to do so.

The PWI had also invited a number of companies to either demonstrate their products and how they are used in track work or set up small instructional demonstrations whilst the delegates were on the railway. KOREC demonstrated the latest survey technology to each group of delegates in turn back at Froghall Station. Robel also demonstrated the latest battery technology for small hand powered plant alongside their more traditional tools. On day two Jonathan Graham of the RAIB gave an on-site explanation of accident investigation and derailment causes, using the track in the vicinity of Froghall station to provide a physical illustration of how an investigation is carried out.

The weather on day two reminded us that outdoor work, even in late March, can be like deepest winter with snow and a cold wind, but that did not daunt the enthusiasm of our young engineers who took turns with bars, rail setters and clip pullers to get the new track installed. Working on a long and narrow worksite also showed the importance of good planning and how road rail machines can have limitations on the activities they can perform. It demonstrated how, when there are two machines with different outputs, their working positions may need to be changed as the work progresses. One of the key safety features of being on site with these machines is learning about the role of the machine controller and how to safely walk past them. With one of ProRail's machines waiting at the north end of the site on the second day, all of the delegates had the opportunity to visit the machine and climb into the cab. What better way than this to learn about the restricted view the operator has of what is near to his machine, especially on the blind side, opposite the cab?

As the last panel was connected to the existing track it was time for the delegates leave and return to Froghall station.

After changing and returning their PPE to their bags, delegates gathered in the station buffet for a presentation of their PWI certificates by Edward Maloney the Joint Managing Director of ProRail Services, in the company of Stephen Barber, PWI CEO.

It was unfortunate that the final activities of the track renewal were not undertaken whilst the delegates were on site, however, later that afternoon the top ballast was unloaded by CVR

staff. Balfour Beatty staff boxed in the ballast and ensured it was fit, albeit with a speed restriction, for the start of passenger services the following Saturday. A CVR tamping shift is planned together with clearance of materials to complete the works.

A DELEGATE'S VIEW

NOYE ISAMAH
PERMANENT WAY ENGINEER
MOTT MACDONALD

For this Practical Trackwork Challenge once again the PWI enlisted the help of its corporate members to assist in maintaining this Heritage Railway and invited delegates to broaden their networks, improve their site awareness, and to learn from a range of their peers and experts. I was one of the delegates from Mott MacDonald.

The design was carried out and checked by delegates Sulaiman Bah and me, and supported by Chris Mannion. The design was an iterative process of communicating with the client to define requirements and available materials, informing the surveyor from Korec of the required design limits and topographical detail, and receiving feedback from the on-site contractors, Balfour Beatty Rail Systems, and plant operators from ProRail and Quattro on construction constraints.

The tamping design limits were restricted by the River Churnet underbridge at low mileage and extended beyond a series of short curves to reach a straight element at high mileage;

giving the final design length of 440m. The constrained area coupled with a lack of close-by access presented challenges at both the design and construction stages.

Horizontally, the design utilised multiple virtual transition elements to limit slues, and site preparation included cutting back the vegetation to create a laydown area.

The existing track was also significantly over-canted from having had the speed reduced over the years and ranged from approximately 80mm at low mileage to 20mm at high mileage. To address this while maintaining practical design limits, a cant transition was proposed extending over a virtual transition from 80mm to 50mm, and a physical transition was possible from 50mm to 20mm. Originally the design applied 35mm of cant; 50mm is still over-canted, but reduced the required amount of lifting and thus kept the design limits reasonable.

The vertical design also posed challenges of multiple short vertical curves and interactions with transitions. To smooth out the curves would have required more tamping than was appropriate for both the construction time and what the ballast could withstand.

Ultimately, the design involved a lot of compromise and the management of realistic expectations for a heritage line running heritage rolling stock at low speed. The frequent maintenance and stricter rules on Network Rail mean that fortunately sites of this complexity don't arise often.

With the design signed off and the site prepared, we were ready for the Trackwork Challenge. The evenings the delegates spent together at the hotel were a good opportunity to learn about the training schemes and work at other companies, and offered insight on the work of many different types of professionals involved in the railway beyond design and site engineers; such as manufacturers, regulators and plant operators.

The PWI volunteers also spent this time with us, and were an invaluable source of knowledge both in understanding processes that we had seen and been taught about, and sharing knowledge of how we got to where we are today and why.

Once things got moving on the first day on site, there was a lot to pay attention to and the necessity of experience and expertise quickly became apparent in even the simplest of decision-making exercises. The single track and lack of direct site access added complexity by making moving people, plant, and materials safely and efficiently quite difficult.

One such early decision was where the rails within the renewal limits were cut. I had assumed they would simply be cut at either end and then broken into manageable pieces. Instead, there was an assessment of the serviceability and rail in usable condition would have the bolts and fishplates removed, and the remainder were cut for easier removal of smaller pieces by plant. This is both a sustainable decision and cost effective.

I enjoyed the interaction with experienced engineers, being able to ask questions on site and point at physical objects rather than drawing diagrams on an office whiteboard.

DELEGATE FEEDBACK





The social aspect of the event was just as valuable - in the evenings with my team, learning about their companies and experiences.

DELEGATE FEEDBACK

After the rail and components had been removed from the renewal extents, the track bed was excavated to the top of the formation. At this point we discussed ballast memory and how, without doing a full dig, the new ballast laid would settle to reflect the compaction of the formation below it. This was part of the reason for the vertical alignment design to be similar to the existing condition, even though this resulted in multiple reverse grades.

We also had a demonstration of how laser receivers are used to check crossfall, and the exchange of data between the measurements and the digger which was used to do the initial formation and ballast laying work. Using the heavy plant to lay the ballast to the correct crossfall, (accounting for cant), meant that less runs of the tamper would be needed, and this would help preserve the quality of the ballast. This was an iterative process as the plant was only able to work with two dimensions of data – a centreline and height at each edge – whereas a faster and more accurate provision would have been a single height, a centreline and an angle as provided by the laser receiver.

We delegates were not left idle during this time and had many miniature 'workshops' to attend in addition to being able to speak with contractors on site. The workshops on the first day centred around tools such as the Trimble GEDO trolley system for topographic surveying, and the Sunbelt plant

hire and personnel management system. I was particularly engaged by the presentation of the Robel power tools which make improvement on traditional tools in terms of safety and sustainability. For example, using battery power as opposed to fuel and improved ergonomic design for long periods of use.

The main talk on the second day was from a representative of the RAIB, who presented the key risks that can lead to a derailment in service. These include obstructions on the track, wide gauge, wheel lift, (which can be due to lateral force, twisted rails which reduce the vertical load, rail wear or insufficient lubrication), and poorly maintained S&C.

A less common risk is cyclic top related to poor maintenance of jointed track, where dips at the joints can cause a train to 'jump'. Regular such jumps may cause train and rails to go into resonance, resulting in a large jump and subsequent derailment.

Although a derailment may usually not be due to the alignment design itself, I did take note that as a designer it is always worthwhile to be aware of where these risks are present and to consider mitigation such as an appropriate ballast shoulder or trap points.

Although the single track and narrow space had made movement on the first day a little awkward, the true inconvenience didn't

become apparent to me until day two when it was time to reinstate the track. The delays on the first day also meant that we were pressed for time. The first task was to lay the sleepers. The physical constraints imposed by the site meant that exclusion zones around the machines moving sleepers from the cess onto the formation had to be very carefully managed, with machine work stopped periodically to enable those on site to pass by safely. Having been allowed to sit in the cab of one of the RRVs in the morning, we were well aware of the limited visibility for the operators and our responsibility for our own safety.

Positioning the sleepers was achieved by measuring out to a false wooden rail from the cess and using a laser to set the height. A string line was then used to provide a guide for manually levering groups of sleepers into place. Doing this periodically was another measure to reduce the work left for the tamper.

Laying the rails had to be done consecutively so that the RRV could roll over the rails that had been laid and bolted. We pulled the Pandrol clips into place using Panpullers – somehow, I had not expected this to be done manually and I gained a level of respect for the amount of manual labour that can be necessary on site. It's certainly something I'll keep in mind if I'm on the fence about extending the length of a renewal in a design.

“

We are very grateful to Churnet Valley Railway for hosting this year, and to the many companies who gave their time, resources and staff.

Thank you.

ALL AT THE PWI



To allow the plant to leave site on time, the decision was made to clip every fourth sleeper ahead of the RRV and to follow behind to clip the remainder. The final task was to lay and tamp the new ballast. Unfortunately, the day ended for delegates before this happened, but we were pleased to hear that it was successfully laid that day and trains were running by the weekend as planned.

I feel extremely fortunate to have taken part in the Trackwork Challenge. My greatest learning point was being able to witness in real time the sort of decisions that don't often occur to a young professional doing most of their learning in an office, and this helped me to see the value of even just observing a site.

The workshops were also an excellent opportunity to share knowledge, and I'm grateful to the volunteers and contractors who gladly shared with us as well.

Thank you to the PWI and all the corporate sponsors. And to anyone considering participation – I definitely recommend it.



HS2 track alignment change process through collaboration

The HS2 Learning Legacy website was launched at an industry event in October 2021, and builds on the experience from the learning legacies of previous major projects. These include the Crossrail Learning Legacy, Thameslink Learning Legacy and the London 2012 Learning Legacy, and it contributes to an overall body of knowledge on major projects captured on the Major Projects Knowledge Hub.

It aims to capture and disseminate good practice, innovation and lessons learned from HS2 aimed at raising the bar in industry, improving UK productivity and showcasing UK PLC.

HS2 is keen to engage with industry bodies and professional associations to work together to further disseminate the Learning Legacy following the launch, and part of this work is the publishing of a number of the HS2 Learning Legacy papers in the PWI Journal.

AUTHORS:

Javier Olazabal MEng Ceng MICE

Carmen Redondo MEng

In every high-speed railway project, the track alignment is one of the most, if not the most, critical element of design. The alignment is the basis that the rest of the civil works design is based on, with any change potentially having a significant knock-on impact.

Hence the creation of a holistic contract-wide change control process was prioritised early on enabling a flexible and technically-sound implementation of opportunities, interfaces and new standards. It has constituted a step change on how collaboration between design, construction teams and client can successfully work.

Alignment determines, in the first instance, the construction feasibility and affordability; mass haul diagrams, tunnel length and ground conditions the structures will have to face, impact on third parties, adjacent contracts and obstructions. More importantly, the whole life cycle performance of the infrastructure: operations, maintenance, whole-life cost and carbon, emerge from and are shaped by the alignment design. This reinforces the need to successfully and collaboratively address measures that take into account all stakeholders at the early stages.

This paper covers how opportunities, interfaces with adjacent contracts, innovation, new standards implementation and how HS2's interfaces with third parties were addressed and processed in a fully collaborative environment.

CONTEXT

This paper focuses on the southern section of High Speed Two (HS2) Phase One – Lots S1 and S2 (Area South) –including the Northolt Tunnels and the Euston Tunnel and Approaches, being delivered by the SCS Integrated Project Team (IPT).

The Project Master Alignment (PMA) is the HS2 alignment that integrates all new developments in an assured manner and is managed and controlled by HS2 Ltd, the ultimate owner of the infrastructure. This ensures a single source of truth and the coordination of all contracts and design packages of the HS2 Project. Every change proposed by any of the intervening parties then follows the Route Development Procedure and is finally consolidated in a Form C. Following its revision and approval, the proposal is integrated in an updated version of the HS2 PMA and shared back with the different contract representatives.

A consolidated PMA was provided to all the Main Works Civils Contractors at scheme design. This combined all component parts of the alignment for all lots within the HS2 Project and was the initial reference to work from.

Design House (DH) (part of the SCS IPT) mobilised a Route Civils team to support SCS on the alignment development for Lots S1 and S2. The first task they developed, after thoroughly reviewing the reference design, was to undertake value engineering, initiated in September 2017. Construction teams and design disciplines participated in the identification and development of new opportunities to bring value to the project.

Following the optioneering process, and once the sifting outcomes were confirmed for all options under assessment, a new alignment was developed and it informed all the assets along the route. HS2 actively participated in the process, denoting a change on how engineering can be undertaken, with a fully collaborative approach. The final product of the aforementioned process was a first version of the alignment Form C[1],[2](July 2018), requesting a change to consolidate the value engineering exercise.

Scheme Design progressed based on the newly created Form C[1],[2] till, once the scheme was finished in Autumn 2018, a new scenario loomed where further opportunities were identified prior to progress to the detail design and construction stage. Alignment was a key to realise those opportunities. The challenge was – how to speed up a process that previously took eighteen months, now with only a third of that period available, and not to jeopardise the construction programme.

A collaborative approach was then promoted, and an integrated working group composed of HS2 alignment representatives, SCS Design Management and DH was created. This group jointly develop solutions proactively, setting up fortnightly control sessions to develop the Alignment Options Reports[3],[4],[5] and ultimately the final Form C[1],[2] (July 2019) that covered all changes promoted by the Integrated Project Leadership Team (IPLT) and enabled the project to progress fulfilling all parties' requirements.

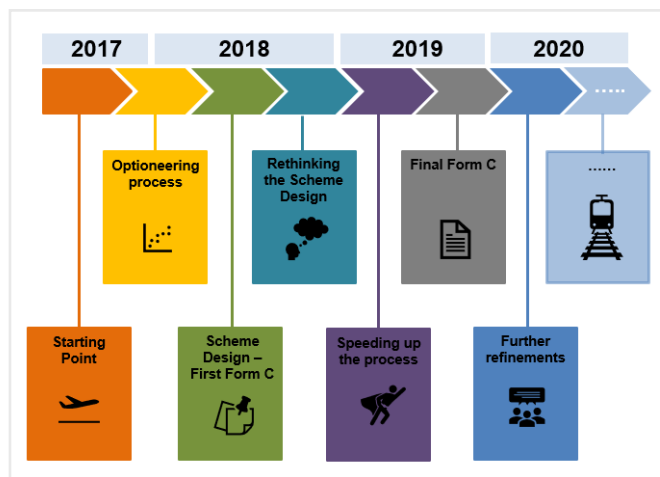


Figure 1: Alignment journey so far.

From then onwards, and learning from the approach undertaken during 2019, the alignment, typically a rigid element of the design, has been able to rapidly adapt to arising challenges and opportunities, and efficiently take advantage of them when required.

The project currently is based on an updated and consolidated alignment that will be the one that constitutes the basis for the construction and operation of HS2. The timeline of the process is shown in figure 1.

SCHEME DESIGN – UNDERSTANDING

In order to take advantage of the opportunities an Early Contractor Involvement (ECI) contract could offer, an Integrated Project Team (IPT) (DH, SCS and HS2) started to work together through an optioneering process, initiated in September 2017.

In Figure 2 below, each column represents an asset that underwent an optioneering process itself. Some of the value engineering exercises performed on an asset in isolation had repercussions on the alignment. An example of this cross-impact was the implementation of a central shaft increasing the distance between bores and thus requiring a horizontal alignment change.

Also in Figure 2, each row represents time, starting with a brainstorming session. A sift was then conducted and with the remaining options an integration workshop was held. The intention of that session was to consolidate the optioneering of the alignment together with the changes that were promoted from the assets individually.

The main ideas generated during the brainstorming period were around various themes which included looking at all vertical and horizontal obstructions to study further options of modifying the alignment in compliance with the HS2 Technical Standards, and improve the Euston throat and Northolt tunnel designs as well as minimising the separation between tunnels.

A first sift confirmed compliance and assurance of the solutions brainstormed and discarded the non-compliances. Compliance checks were undertaken as shown in Figure 3, in line with HS2 Route Development Procedure [6].

Alignment was used as an integration tool along the whole scheme, becoming an assurance check process. This integration exercise, conducted jointly by SCS construction, HS2 and DH representatives, enabled the project to progress towards the final sift and finally with the alignment that informed the Scheme Design and was defined in detail in the first alignment Form C [1], [2] issued in Summer 2018.

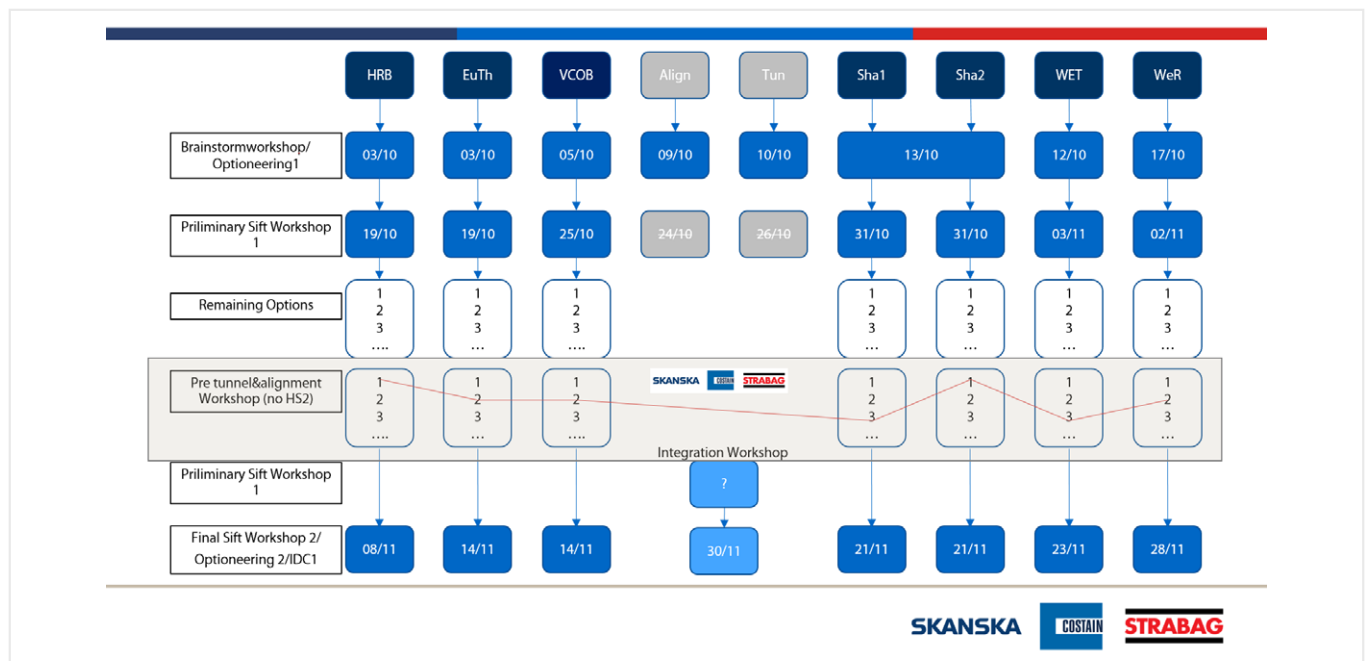


Figure 2: Optioneering process.

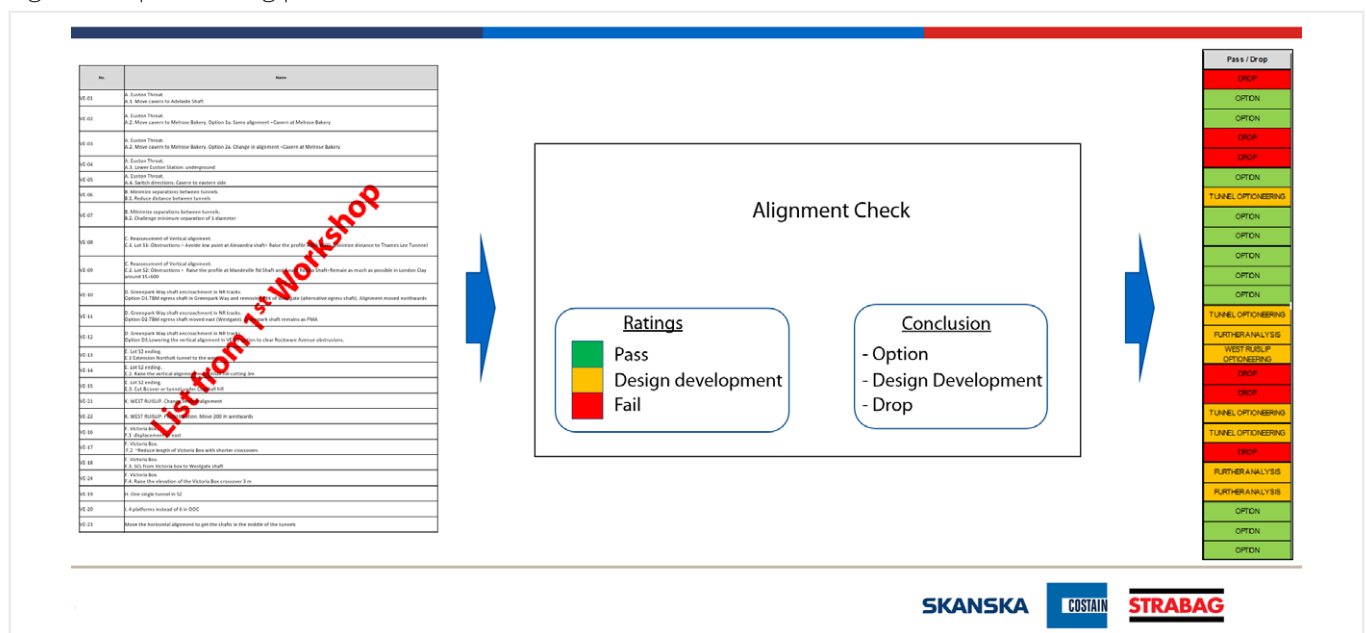


Figure 3: Compliance checks to confirm compliant solutions.

As a summary, the most relevant alignment changes consolidated during the Scheme Design were:

- Euston Throat – Cavern realignment (S1)
- Reassessment of vertical alignment / obstructions (S1 and S2)
- Minimisation of separation between tunnels (S1 and S2)
- Horizontal alignment changes to accommodate the shafts horizontal fans solution (S1)

RETHINKING THE SCHEME DESIGN. ACTIVE COLLABORATION

Once the Scheme Design was closed, the project progressed into a stage where further opportunities were identified, with the alignment at the core of every decision to make the engineering changes work holistically.

Through critical review of the design assurance process to maximise the benefit of our co-located strategy (same team, same office), a fully interactive approach was undertaken. This approach went a step further compared to the previous phase; An Alignment Working Group (AWG) composed by HS2 alignment representatives, SCS and DH design management was conformed to ensure the main opportunities promoted of the IPLT were assured and progressed.

The main alignment changes within this stage related to the development of new solutions for certain assets. Once a specific opportunity was approved by the IPLT, it was discussed and reviewed by the AWG and then the alignment integrated it if the resolution was favourable. Ultimately, the alignment acted as a final sift of all IPLT promoted opportunities to ensure compliance and its suitability (see Figure 4).

The main sources of change during this period were:

- Opportunities (GW5 and GW6, depending on the IPLT identification period).
- Incorporation of changes generated by the adjacent lots (S3 and C1).
- Update to new set of HS2 Standards and implementation of EDC-076 (Engineering Design Change) specifically including the consideration of “passive provision for a perturbation crossover between West Ruislip Portal and Colne Valley Viaduct”.
- GI / Obstructions improvements and overall risk reduction (see Figure 5).

Once the review process took place, Alignment Options Reports[3], [4], [5] were developed to collect all decisions made to date and informed the creation of a revised Form C [1], [2] that was subject of HS2 subject matter experts' (SME) review and acceptance.

To enhance the communication with other HS2's disciplines not co-located with SCS (operations, maintenance, systems), the AWG presented in May 2019 all the changes under development to seek acceptance and ensure a direct line of communication, streamlining the decision making process and avoiding unexpected surprises once the formal documentation was transmitted to the relevant approval body.

The AWG was a key that enabled an agile and versatile management of the changes improving the way the team had been working during the previous stages by learning from it. It constituted a useful tool that helped the IPLT decisions to be implemented on time ensuring compliance with HS2 standards and the creation of a strong communication strategy across the project.

The Route Development Procedure [6] (RDP) was applied during the process resulting in a Form C [1], [2] by the end of July 2019. See Figure 6.

Some of the main opportunities that were successfully implemented in the period were:

- Increased clearance to Thames Lee Tunnel and Adelaide Ventilation Shaft civil works depth reduction (See Figure 7, where the green line represents the consolidated option).
- New Tunnel Ventilation Strategy Implementation (redesign of S2 Ventilation Shafts) with an alignment impact (see Figure 8).
- New excavated material opportunities, including a Portal Shift, raise of vertical profile and the siding close to the Chiltern Line realignment. See Figure 9.

FINAL ALIGNMENT FORM C

The final alignment Form C [1],[2] of July 2019 (version C03 of the Form C documents [1], [2]) incorporated all track alignment refinements approved by the IPLT as described in the previous section. Since then, this Form C has constituted the basis of the assets civil design for both S1 and S2 HS2 Phase One lots.

This final Form C collates a wide range of documents in order to prove that the track alignment design complies with HS2 Technical Standards applicable to this specific project:

Schedule of TADS (Technical Standard – Track Alignment Design [7] gives Exceptional Values and Non-Compliances, providing a comparison between the baseline option for the track alignment and the proposed change, based on non-compliant and exceptional values.

	Code	Baseline	Reason for change	Title	Status Alignment Freeze 28/03/19	Lot
GW5	AI1	PMA Rev02	Opportunity GW5	NEMO - 140m Portal Shift	IN	S2
	AI2	PMA Rev02	Opportunity GW5	Raise the vertical profile 1m over Breakspear Rd overbridge	IN	S2
	AI3	PMA Rev02	Opportunity GW5	Move the siding closer to Chiltern Line	IN	S2
GW6	AI4	PMA Rev02	Opportunity GW6	S2 Ventilation Shafts new design	IN NEXT REVISION	S2
	AI5	PMA Rev02	Opportunity GW6	1a) Raise of tunnel from fom Greenpark Way to South Ruislip inside LOD	PENDING DECISION	S2
	AI6	PMA Rev02	Opportunity GW6	1b) Raise of tunnel from fom Greenpark Way to South Ruislip inside LOD disregarding Rockware and Stanford house as constraint	PENDING DECISION	S2
	AI7	PMA Rev02	Opportunity GW6	2a) Raise of tunnel from fom Greenpark Way to South Ruislip up to 2 m above the LOD disregarding Rockware and Stanford house as constraint	PENDING DECISION	S2
	AI8	PMA Rev02	Opportunity GW6	2b) Primrose Hill Area tunnel raise up to 2 m above the LOD	OUT	S1
	AI9	PMA Rev02	Opportunity GW6	New Euston Cavern optimisation	PENDING DECISION	S1
C1 S3	AI10	PMA Rev02	S3 Interface	S3 track layout changed	IN NEXT REVISION	S1
	AI11	PMA Rev02	C1 Interface	C1 vertical profile changed	IN	S2
P O R T A L	AI12	PMA Rev02	GI/Obstruction update	Thames Lee Tunnel (local change)	IN	S1
	AI13	PMA Rev02	GI/Obstruction update	Mandeville Shaft Depth Reduction (local change)	IN	S2
	AI14	PMA Rev02	GI/Obstruction update	Vertical alignment refinement according to new obstructions' information (lotwide)	IN	S1
	AI15	PMA Rev02	GI/Obstruction update	Vertical alignment refinement according to new obstructions' information (lotwide)	IN	S2
	AI16	PMA Rev02	P02 Standards	Horizontal alignment new exceptionalities	IN	S1
S T A	AI17	PMA Rev02	P02 Standards	Horizontal alignment new exceptionalities	IN	S2
	OTH	PMA Rev02	Other (see description)	Perturbation crossover	IN	S2

Figure 4: AWG sift of main IPLT promoted opportunities.

Alignment Design Change Report (ADCR), including a designer's log with key decisions for the change as well as new risks and assumptions associated with the proposed change records both interdisciplinary and interface consultations including a summary of high-level impacts. Designer Geometry Check Sheet and Summary of Changes is where the occurrence of new non-compliant and unavoidable exceptional values is recorded.

Plan Profile and obstruction drawings are supporting plan and profile drawings which include both the baseline option and proposed track alignment change. They provide a graphic comparison for a better understanding. 3D models and the alignment file, the main alignment tools that will be part of the future HS2 PMAs.

These documents are focused on the alignment only but do not compile all aspects related to the change assessment as a whole. That was the starting point of the Alignment Options Reports, which were included in the project to provide a structured and evidenced approach of the changes. Options Reports summarise merits and weaknesses, for all disciplines, of all studied options and against the baseline option as developed and reviewed by the AWG.

FURTHER REFINEMENTS

That version of the alignment Form C is considered the basis of the civil design since July 2019. Nevertheless, the integrated project team has developed further opportunities to de-risk or improve the scheme when it was feasible. The incorporation of an alignment change at Greenpark Way Ventilation Shaft into the HS2 Project Master Alignment (PMA) is a good example of this.

Greenpark change is the result of an engagement process carried out on the development of different opportunities where design, construction and operation & maintenance disciplines were involved following the successful example set by the AWG in 2019.

The design change process finalised with a Joint Engineering Change Panel (ECP), session where the possibility of shifting the alignment by 4m northwards was put forward in order to reduce the risk on the operation of the Network Rail Chiltern lines, running adjacent and parallel to the south of the HS2 alignment.

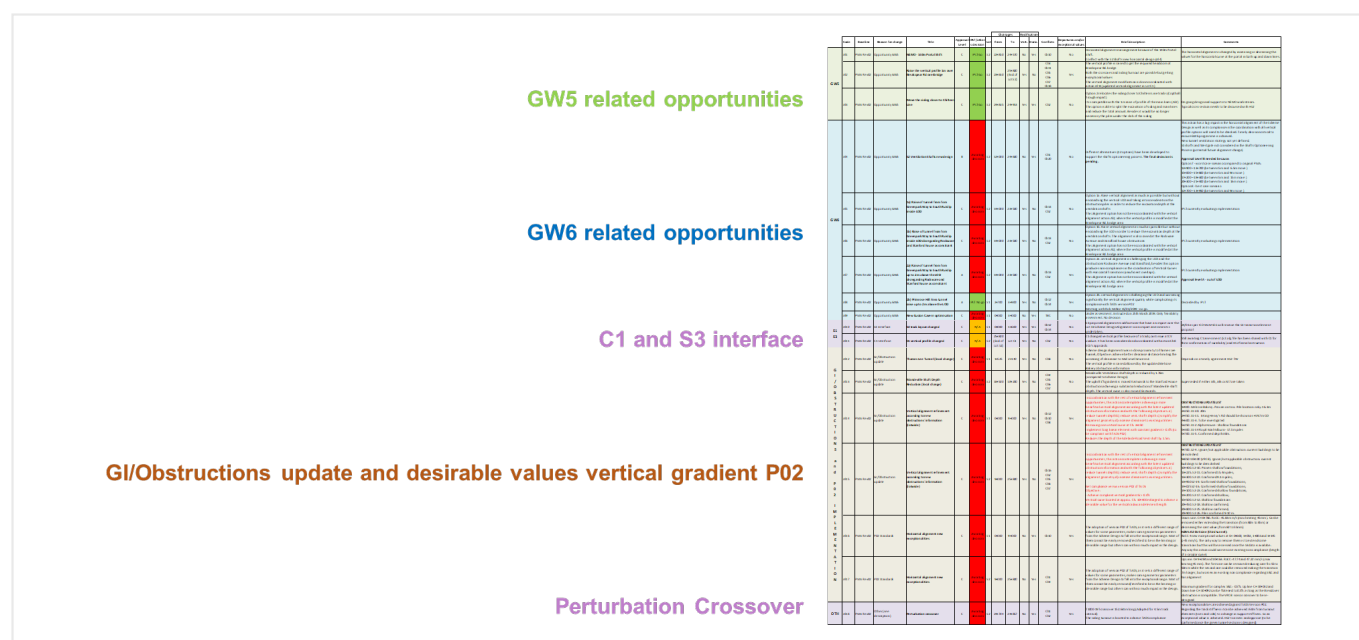


Figure 5: Alignment Changes reviewed by the AWG (2019).

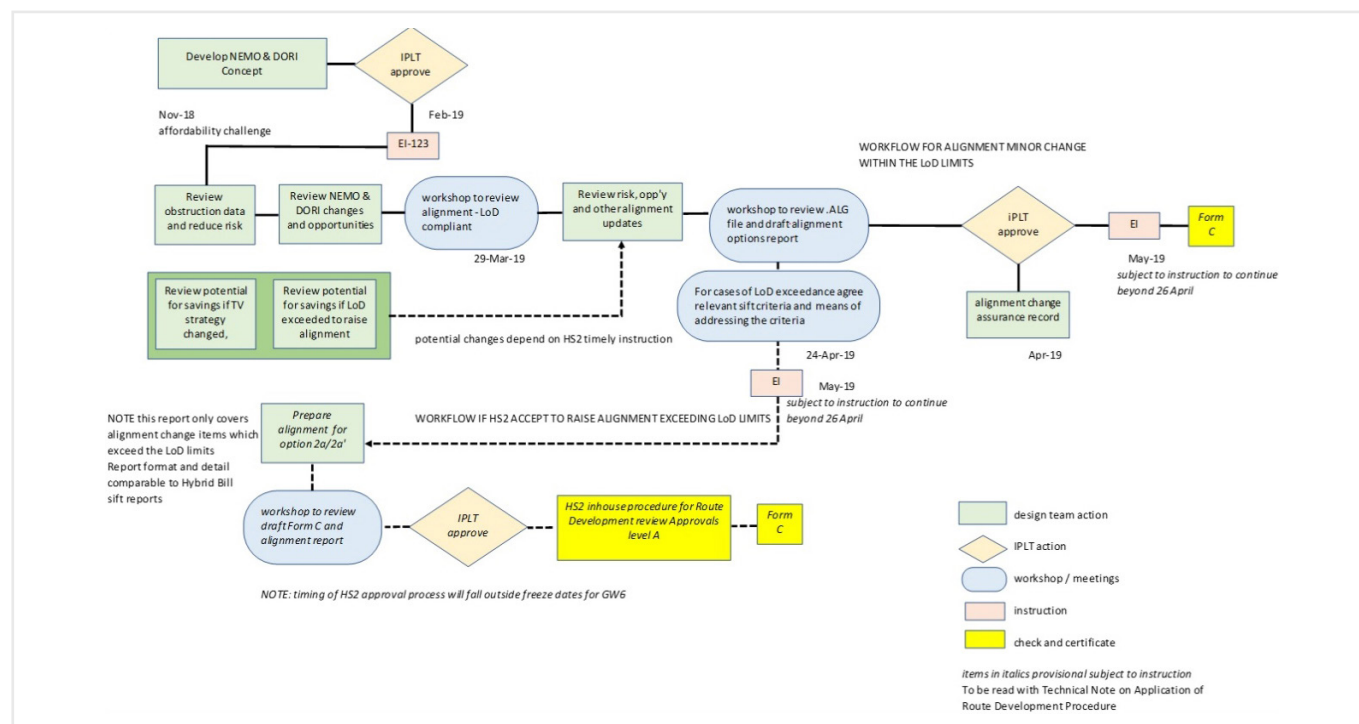


Figure 6: Assurance process and RDP followed from IPLT decision until final alignment change consolidation.

In addition to that, clear benefits in terms of health and safety, temporary works rationalisation, drilling and ground movement reduction were the main drivers for the ECP to support this alignment refinement.

The benefits of the change were clear but its integration in a new alignment iteration was challenging. With on-going detail design for most of the assets underway along the S1 and S2 scheme, the alignment had to be modified mitigating knock-on impacts on other elements of the design and complying with HS2 Technical Standards. See Figure 10.

Greenpark alignment change was carried out with the support of HS2 specialists following the Route Development Procedure [6]. This provided an informed decision on the alignment design option the project should progress with. As a result of that collaborative work, the initial alignment for Greenpark underwent further refinements until a final proposal was agreed by all parties. The result was the Greenpark Alignment Form C [2].

The newest alignment Form C was backed by a new Alignment Options Report [8]. In that case, the report collated all decisions made related to the new alignment change.

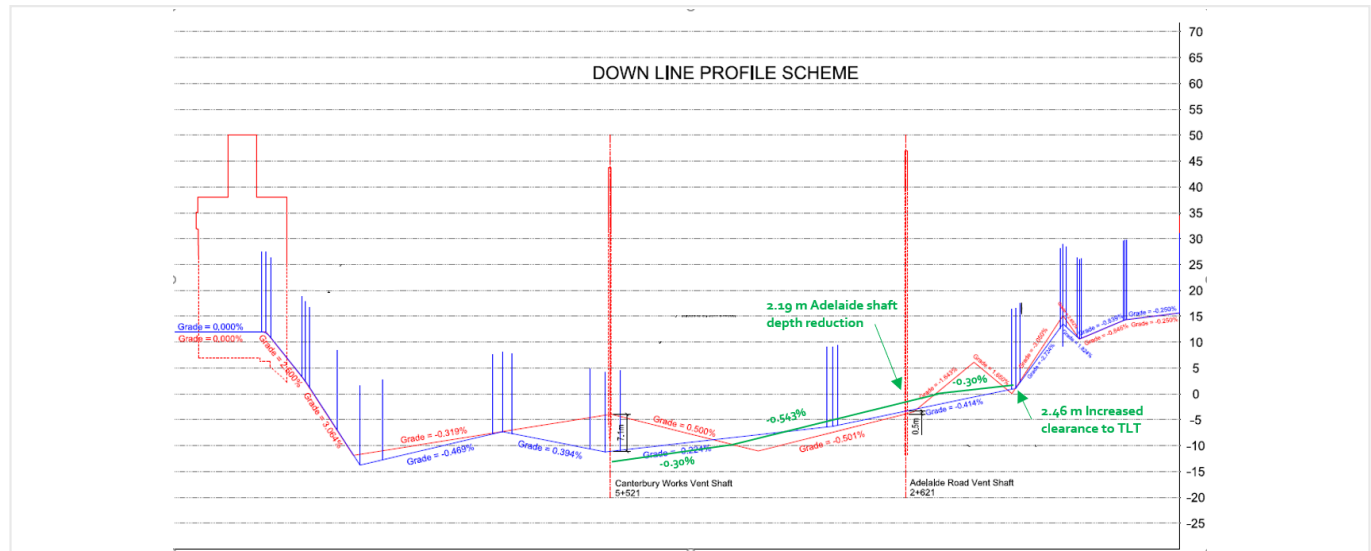
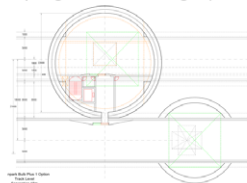


Figure 7: Alignment changes around Adelaide Ventilation Shaft.

- IPLT decision on new S2 shafts design following new Tunnel Ventilation Strategy
- Preliminary assessments indicate that these changes represent a £12-15 million cost saving and significant programme savings (8+ months)



• **Alignment impact – causes**

- 1) Layout of the shaft: distance between tracks may vary
- 2) Adjustment to the shafts existing plots
- 3) NR tracks interface (surface)
- 4) Obstructions

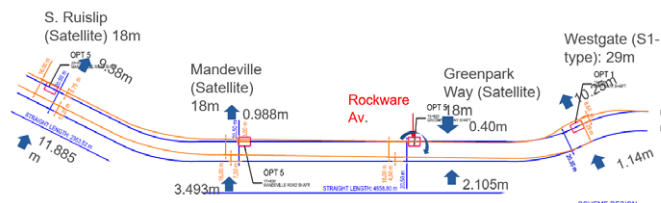


Figure 8: Alignment changes to incorporate the new tunnel ventilation strategy.

Excavated material opportunities at West Ruislip

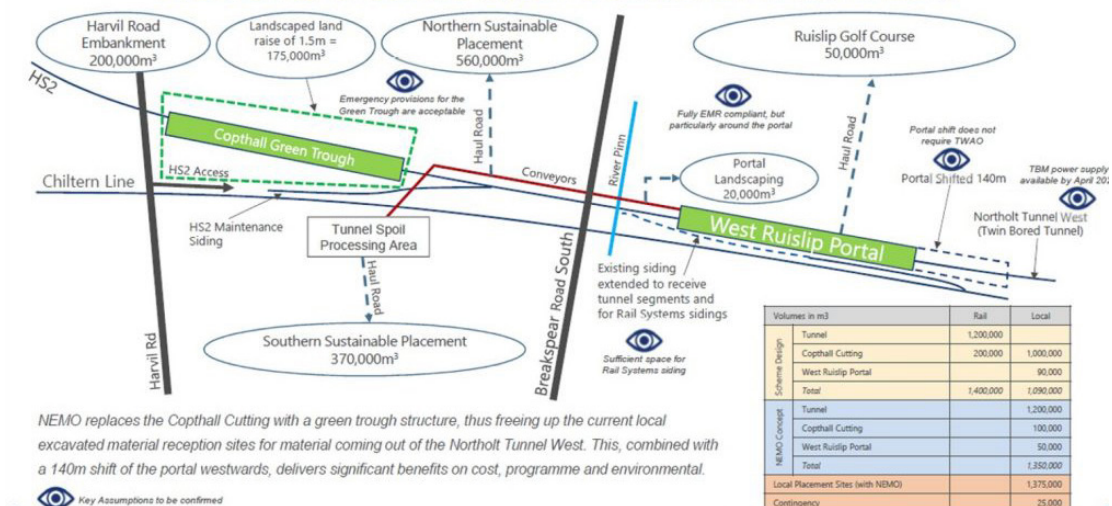


Figure 9: Summary of changes related to excavated material opportunities.

The ECP meeting gave all parties involved the confidence that a satisfactory design could be achieved. A collaborative exercise carried out by a multidisciplinary team that has ended up in an improvement of the former design.

CONCLUSIONS AND LESSONS LEARNT

The main focus of this paper is not to demonstrate the thorough engineering and technical work undertaken behind the scenes, but an approach to collaboration that if properly managed could bring lean and integrated management practices to future projects.

It is all about a learning curve. It has been presented how SCS and DH started to work together during the Scheme Design, how a single team was set in motion sharing a common vision and objectives, which was continued during the opportunities implementation stage later on. Finally, a further demonstration of the effective collaboration is the direct implementation of a change at Greenpark Ventilation Shaft. A task that could have taken a long time at the early stages of the contract was performed in a short period of time following an assured, transparent and consistent process.

Throughout the process we have learned how to work collaboratively in an ECI environment, with a seamless design, construction and HS2/operations integrated project team sharing objectives and actively participating in a process that has been beneficial for the project as a whole.

Collaboration is the key in engineering of the future, we are stronger together, and by bringing out the best from each and every discipline and organisation, with a proactive attitude and an integrated approach, future engineering projects cannot be but successful leaving an enduring legacy for generations to come.

ACKNOWLEDGEMENTS

Bryan Todhunter (HS2), for his understanding and support throughout the process, ensuring HS2's visibility and contribution to the process.

Carlos Gomez Milder (DH), for his support and productive participation in the alignment evolution from day one on behalf of DH leadership team.

Tom Beales-Ferguson (DH), for his continuous support to the Route Civils team ensuring impact on third party assets was at the core of every decision and for his coordination role, key to ensure consistency between the alignment and GMAs (Ground Movement Assessments) development.

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- [6] HS2-HS2-SA-PRO-000-000007, Route Development Procedure.
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PEER REVIEW

Vara Suntharalingam, Civil Engineering Director HS2 Ltd

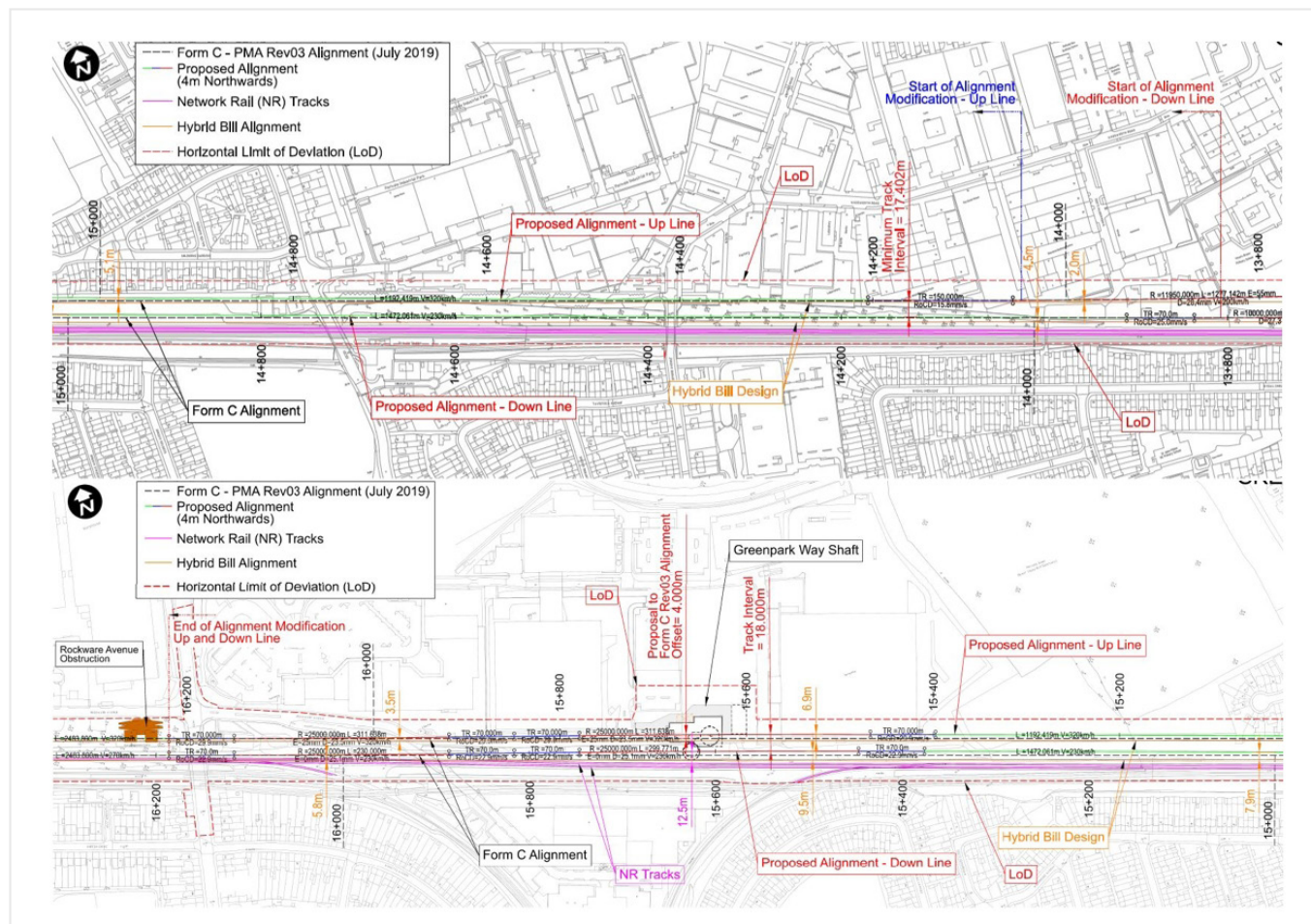


Figure 10: Alignment proposal in comparison with hybrid Bill design and the Form C [1],[2] July 2019.

Sea defences - friend or foe?



AUTHOR: John Parker

A railway Civil Engineer with over 40 years asset management experience in track, structures and earthworks. Started on Preston Division of British Rail at the time of the WCML electrification to Glasgow. Progressing to responsibilities including Bridges and Tunnels Engineer for BR in Liverpool, Zone Structures Engineer for Railtrack NW in Manchester and Senior Earthworks Management Engineer For LNW Territory (NR, Manchester). John is currently acting as rail advisor to Preston Trampower Ltd and is Chairman of the Lancaster, Barrow & Carlisle Section of the PWI.

Introduction: Water has been said to be the greatest enemy of the Permanent Way Engineer, even more so where a railway is alongside the sea. Although sea defences provide vital support and protection to the railway, there is a darker side! They are prone to failure, vertical walls in particular cause beach scour and hard defences prevent coastal erosion and hence in some instances have a negative environmental impact.

In this article John looks at various examples of sea defences, the problems they can have and some solutions which have been applied.

TYPES OF DEFENCE

1. Sea Walls: Built usually to form a bench for the railway between the sea and adjacent cliffs which are typically weathered and unstable. Constructed of masonry or concrete and either built vertically, inclined or concave to deflect waves. (See figure 1).

2. Revetments: Embankments, usually alongside estuaries that are protected from wave action erosion by stone pitching placed on the seaward side. An example of a revetment is the Capes Head embankment on the approach to Leven Viaduct in Cumbria, which was built by James Brunlees in 1855 and varies in height from 4.5 - 7.6 metres (15ft to 25ft). The viaduct carries the Carnforth to Barrow section of railway over the Leven river estuary. (See figure 2).

The construction of the revetment comprises sand which is covered on the seaward face with clay, rid and stone pitching not less than 1200mm, (4ft), thick. The pitching extends 915mm, (3ft), below the beach level and is 450mm, (18ins), thick at the bottom and 305mm, (12ins), thick at the top. (See figure 3). Revetments can be either open jointed or mortared. However, by sealing the surface the latter may do more harm by increasing wave-suction on the face

of the revetment. Glan Conwy revetment, on the Conwy estuary has been larried, (plastering term), on the surface with concrete as have other defences in North Wales. This provides a good wearing surface but can eventually become detached in large slabs, which as well as exposing the underlying structure are unsightly and cause environmental problems.

3. Groynes: Post and plank walls perpendicular to the coast which prevent loss of beach materials caused by a phenomenon known as long-shore drift. Groynes are particularly effective on holiday beaches for retaining sand. They also provide a good depth of beach material, which reduces wave height and hence damage from wave action.

The railways used these extensively at one time constructed, (not surprisingly), of bullhead rail and greenheart timber. A number have fallen into disrepair as at Old Colwyn in North Wales, in most cases partly due to the problem of maintaining an asset which is usually on someone else's land, and partly due to the use of rock armour as a preferred method of protection. (See figure 4). There may also be issues around 3rd party liability. Groynes may come back into favour since by retaining beach material as a form of defence they offer a good environmental solution, though the use of greenheart timber as planking needs to be considered for sustainability. Alternative materials such as recycled plastic may be an answer.

4. Shingle Banks: These comprise a beach which is protected by pebbles or small-to-medium-sized cobbles, as opposed to sand. Size of the stones is likely to be in the range between 2mm to 200mm, (0.1 to 7.9 ins), diameter. The banks are usually steep as the waves readily flow through the coarse, porous surface of the beach. This reduces the effect of backwash erosion and increases the formation of deposited material to form a steep slope.



Figure 1: Nuclear flask train passing along the sea wall at Parton, Cumbria.



Figure 2: Revetment at Capes Head embankment.

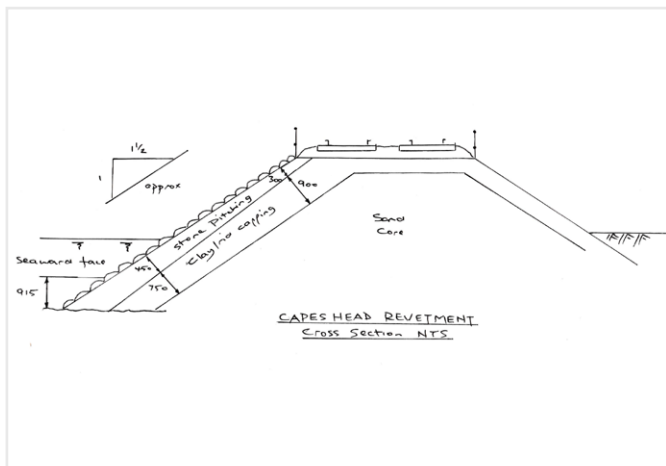


Figure 3: Cross-section through Capes Head embankment.

Shingle banks offer one of the best forms of sea defence by absorbing wave energy and reducing the depth of water and hence wave height on the upper beach. However, they do require significant maintenance involving replenishment of stone and reprofiling after severe storms. The residents in the chalets at Nethertown in Cumbria, shown in figure 5, have maintained a shingle bank defence to mainly good effect over many years. This has in turn provided protection to the railway.

5. Salt Marshes: Salt marshes form as estuaries alter course over the years ie Kent and Dee. The slower moving water on one side deposit silts and sands and this gradually builds up to force the estuary further away from that side. The mud banks thus exposed are not regularly covered in sea water and hence sea grass establishes itself. These areas form ideal defences as even in storm conditions the water depth on them is shallow hence the wave height is low. They also become very environmentally sensitive areas, usually SSSIs for the bird life they attract. They are, however, very fragile formations and can be quickly eroded when the estuary changes course again as discussed later in this article. Most estuaries oscillate from one side to the other over a period of maybe 100 years. Kents Bank frontage from 1964 to now has changed from a sandy beach to a full salt marsh as shown in figure 6.

THE ENGINEERS: SOME HISTORIC EXAMPLES, PROBLEMS AND SOLUTIONS

George Stephenson in 1837 proposed a route to Scotland via the Cumbrian Coast with a causeway across Morecambe Bay, a tunnel under the Furness peninsula and a viaduct across the Duddon estuary, (the start of the approach embankment is still visible near Askham). This would have been spectacular! He was therefore the ideal man to act as consulting engineer when the Cumbrian iron works and coal mine owners were promoting the Whitehaven Junction Railway from Maryport to Whitehaven.



Figure 5: Shingle bank sea defence at Nethertown.

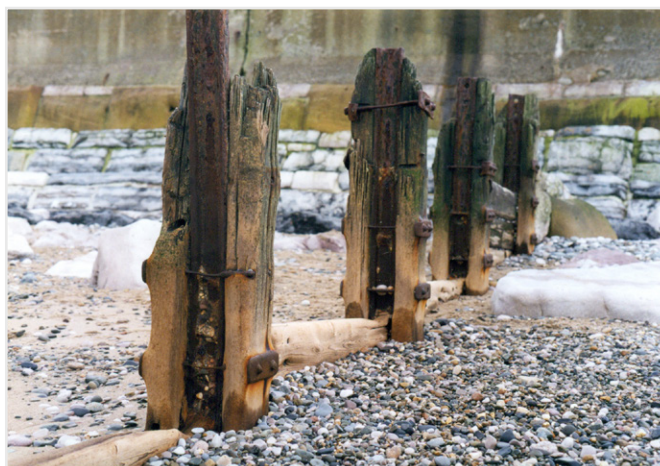


Figure 4: Groyne in degraded condition.

It was towards the end of Stephenson's life but his experience, mining background and knowledge of the route would all be attractive to the promoters, but expensive. The line was incorporated in 1844 and opened in 1847 one year before Stephenson died. In addition to the extensive sea defence works another structure of note was a timber trestle viaduct across the creek at Harrington. This was heavily repaired in 1860 and reconstructed in 1888 in the form that existed until 2004. Timber trestle viaducts were common on early railways as they enabled the lines to be opened quickly and cheaply. They were also a form of construction early engineers would be very familiar with from early colliery days. (See figure 7).

The line was problematic from early days with the loco crews naming the Parton Sea Brows section 'avalanche alley'. In 1852 there was also a serious washout at 1MP when 23 metres, (30yds), of wall was lost. This was rebuilt with granite setts inclined at a steep angle.

Robert Stephenson In 1846 he was busy with the construction of the Chester – Holyhead Railway and particularly the sea wall at Llanfairfechan, 183 metres, (200 yards), of which failed following a storm in October of that year. He replaced that section with a viaduct initially with CI beams forming the spans. Brick arches were substituted in the late 19th century. (See figure 8). It was also found necessary to drive timber piles 4.5 metres, (15ft), from the wall to prevent scour to the foundations as the work progressed, a problem that exists to this day. It is interesting to reflect on Robert Stephenson's thoughts at this time as recorded in 'Lives of the Stephensons' by Smiles:

'Mr Stephenson confessed that if a long tunnel had been made in the first instance through the solid rock a saving of from £25k to £30k would have been effected. He also said he had arrived at the conclusion that in railway works engineers should endeavour as far as possible to avoid the necessity of contending with the sea. But if he were ever again compelled to go within its reach he would adopt, instead of retaining walls, an open viaduct, placing all the piers edgewise to the force of the sea, and allowing the waves to break upon a natural slope of beach'

He was ready enough to admit the errors he had committed in the original design of this work, but said he had always gained more information from studying the causes of failures and endeavouring to surmount them than he had done from easily won successes. Whilst many of the latter had been forgotten, the former were indelibly fixed in his memory. According to Smiles, Stephenson estimated the force of a wave as 144 to 190 kNm-2 (1.5 to 2 tons/sq ft), he also said that the lighthouse engineer Stevenson had measured a force of 290 kNm-2, (3 tons/sq ft) in the Atlantic at Skerryvore.

William Cubitt, Engineer to the South Eastern Railway was responsible for the Folkestone to Dover section, which was the first coastal railway completed. This was a heavily engineered section of railway 16 Km (10 miles) long, with 3.2Km, (2 miles), of sea walls, 3 tunnels totalling the same distance, and including the notorious slip prone Folkestone Warren.

The last section was built on a timber trestle viaduct 235m, (257 yds), long across the beach. The viaduct was remarkably resilient, lasting for 85 years until 1927 when the Southern Railway protected the structure with a sea wall and infilled it with chalk spoil.

On Christmas Eve 2015 sink holes were reported on the structure and the line was closed. Consultants Tony Gee and Partners looked at various options to remedy the problem which appeared to be caused by fill settling/ leaching from the structure. The preferred option was a piled concrete ground slab similar to a more recent scheme at Eden Brow on the Settle to Carlisle line and protected by sheet piles and rock armour. The £40m scheme had a 12-month construction phase.



Figure 6: Kent's Bank salt marsh.



Figure 9: Reconstructed sea wall at Dawlish.

Isambard Kingdom Brunel engineered his South Devon Railway as an atmospheric railway, and chose a coastal alignment to avoid heavy engineering works that would have been necessary for an inland route. From opening in 1846 the frontage at Dawlish has been subject to continual damage including four breaches by 1860. This has continued into this century with the recent well publicised failure in December 2015.

The sea wall is prone to overtopping and is backed by weathered sandstone cliffs, but has the added problem that it is fronted by a popular holiday beach which precludes standard sea defence solutions such as rock armour. The wall is also topped by a public footpath. (See figure 9).

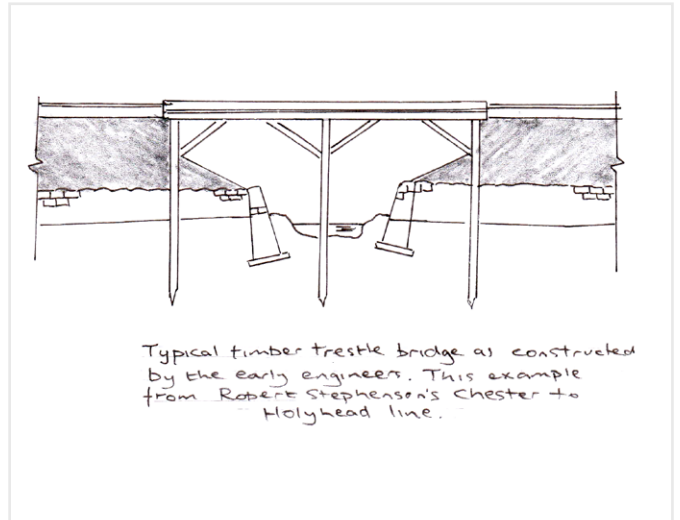


Figure 7: Example of a timber trestle bridge.



Figure 8: Viaduct at Llanfairfechan.



Figure 10: Wave action at Parton Sea Brows.

A budget of approx £600k a year is spent by Network Rail on continual maintenance, including underpinning the sea wall. Annual inspections are carried out together with periodic ones especially after storm conditions. This process of examination and maintenance of the sea wall was managed locally from Exeter where Peter Haigh was the engineer responsible for many years. There is a plaque commemorating Peter on the footbridge at the western end of Dawlish.

Following a recent feasibility study BAM Nuttall are now on site (Feb 2021) constructing the chosen option which is a partial reconstruction and raising of the sea wall with precast concrete units. Work has progressed from the west end to just beyond Dawlish Station.

CASE STUDIES

Parton Sea Brows: This section of coast is particularly prone to storm damage as seen from the failures soon after construction. The main causes of failure are wave overtopping forming sink holes in the cess, and erosion of the rock foundation allowing sea water to wash out fill material from behind the wall. (See figure 10). Historically, ad-hoc repairs have been carried out over the years usually involving filling sink holes and pouring concrete to seal the base of the wall.

This section of route was singled c1970 due to historical problems with the stability of the cliff face on the up side, which consists of sandstone inter-bedded with mudstone and dipping towards the sea. It is prone to erosion in this exposed location resulting in undercutting to and toppling failure of the sandstone blocks. The rock is also overlaid with glacial deposits supplemented over the years with spoil from industrial processes including mining. These continue to form slips resulting in earth flow down over the rock face to cess level.



Figure 11: Repairs to the sea wall at St. Bees.

The original singling scheme allowed for the construction of an H pile and sleeper rock trap wall which protected the remaining down (single line). This however needed regular possessions for the removal of debris from behind the stockade which was then tipped into the sea.

In the early part of this century, rock armour protection was put in place at this location and has prevented further failures. Major re-grading and drainage works above the cliffs have drastically reduced the number of rock falls and a recent extensive rock netting scheme has enabled the rock trap wall to be removed.

St Bees: The St Bees sea defence in Cumbria suffered many failures during the late 20th century. This was due to voiding beneath the stone pitching which had weakened the structure over time. It was always essential to start repairing damage at low tide before further loss of pitching on subsequent tides. In figure 11 the void is being filled with rock armour before sealing with concrete. However the solution was not always that neat, quite often scrap concrete units were used and on one infamous occasion redundant 'brutes' (parcel trolleys) from Carlisle station filled with concrete!

With the advent of Railtrack a decision was taken to tackle some of the longer running structural problems such as St Bees. Following a feasibility study a contract was let to Christiani Neilsen to reconstruct the defence with a low level rock armour defence and upper slope erosion protection. Access was naturally required along the beach which had belonged to BR but following privatisation now resided with BR residual who were just in the process of selling it by auction. It was therefore necessary for Railtrack to bid for it, and eventually ownership of the beach was secured for the benefit of the railway.

The rock armour was placed first and used as a platform for the upper works. There may have been a more cost-effective solution than concrete revetment blocks, but they provided a reasonable appearance and will last a very long time. (See figure 12).



Figure 12: Upgraded sea defences at St. Bees.



Figure 13: Lord Vivian's Embankment.



Figure 14: Construction of rock bund at Micklam.

Lord Vivian's Embankment: This is an unusual location where a railway sea defence protects third-party property. Lord Vivian's Embankment in Flintshire, North Wales, pre-dated the railway and it is likely that as part of the agreement for allowing passage of the railway he transferred responsibility for the embankment to the Chester and Holyhead Railway.

Many years ago the salt marsh in front of the revetment was several hundred metres wide but as the River Dee altered course the salt marsh was eroded at an alarming rate. With the main channel so deep there was a serious concern that the estuary would eventually undercut the revetment and collapse it. (See figure 13).

To quantify the risk trial holes were dug to find the toe of the stone pitching, and fortunately the depth of it was such that undermining would be unlikely. This confirmed that the estuary had been hard up against this defence in past times, hence the need to build it. It also shows how fragile a salt marsh is, when accretion is taking place as at Kents Bank it reduces maintenance of sea defences, but erosion on the scale of the Dee at Lord Vivian's Embankment can quickly increase maintenance budgets and risk to railway infrastructure.

It is therefore important to monitor changes in salt marshes to understand, in advance, when preventative work is likely to be required.

Micklam Slip: The deep-seated slip at Micklam in Cumbria has been an on going problem for track engineers, who have frequently had to realign track distorted by ground movement. An historic solution was to weight the toe of the slip with scrap concrete units, mainly sleepers. This was reasonably effective, but the sleepers were not heavy enough to withstand the full force of the Irish Sea and over time ended up spread across the beach. This was undesirable for a number of reasons, being very unsightly and a risk to members of the public as the concrete eroded and exposed reinforcement strands, and the loss of the sleepers obviously weakened the defence.

Work was initially undertaken to contain the sleepers by constructing a rock bund along the frontage. (See figure 14). This proved to have additional benefits by trapping beach material behind it, forming a raised platform in front of the defence which absorbed and reduced the effect of wave action.

The whole frontage has since been rebuilt and strengthened using material from the recycled sleepers and rock armour. The use of scrap concrete and building materials to strengthen sea defences is not new. A scrap concrete beam from West Allerton forms part of the sea defence near Askam. This was from demolition work done as part of the West Coast Main Line modernisation works in the 1960s.

Another example is where rubble from bomb damage in Liverpool during WW2 was used by the local authority to strengthen the coast near Formby.



Figure 15: Exposed location at Siddick showing continual erosion.

Siddick: The railway here is on a level coastal strip near Workington in Cumbria, and historically no defence was provided. The stony beach was regularly supplemented with waste from coal mining and the steel industry which formed a protection from the sea. With the decline of industry and a more environmentally aware society this practice stopped. (See figure 15).

The frontage was then subject to fairly rapid erosion resulting in the substantial damage in 1977 detailed in Mike Chorley's paper 'The Great Washout', which was published in the PWI Journal in 1984, (Vol 102 part 2). Initially a gabion defence was provided, and as this deteriorated concrete was cast to protect the gabions. In this exposed location the scour effect of the sea undermined the defence and made it necessary to construct a rock defence in early 2000s. However, erosion continues to the north along this very open and level stretch of coast which extends all the way to Flimby. This is an example of a defence growing in a reactive way.

It is interesting to note that the weathered blast furnace slag on the Cumbrian beaches is now considered of historic interest and should not be removed!

Nethertown: The toe of a railway embankment can have adequate protection from coastal erosion provided by rock armour held in place on the rock shelf by steel pins. However the upper slope can still be vulnerable to erosion by wave over topping or run off from the fields on the higher ground inland of the railway. A cost effective solution is to grade the upper slope, place 150mm of Type 6G stone and retain it with rock netting. (See figure 16). This solution could have been used at St Bees but the design life is probably only 30 years due to corrosion of the netting and settlement of the stone.

To close on a high, I once said that looking out over the lagoon at Nethertown on a sunny day was as good as anywhere. A colleague remarked I should get out more, which was probably true!

CONCLUSION

High risk sea defences should be identified by examination, monitoring and viewing historical records; in fact the history of a structure can often reveal more than mere observation. A management strategy can then be put in place.

Lower risk defences should be examined annually and additionally after severe weather as necessary. Any noted defects, especially loss of masonry blocks and voiding, should be rectified quickly to avoid rapid deterioration which can happen after consecutive tides when structures are exposed to wave action.

Finally, the words of Robert Stephenson are as true today as when he said he learnt far more from his mistakes than his successes. Lessons can always be learnt to improve the outcome of future projects.



Figure 16: Upper slope with 6G stone and rock netting at Nethertown.



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Intelligent tamping - from research to automation

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INTRODUCTION AND PROBLEM STATEMENT

Current practice of track maintenance is based on modern tamping machines that provide a wide range of advanced functions, such as the multiple sleeper tamping mechanism, dynamic track stabilization and combined levelling and lining of the tracks.

Tamping process, the core maintenance activity in ballasted track, is a result of experience and knowledge collected from railway operations worldwide. An extensive basic research conducted in 1983 at Graz University of Technology investigated and determined the optimum tamping frequency (35 Hz) and an oscillation amplitude of the tamping tines (4-5 mm) [1]. However, different global tamping standards driven by local regulations and divergent boundary conditions define a wide spectrum of other tamping parameters such as tamping time, squeezing force, minimum lifting values and number of insertions [2].

State-of-the-art tamping machines operate with a parameter combination previously empirically selected by the machine operator on the spot, which significantly aggravates comparison of conducted tamping work on different locations and in different conditions. Given that an incorrect setting of the tamping parameters leads to sub-optimal ballast bed compaction and shortens the interval between track maintenance activities, the importance of experienced and well-coordinated machine crew becomes even more prominent. Variable tamping parameters and machine settings that are selected by the operator such as the squeezing force and time, frequency modulation during ballast penetration, correction values and tamping depth greatly influence the quality of conducted work.

In addition, only a minority of tamping parameters can be altered in accordance to the ballast condition. Thereby, the process of ballast fouling or attrition is an important aspect to be considered during tamping parameter optimization in a greater scope of developing a fully automated tamping process which would lead to a reduction of workload for the machine operator and to an improvement of quality of conducted track maintenance [3].

AUTOMATION OF THE TAMPING PROCESS

PlasserSmartTamping - THE ASSISTANT

The desired result of the tamping process, extended by lifting and lining, is to restore the defined track geometry. Prior to carrying out the tamping process, the lifting and levelling unit is set in motion. Independent of the tamping technology and tamping machine used, the track must be lifted so that a void is created under the sleeper. Simultaneously, the track is positioned laterally. As a first step towards an automation of the tamping process as a whole, PlasserSmartTamping - The Assistant (Figure 1) is developed in order to support the machine operator in his demanding task. Laser scanning units are used to record the track and its surroundings and digitize them into a 3D model. The usage of artificial intelligence makes it possible for the system to recognize objects in the track and assign them to the correct category. This enables the machine to autonomously distinguish between rails, sleepers and even obstacles such as cables, located in the sleeper bay.

Based on this information the system provides recommended actions for the lifting, levelling and tamping units in "real time" and displays them to the machine operator who can approve or reject recommended actions. As soon as the recommended action is approved, positioning of the lifting, levelling and tamping units is carried out autonomously by the machine [4].

AUTOMATION OF TAMPING PARAMETERS

In the next step towards the development of a fully autonomous tamping process, parameters set during the tamping operation are investigated. Correct assessment and selection of tamping parameters provides a homogeneous, durable and stable track bedding as a result of track tamping. Understanding different soil mechanical and dynamic aspects of track ballast behaviour during tamping is of crucial importance. A comprehensive investigation of the tamping process during regular track maintenance in different ballast conditions was conducted in the scope of a research project

initiated by Plasser & Theurer, and carried out in cooperation with the Institute of Geotechnics at TU Wien in 2016 [3]. Main focus of the project was the measurement, recording and analysis of the interaction between the tamping tine and ballast matrix during ballast compaction. Most significant results and conclusions that arose from this research project show that a determination of ballast condition is possible during the tamping process and that the tamping characteristics obtained from measurement conducted in different stages of ballast fouling significantly differ from each other [3].

In the next step, a definition of a desired parameter combination needed to achieve optimum compaction in every ballast condition is necessary. Once fully developed, this system will, for the first time, allow a full automation of the tamping process for lines, switches and crossings, at the same time increasing the quality of conducted track tamping and leading to an autonomously operating tamping machine.

TAMPING PROCESS - STATE OF THE ART

Track tamping is used to produce (in the case of new track) or restore (in the case of track maintenance) the defined track position. This complex process starts with lifting the relevant track section, which comprises 1 to 4 sleepers depending on the unit, up to the level determined by previous measurements and dependent on the minimum lifting values, and simultaneously positioning it laterally. Both are done using lifting and levelling units mounted in front of the tamping bank, between the bogies. As the track is lifted in order to be positioned, the contact area between the ballast and the sleeper is dissolved and a void is created [5].

PHASES OF THE SQUEEZING PROCESS

Once the track is in the intended position, the tamping process, consisting of three phases (Figure 2), begins. In the first phase, tamping tines penetrate the ballast on the left and right hand side of each sleeper, reaching the level defined by the nominal

tamping depth. This phase is characterized by a higher frequency (approximately 45-48Hz) that temporarily reduces ballast friction angle and thereby aids ballast penetration.

Following the penetration phase, the squeezing movement is initiated, defined as a closing movement of the tamping tines towards the sleeper, instigated by the pre-set squeezing pressure. The squeezing movement is conducted with a frequency of 35Hz and tine oscillation amplitude of 4-5mm, a parameter combination that enables the best compaction effect in combination with the desired ballast elevation [1][6]. Duration of each squeezing movement is given by the squeezing time, pre-set by the machine operator based on several factors such as the in-situ ballast condition, standards, regulations and lifting values, but primarily experience – based. Dependent on the encountered track geometry, correction values and sleeper type, multiple (up to three) tamping processes, ie multiple tamping tine insertions are possible on each sleeper.

During the squeezing movement, the void created under the sleeper (Figure 3) needs to be filled and the ballast matrix compacted in order to create a stable and durable bearing for the track [5]. Total motion of the tamping tines during track tamping incorporates the absolute tine movement driven by the squeezing velocity and the relative tine movement that is dependent on the excitation frequency and amplitude (Figure 4).

Without dynamic excitation, the lowering of tamping bank alone would increase the wear of the tamping bank and the ballast. It would not be sufficient for the tamping tines to penetrate the ballast and reach the necessary position under the sleeper. If the dynamic excitation was only utilized to facilitate the ballast bed penetration but not to perform the squeezing movement, the usual tamping force would not suffice to overcome the passive earth pressure and rearrange the ballast grains to fill the void under the sleeper. On the other hand, increasing the excitation frequency would accelerate the process, but could also lead to ballast bed loosening by dilatation [3].



Figure 1: Tamping machine equipped with PlasserSmartTamping - The Assistant [4].

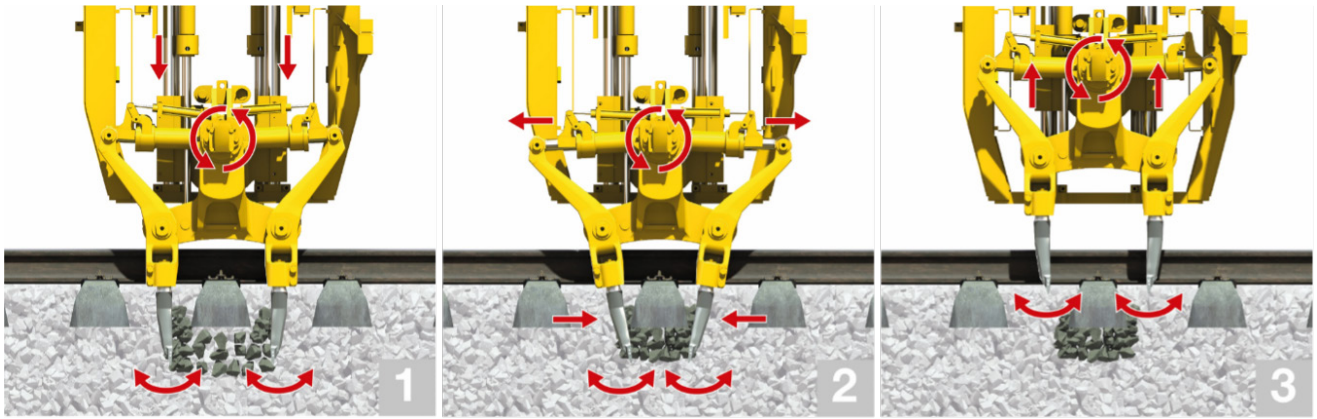


Figure 2: Phases of the tamping process: (1) ballast penetration, (2) squeezing movement, (3) lifting followed by the relocation of the tamping bank [3].

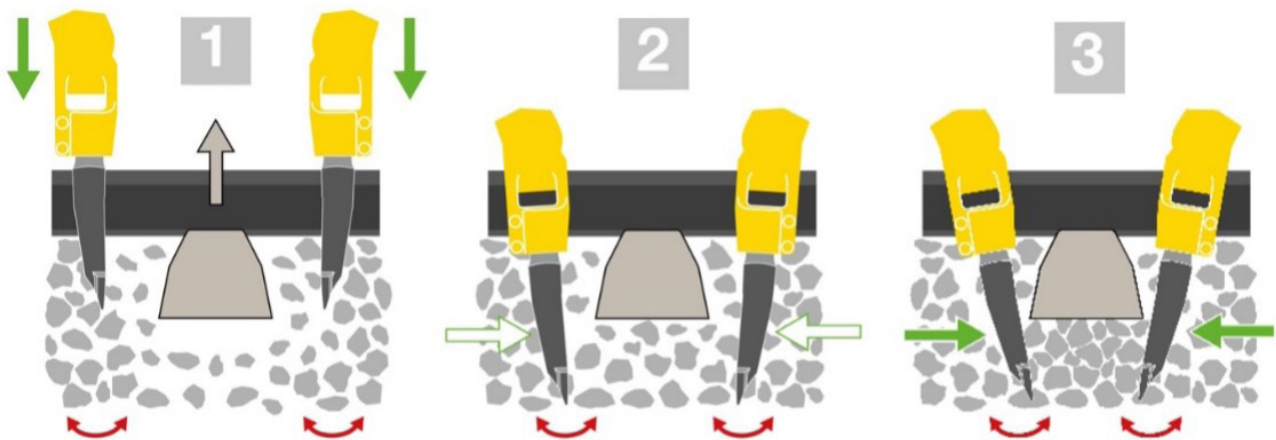


Figure 3: Lifting and creating the void under the sleeper (1), filling the void (2), ballast compaction (3).

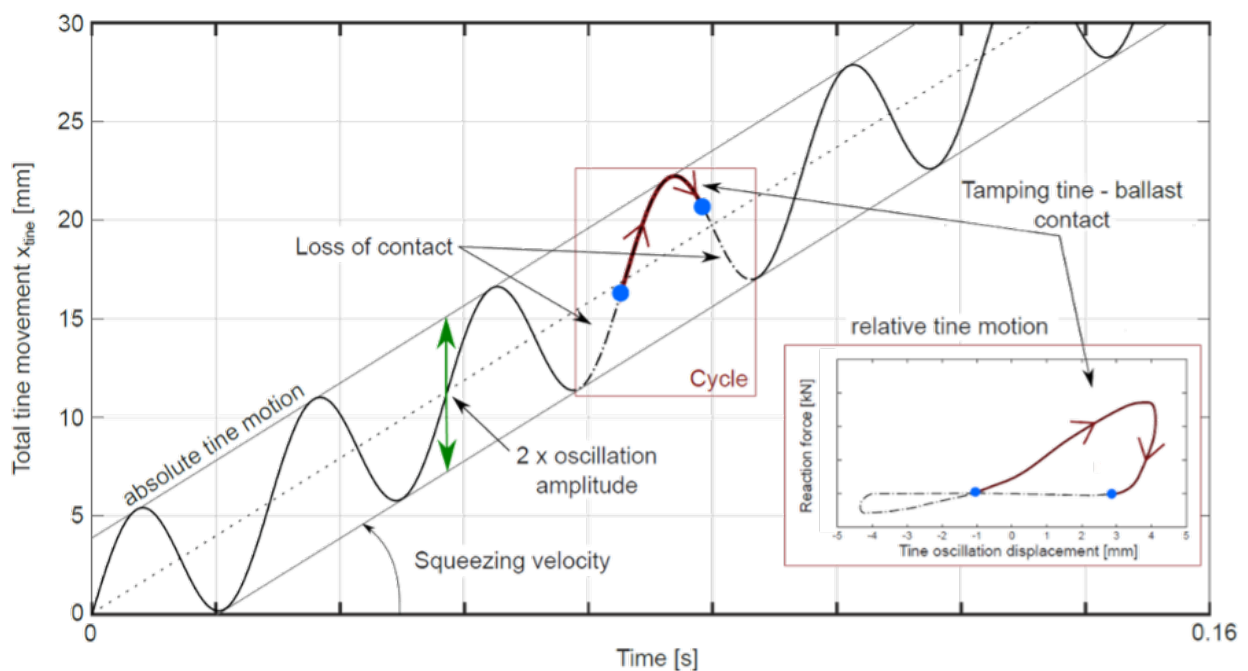


Figure 4: Total tine motion – a combination of squeezing motion and tine oscillation [3].

Once the void under the sleeper has been filled, relative tine movement, ie tine oscillations initiate further ballast compaction in this area [5]. During compaction, a periodic pulsating load is transferred from the tines to the ballast matrix, allowing a rearrangement of ballast grains into a denser configuration [3]. In order to achieve a durable and stable bearing for the sleeper, the highest possible compaction should be achieved, thus reducing settlements that could be induced by following traffic loads. However, the implemented compaction energy should only be utilized to rearrange the grains which make up the ballast matrix, without initiating/accelerating the ballast fouling process, ie changing the ballast matrix grain-size distribution. Following a successful compaction, the tamping tines are simultaneously opened and pulled out of the ballast, as the last phase of the tamping process is initiated. The lifting phase (Figure 2) is characterized by the closing of hydraulic cylinder and loss of contact between the tamping tines and the ballast.

EXPERIMENTAL APPROACH

MEASURING SYSTEM

The cornerstone of a full tamping process automation is the autonomous identification of ballast condition to which the tamping parameters could be adapted. As a necessary foundation for the development of this condition-based tamping process, information about the track substructure and the ballast condition need to be determined and related to a customized parameter combination. In order to make the on-the-spot condition determination possible, the machine has to be able to differentiate between different degrees of ballast bed fouling. For this purpose, a specially developed measurement system was implemented directly to the Plasser & Theurer tamping bank of a four-sleeper track tamping machine Dynamic Tamping Express 09-4X E³ as well as to a single sleeper track and turnout tamping machine Unimat 09-4x4/4s E³ (Figure 5) [7].

The sensor set-up (Figure 5b) consists of strain gauges that are used to measure the penetration resistance and reaction forces at the tamping tine plate. Angle encoders and accelerometers placed on the tamping arm allow a precise calculation of both the absolute and relative tamping tine motion. In conjunction with pressure sensors, the tamping process could be fully documented and subdivided into the respective operating phases – ballast penetration, squeezing movement and tamping bank lifting and / or relocation to the next sleeper [4][7].

Data collected by the sensors mounted on several Plasser & Theurer tamping bank provided approximately 600,000 data points per

sleeper and made a detailed analysis of the tamping tine movement and interaction with the ballast matrix possible. As mentioned before and shown in Figure 4, total tine motion can be subdivided into an absolute and a relative one. The latter can be presented in the form of a load-displacement diagram (Figure 6), showing each individual tamping tine oscillation, ie each cycle with its three constituent phases (loading-unloading-withdraw) as well as the following tamping characteristics:

- oscillation amplitude ie displacement
- maximal reaction force per cycle
- ballast matrix response during loading and unloading
- energy transferred into the ballast (red area underneath the load-displacement curve)
- points of tamping tine-ballast begin and loss of contact

After the measurement data was analysed, several irrefutable differences were recognized among the derived tamping characteristics on different measurement locations. Relevant differences between ballast conditions are found for the following tamping characteristics: maximal reaction force per cycle, energy per cycle and the ballast matrix response during loading. The measured differences can be attributed to the condition of the ballast bed, ie to the differences in ballast matrix reaction to the interaction with the tamping tine. This knowledge provided experimental verification of the influence of ballast fouling on its behaviour during compaction and once again emphasized the importance of ballast condition in the process of automation of the tamping process.

MECHANICAL MODEL

In order to investigate the influence of ballast bed condition on the quality and durability of the conducted track tamping, a semi-analytical mechanical model of the tamping tine - ballast matrix interaction during the squeezing movement was developed. The model depicts both relative and absolute motion of the tamping tine and consists of two fundamental parts: tamping bank and ballast matrix model (Figure 7). The tamping bank is modelled as a simple system of rods with a dynamic excitation overlapped by a hydraulic cylinder movement modelled by a variable rod length.

The tamping bank model depicts the geometry of the Dynamic Tamping Express 09-4X E³ tamping bank and can be easily altered to another bank geometry. The ballast matrix model consists of three components and can be used to simulate elastic and plastic ballast matrix deformation as well as ballast grain motion during loss of contact between the tine and the matrix. Dynamic shear modulus, Poisson's ratio and ballast density are used to describe ballast properties. Special attention is given to the tamping tine – ballast

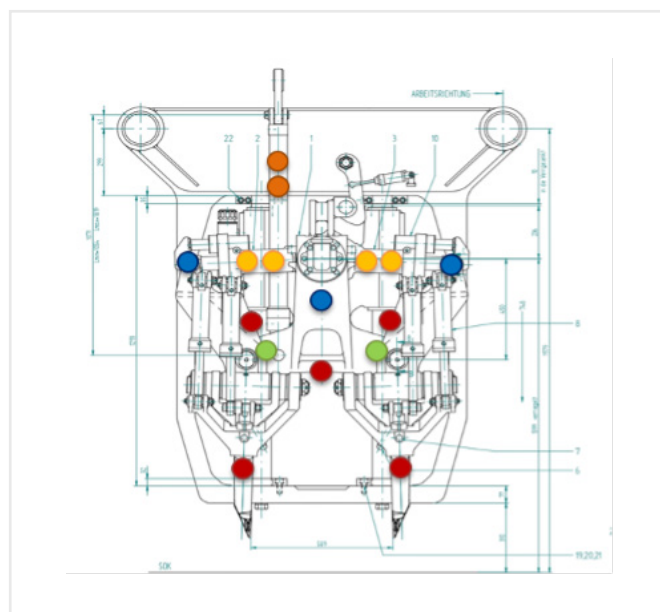
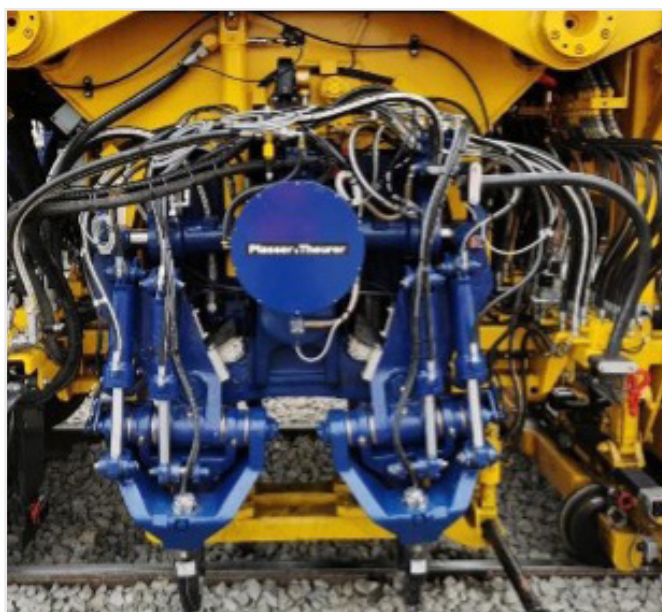


Figure 5: Tamping bank of the universal tamping machine Unimat 09-4x4/4s E3 (a left); Position of the installed sensors – strain gauges (red), angle encoders (green), accelerometers (blue) and pressure sensors (orange) (b right).

matrix model contact conditions, providing the possibility to simulate both continuous contact and the loss of contact between the two model parts, (in detail in [3] and [7]). Following the development of a stable algorithm the model was calibrated using the results from in-situ collected data and is able to simulate different encountered ballast bed conditions. In the next step, the model is used to conduct parameter studies in order to determine the influence of selected tamping parameters and parameter combinations on the quality of performed track tamping that are, in further consequence, going to be adapted to the ballast condition [3].

FILLING PROCESS MONITORING

As a next step in the development of a fully automated tamping system, the squeezing movement and its constituent phases, void filling and ballast compaction, were additionally investigated. As mentioned before, filling the voids created during lifting is the basis for producing a precise and durable track layer. Only if the area under the sleeper, which is subjected to regular traffic loads, is filled and compacted successfully, can the desired track geometry can be maintained. Therefore, a monitoring system designed to survey the filling process was developed in order to further improve the quality of the tamping work [5].

This system, developed by Plasser & Theurer, is based on the change in resistance when the void under the sleeper is filled with ballast. Before the void is filled, ballast grains encounter less resistance during their motion, resulting in comparatively higher squeezing velocity, depending on the set squeezing force. As soon

as the void is filled, the ballast grain range of motion is reduced and the resistance increases, resulting in a decrease of squeezing velocity (Figure 8) [5]. This ensures an automatic adaptation to the track and ballast conditions in-situ and at the same time prevents ballast fouling that would be initiated by attrition at higher force values.

Figure 8 shows an example of a tamping process with high lifting values creating a larger void under the sleeper. Low resistance at the beginning of the squeezing movement leads to a higher squeezing velocity that starts to decrease as soon as the void is filled. In Figure 9, measured data showing both incomplete and complete void filling is plotted. It can be clearly distinguished between the two cases based on the curve slope – as soon as the filling is completed the slope decreases (Figure 9b) while the curve showing incomplete filling (Figure 9a) runs almost linear during the entire squeezing movement.

Similar to several other tamping parameters, there are a number of guidelines and recommendations such as minimum squeezing time and number of insertions that should be taken into consideration in order to insure a complete void filling and a stable, durable sleeper bearing. These guidelines, although they provide good results, are mostly driven by local regulations and are largely based on experience, meaning that they cannot guarantee optimum void filling under any conditions. For this reason, Plasser & Theurer developed a filling monitoring system that can alert the machine operator of incomplete void filling for each individual tamping arm immediately after tamping [5]. This is achieved by showing the operator the

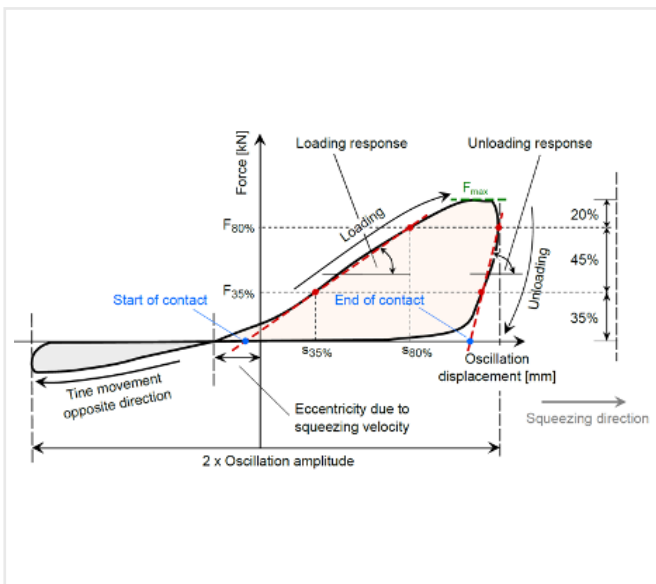


Figure 6: Simplified load-displacement diagram [3].

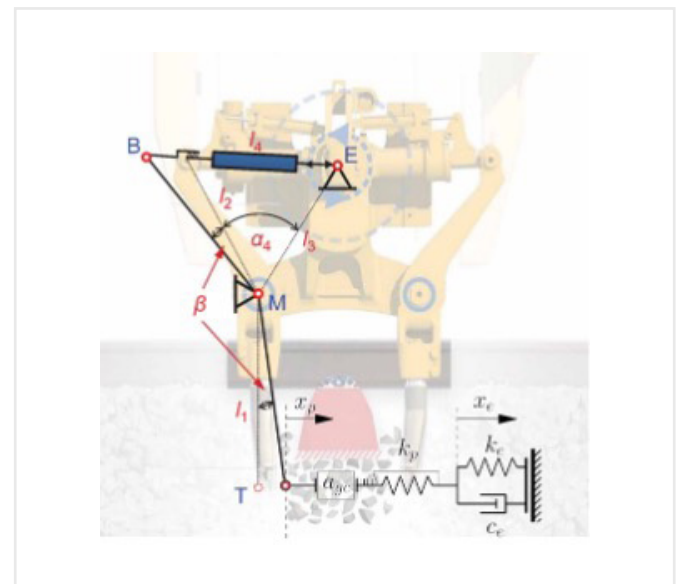


Figure 7: Mechanical model of the tamping bank and the ballast matrix during squeezing movement [3].

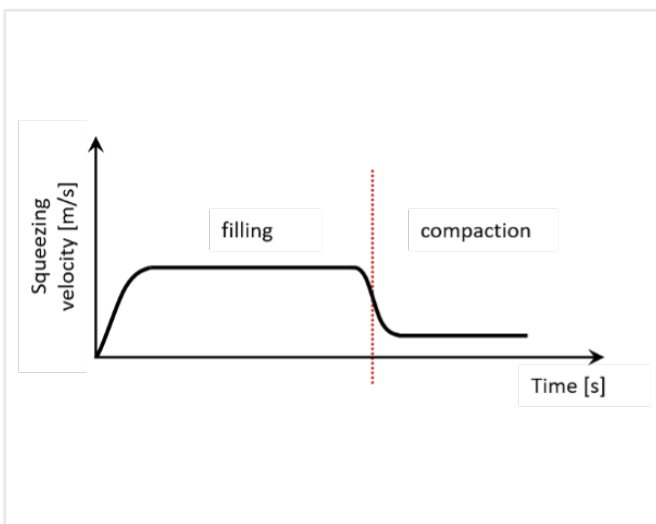


Figure 8: Schematic representation of the squeezing velocity during the filling and compaction process [5].

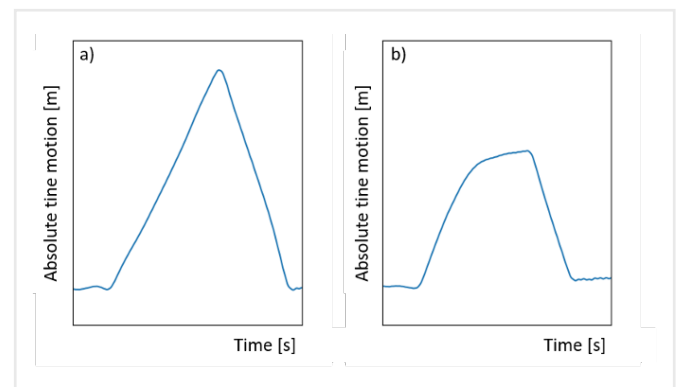


Figure 9: Measured squeezing displacement (absolute time motion) with (a) incomplete and (b) complete void filling. Both curves were recorded with the same working parameters (tamping pressure, squeezing time, penetration depth, lifting values and sleeper type) [5].

squeezing velocity and the ballast resistance reached at the end of the squeezing movement. Ballast resistance is calculated as a ballast resistance coefficient $\gamma_{ballast}$ from the force F_{end} and the squeezing velocity v_{end} , using the following equation:

$$\gamma_{ballast} = \frac{F_{end}}{v_{end}}$$

F_{end} describes the force at the tamping time calculated using the pressure in the squeezing cylinder. The squeezing velocity v_{end} is calculated as follows:

$$v_{End} = \frac{\Delta x_{End}}{\Delta t_{End}}$$

where Δt_{End} is given by last 0.1 s before the maximal time displacement is reached and Δx_{End} the distance travelled by the tamping time during Δt_{End} . Based on this information, the machine operator can now initiate an additional insertion on a sleeper in case of incomplete filling. For the implementation of this monitoring system, several measured values must be continuously recorded and analyzed. For this purpose, additional sensors are installed to the tamping bank (in detail in [5]) and the system has been in use by customers for the first time.

In addition to the squeezing velocity, the system also shows the operator the tamping depth and squeezing force. With this information, it is now possible to detect and react to incomplete void filling directly during tamping thus avoiding individual defects and further improving the durability of the track position.

THE TAMPING PROCESS PROTOCOL

An important step towards a completely transparent process recording has been made by the development of the tamping protocol (Figure 10), recording all tamping process aspects and parameters that are considered quality-relevant. It shows data recorded during track tamping, tamping bank positioning and setting of machine parameters. From the infrastructure manager point of view this system enables a new type of verification documentation. The system has a modular structure - the basic version comprises the control of lifting and leveling/levelling units and it can be extended to control the tamping bank.

OUTLOOK AND CONTRIBUTION TO FURTHER DEVELOPMENT

Complexity of the track system together with an increasing demand on track quality and durability, environmental influences and loads during regular operation ensure continuous challenges and demand for further development of the state-of-the-art tamping machines that must be designed and operated to deliver optimum results under all operating conditions.

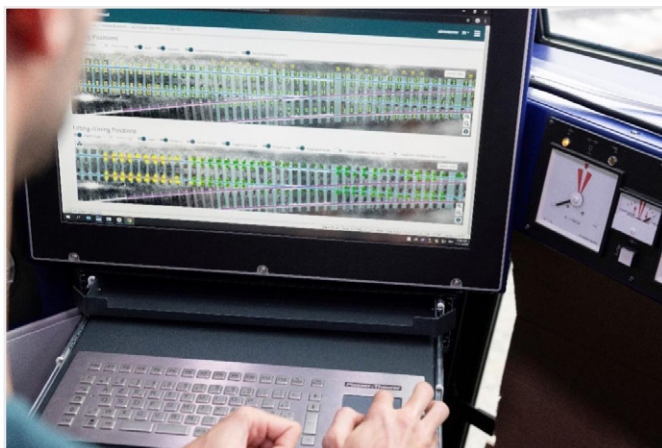


Figure 10: PlasserSmartTamping protocol [7].

Together with the proven asynchronous track tamping principle that Plasser & Theurer has been relying on and that has been proved to be extremely effective over decades, new technologies and developments described in this paper will assure that the core technology is further improved and adapted to meet the increasing demands. The worldwide strive towards automation exists not only to relieve the machine operators, but also to ensure homogeneous work quality and reduce the possibility for an error to occur.

State-of-the-art sensors and control technology implemented to Plasser & Theurer tamping machines are successfully advancing along path to full automation - PlasserSmartTamping - The Assistant, and the usage of artificial intelligence already makes it possible for the system to recognize objects in the track and assign them to the correct category, displays them to the machine operator who then has only to approve or reject recommended actions.

As soon as the recommended action is approved, positioning of the lifting, leveling/levelling and tamping units is carried out autonomously by the machine. The measuring system that has been developed and used to conduct measurements in different ballast condition over the past years, as well as the development of the mechanical model to simulate the tamping action and conduct studies on different ballast parameters, build a strong foundation for the condition-based tamping parameter selection that is needed for a fully automated tamping process. In addition, the automatic adjustment to the ballast resistance and the filling monitoring will prevent isolated defects due to inadequate or incomplete filling of the void under the sleeper, given that ballast compaction that is crucial for producing a precise and durable track layer can only take place when the void has been properly filled. Insufficient compaction not only leads to rapid deterioration of the track position, but also contributes to ballast fouling.

As a results of these new developments, the tamping bank is being transformed and upgraded from a track maintenance tool into an integrated measuring system whose possibilities go far beyond the familiar post-measurement documentation. In addition, machine personnel are supported in producing a long-lasting and precise track position and the infrastructure operator gains valuable data and insights into the condition of the track infrastructure.

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Expansion of the Sheffield tram-train network



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This paper will explore why the Northern Powerhouse Rail programme is considering an expansion to the existing Sheffield tram-train network, highlighting the benefits and challenges of tram-train systems and the future potential of tram-train in the UK.

INTRODUCTION

Northern Powerhouse Rail is a transformational rail investment programme aiming to promote economic growth across the North of England by providing faster and more frequent services between major cities and economic centres across the North. This paper will discuss the consideration of extending the current Sheffield tram-train network, why this is being considered for Northern Powerhouse Rail and outline some of the challenges and work being undertaken to overcome these.

Operational analysis work concluded that the heavy rail network north of Sheffield Station is constrained, due to a mix of train service types and destinations (local, regional and long distance), and to accommodate additional trains would require significant infrastructure works. As part of delivering transformation, Northern Powerhouse Rail is considering the expansion of the existing Sheffield tram-train network, beyond its current terminus in Rotherham, to improve connectivity and capacity elsewhere in the region. This paper will outline the benefits identified and challenges experienced as part of work to assess the feasibility of expansion of the existing tram-train network, including how these challenges have been overcome and how this knowledge and experience might be used in the future to tackle some of the biggest issues facing the UK rail industry.

WHAT IS TRAM-TRAIN?

Tram-trains are light rail tram vehicles adapted to run on heavy rail lines, allowing them to transition between operating as a tram within a city centre, and as a train on the existing heavy rail network. These adaptations give them the benefits of both rail systems; the increased flexibility of a tram, such as the tighter working radius of as small as 25m, and the higher speeds achievable by a heavy rail vehicle. Tram-train vehicles are therefore capable of not only serving passengers within in a city region but also serving passengers between cities and towns.

Tram-train systems are more frequently being considered as a cost-effective means to tackle the industry challenge of increasing capacity on the network, particularly in typically more congested urban areas. By utilising the existing intra-city road network in city or town centres, as well as the existing heavy rail lines, tram-train networks can improve transport connections between cities and/

or towns, thus minimising the infrastructure impacts, disruption and cost implications of bringing a heavy rail line or station into a city or town centre. Furthermore, enabling greater local connectivity and capacity through tram-train networks can also open up capacity on heavy rail lines for longer distance services.

Although tram-train projects are not new concepts globally, they are novel for the UK with Sheffield being the first and only tram-train system in the country to date having opened for service in 2018. Tram-train is an innovative solution in the UK to improve network capacity across a large area – an issue that has previously been solved by development of separate light and heavy rail networks. There are many ways in which tram-train vehicles operate differently from trains once they are using the heavy rail network. For example, tram-train vehicles have much higher acceleration and deceleration rates than heavy rail trains, making it feasible for more stops. Furthermore, in comparison to a heavy rail network that might only have one major station within a city-centre where all passengers must alight at once, a tram-train system would have numerous stops, avoiding a large build-up of passengers in one area. A single heavy rail station is also likely to be further from each passenger's intended final destinations than a tram-train stop and may even require further onward travel within the city.

Another notable benefit of tram-train vehicles is that they are lighter than heavy rail vehicles, with Class 399 tram-train vehicles weight approximately 66 tonnes and a Class 390/0 Pendolino weighing approximately 466 tonnes and as a result they cause less rail wear. This in turn reduces the frequency and cost of track maintenance. As mentioned earlier, a key factor in driving the tram-train expansion is that tram-train is a good way of opening up wider heavy rail capacity, typically with more modest price tags compared to heavy rail. This can help generate the demand for the expansion work and strengthen the business case behind both tram-train and potentially future heavy rail interventions.

CHALLENGES

One of the challenges with tram-train systems is the requirement to comply with both light rail and heavy rail standards and the relatively unknown, added complexities when transitioning between the two. This applies to both the vehicles themselves and other rail infrastructure. As part of Northern Powerhouse Rail development, both heavy and light rail experts have worked together to manage these challenges in the feasibility design process. Below are a few of the examples of the challenges that have arisen, and how they have been overcome.

LOW HEIGHT PLATFORMS

Tram platforms typically have a height of approximately 375mm above rail level, whilst heavy rail vehicles are designed for a standard 915mm height platform. The safety implications of placing a low height platform on a heavy rail line have been at the forefront of the design process. One of the major concerns is that heavy rail lines will be mistakenly identified by users as light rail due to the lower platforms, causing pedestrians to potentially act with a false sense of safety when moving around or interacting with the heavy rail lines. For example, pedestrians may attempt to cross the heavy rail track at grade, rather than using designated footbridges or underpasses, putting them at significant risk of harm. Precautionary measures such as platform staggering, safety fencing and signage have all been considered to manage and mitigate this risk.

For example, the safety fence not only needs to comply with heavy rail gauging standards but also must act as a sufficient deterrent for passengers not to climb over, nor end up 'trapping' a pedestrian in an emergency situation.

SAFETY

There are a number of safety precautions that have to be considered for tram-train systems which do not typically apply to heavy rail projects, such as on street running. For example, when considering on street running the safety of pedestrians and road vehicles must also be taken into account. How tram-train vehicles interact with both of these other methods of transportation in a city centre environment needed to be considered throughout the design development. Measures such as segregating tram-train vehicles and road vehicles at complex junctions, increasing white lining to control how road vehicles can operate, and analysing how pedestrians and drivers might interact with tram-train vehicles within the city environment and traffic network, aim to reduce or mitigate some of the risks. Engagement with the local authority and the infrastructure owner to gain an understanding of the issues they normally experience is key to informing the final solution. All of these safety considerations aim to reduce the risk of collisions between pedestrians or road vehicles with the tram-train vehicles.

TRACK GEOMETRY

The track geometry was also a key consideration. Light rail vehicles can navigate steeper gradients and tighter curves than heavy rail vehicles. Whilst designing new alignments, it was imperative to ensure that, when necessary, it complied with both heavy and light rail vehicle standards. For example, tram-trains can run on a minimum 25m radius curve, whilst a standard minimum curve for trains is 250m for new track. This means that for tram-trains to navigate a curve, significantly less land take would be required in comparison to heavy rail. Another example is gradients, tram vehicles are capable of climbing an 8% (1 in 12.5) gradient, whereas the maximum gradient for a passenger train would be 3.5% (1 in 28.5), more than doubling the length of infrastructure needed to achieve the required height. The length of infrastructure required for a freight line would need to be greater still, with a maximum gradient of 1.25% (1 in 80) for freight vehicles.

TRAIN CONTROL

Different methods of train control are typically used on heavy and light rail systems, conventional colour-light signalling and 'Line of Sight', respectively. Tram-train vehicles on the heavy rail network need to work with the heavy rail conventional signalling, with heavy rail passenger services tending to take priority. Where both vehicle types share track and where the tram-train vehicles join and leave the heavy rail network, signalling had to be a key part of the design process. Tram-trains cannot operate using line of sight signalling on the heavy rail network, due to the interaction with heavy rail vehicles, existing curves and obstructions on the heavy rail network.

Tram-train vehicles can stop relatively quickly in comparison to passenger trains, with freight trains even slower still. For example, travelling at 55mph a light rail vehicle could have a braking distance of approximately 180m, where as a train at the same speed would be closer to 1600m. Largely, tram-train vehicles share rail lines with freight trains, meaning the signal design needs to plan in sufficient time and distance for freight trains to stop if required.



Figure 1: Sheffield tram-train. Image © Chris Morgan (cc-by-sa/2.0).



Figure 2: Example of a tram at a low height platform.
Source: Image © Robert Schwandl (cc-by-sa/2.0).

INTEGRATION WITH HEAVY RAIL VEHICLES

Tram-train vehicles operating on the heavy rail network can travel at higher speeds than when using the intra-city tram network, usually operating at a maximum speed of 60mph. However, the interaction of these tram-train vehicles with other, potentially faster, heavy rail vehicles and with services that stop less frequently on the same network also needs to be considered. It is vital that these other services are able to operate unimpeded.

The drivers of both tram-train vehicles and heavy rail vehicles need to be mindful that the network won't operate exactly like a typical heavy rail system. Factors such as passengers behaving differently on low height platforms to standard heavy rail platforms are differences drivers of these vehicles need to be aware of and prepared for. More specifically for Tram-train drivers, there are the additional challenges of operating between different power sources and transitioning between signalling methods.

A further consideration is that as the tram-train system needs to integrate into both the heavy rail network timetable, and the existing tram timetables. The Sheffield tram network currently operates four service groups which operate on three different service frequencies, (6 trains per hour (tph), 2tph & 3tph). It is desirable to operate all service groups on even-interval headways, (ie 6tph, all ten minutes apart). However, with a mix of service frequencies increasing the number and destination of the tram-trains whilst also needing to integrate with the heavy rail timetable building a timetable that is both attractive to users and also reliable was challenging. A practicable solution to resolve this challenge is to provide further infrastructure in some locations. These infrastructure interventions, such as adding an additional platform and doubling currently single-lead junctions, provide the necessary timetabling flexibility to accommodate the proposed service pattern and frequencies in a cheaper and less disruptive manner than what could be expected for providing equivalent heavy rail interventions.

POWER SUPPLY

Particularly on the Sheffield system, the tram-train vehicles will need to operate on both 750V DC power and 25kV AC power supplies during different parts of the journey. How and when to operate this power supply change-over was a key point of design. To determine the optimum solution both static and dynamic handovers were considered, as well as evaluating electrical clearances, overline structures, gradients and stations/stops.



Figure 3: Example of a train at a full height platform.
Source: Image © Pauline E (cc-by-sa/2.0).

As a potential solution to manage the increased power requirement of the extension to the tram-train network, it is being considered, that battery powered vehicles may provide a more sustainable, lower cost solution. This innovative approach to powering the vehicles could alleviate the need for new traction power and overhead line infrastructure if factors such as journey length and charge time deem this a suitable solution.

DEVELOPMENT OF TRAM-TRAIN SYSTEMS

As mentioned previously, although tram-train is not a new concept, it is novel for the UK and for those designing, operating and working on heavy rail systems within the UK. Therefore, it is paramount that knowledge from other tram-train systems designed and deployed around the world is utilised in this and other similar projects. For example, experts have provided knowledge from the existing pilot scheme in the area. Other industry experts within the design team have provided research and experience from other European tram-train systems to inform the approach to the Sheffield tram-train extension, for example specifically Mulhouse and Karlsruhe were used to inform the power change-over design, to understand what the common approach is.

THE FUTURE OF TRAM-TRAIN IN THE UK RAIL INDUSTRY

Tram-train has an increasing role to play in the future of improving connectivity within and between cities and city regions. With cities constantly expanding outwards and the population of cities increasing, innovative ways to improve the reach and capacity of the transport network are in extremely high demand. Tram-train systems provide a cost-effective, less intrusive solution to this, whilst utilising the existing infrastructure to maximum effect. The understanding of the potential benefits of a tram-train solution over a separate light or heavy rail system are evident, even within the UK where tram-train systems are only in the early stages of development and deployment. As the introduction of tram-train systems across the country and the rest of the world increases, this will drive innovation in the field, improving the understanding of what the possible further capabilities of these systems could be.

The prospects of tram-train are being recognised across the country with plans already underway in Manchester, Glasgow and parts of Wales to bring more tram-train systems to the UK. Despite the challenges that these systems bring, it is clear that they will become an increasingly integral part of the railway industry.



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Weather forecasting for the railways: Current & future – tools & analysis



AUTHOR: Brian Douglas Haddock

Brian Douglas Haddock is a visiting Professor within the School of Engineering at Newcastle University and visiting Professor at Loughborough University and holds the position of Head of Weather Resilience at Network Rail. He is also Chair of the Rail Industry Group that manages seasonality. Brian has been Head of Weather Resilience for around two years and started off in the National Weather Team in 2008. Brian has worked within Network Rail Route (Anglia) as a weather specialist and has also worked for train operators, First Capital Connect and Greater Anglia where he was Head of Performance. Brian was also Head of the National Operations Centre (NOC) before being drafted into lead a National Review of the effects of Summer weather on the railway. Brian's fascination with the railway is inherited from his father who worked as an engineer on the railway for over forty years.

Network Rail contracts a weather forecast supplier to deliver two to five-day forecasts that are aligned to the five regional divisions across Scotland, England, and Wales. Each of the five regional divisions is split into individual Routes.

The weather forecast provider aligns geographical forecast areas across each Region with Delivery Units (DUs). For example, within Scotland Region there are five geographical forecast areas, these are:

- Perth
- Glasgow
- Highland
- Motherwell
- Edinburgh

Delivery Units are where the general maintenance teams are situated. This includes the response vehicles, tools, spares, equipment, and staff. Delivery Units are not only resourced for track but also for 'Off Track' activities such as drainage, vegetation management and earthworks etc. In addition to this there are other maintenance specific depots such as Overhead Line located along the Route.

Alignment of geographical forecast areas to Delivery Units demonstrates that the forecasting tools at the industries' disposal were and are still designed with the intention of responding to weather related incidents and recovering the train service once the weather event has passed. Response and recovery of incidents is a mature process within the rail industry and receives a great deal of focus, in resource, training and competencies. By contrast, the planning activities have historically not had the same focus as the response. A large part of the current transition in the management of weather is the development of the planning activities to get them to the same maturity as response and recovery. Routes and Regions are currently developing leading indicators and preparing plans to benefit the passengers and freight users.

Weather forecasting currently plays a critical role in how the industry responds and recovers from impending weather events in a two to five-day time frame. Once the forecast is received by email to each control centre (ROC) across the National Network it is assessed by the Route Control Manager (RCM), or equivalent role to see if any risks have been forecasted over the five-day period of the forecast. It is then distributed across the entire Region. Thresholds are set for each weather parameter that define the risk to the network, (these are referenced in the weather management standards).

The thresholds for all weather parameters are set around four core alert levels, and each of these levels has an assigned colour code, as follows:

- Normal - Green
- Aware - Yellow
- Adverse- Amber
- Extreme- Red

This simple colouring of alert status allows the teams within the ROCs to expedite a judgement on whether to initiate any actions required in accordance with their Extreme/Adverse weather management plans (E/AWMPs). See figure 1.

If an extreme threshold for a weather variable is breached within the forecast the control team will initiate what is known as the Emergency Weather Action Teleconference (EWAT). This is a five-day process in alignment with the 5 forecasted days. The EWAT process follows five stages from the initial 5 day forecast to the day of the event.

On receipt of a forecast where an extreme threshold has been breached five days in the future, for example where 'Extreme' has been alerted for 'Rain' on Sunday, on a forecast issued on the Wednesday the control will initiate the five-stage process.

The first stage is 'awareness'. On the Wednesday an RCM will issue the forecast highlighting the potential risk for the Sunday. Delivery Units will be made aware of the alert by the control over the course of the following day. Using the example, on the Thursday, if the alert status remains extreme for the Sunday the RCM will move to the next stage 'Preparation'. A teleconference will be convened and chaired by the RCM. EWATs have a templated attendee list, dependant on the weather risk but will invariably include Delivery Unit Maintenance teams, Train and Freight Operators, Structure teams, Off Track Teams, Earth Works Teams, Train Running Controllers and Communication Teams.

Agendas for EWATs are templated and on these calls a weather forecaster will provide a summary of the event forecast as well as the confidence levels associated with the alert status and any localised risks. For example, a variation of risk at a coastal location compared to the risk further inland. This may include elements such as high tides and 'over topping'.

In addition to the controls, individual bespoke forecasting tools have been developed in collaboration with asset owners, where known individual asset vulnerabilities exist. Asset groups have an array of vulnerabilities and some bespoke forecasting services have been developed over the years through information gathered at Incident Learning Reviews (ILRs). Some of these bespoke forecasting services include:

- OLE: temperature forecasting,
- Third Rail: conductor rail icing forecasts,
- Track: critical rail temperature (CRT) forecasting,
- Lightning: Lightning forecasts
- Earthworks: Precipitation Analysis Tool (PAT)

There is a broad-brush approach to thresholds set for each of the bespoke forecast asset group suite of tools. These are very much derived from the specified tolerances in the original design. What these thresholds do not take account of is the condition of the individual asset or the variety of asset designs, for example OLE assets and the varieties that make up their individual vulnerabilities.

The risk profile between a portal OLE stanchion and a head span OLE configuration for forecast wind gusts is known to differ dramatically from historical incidents where wires have come down, but the industry 'extreme' threshold for wind gusts is 59< mph. When this extreme is breached in a forecast anywhere on the National Network, a blanket 50mph speed restriction is implemented.

This is regardless of whether the line has a portal or head span OLE design, or if there isn't any OLE at all within the geographical forecast area that has breached the wind gust threshold. This, of course, is in part due to the fact that wind gusts cause other objects such as trees and other debris to be blown onto the running lines. Much work needs to be undertaken to determine thresholds such as wind gusts for different types of assets, including OLE.

These thresholds need to include the design configuration, the asset condition, (including the maintenance cycles), and the local environmental factors. Through the work of the industry forum the Seasonal Challenge Steering Group (SCSG), the detailed scientific data required to form a robust system risk-based model is being developed called the Seasonal Agnostic Railway Model (SARM). Rather than focus on train performance (PPM), the SARM is looking

at metrics that reflect the impact on individual passenger journeys, considering operational concerns such as the frequency of train service and the criticality of particular service groups. The Model is synthesising and expanding on progress made historically where individual asset types have assimilated weather and asset data.

Since 2015 Earthwork engineers, (in isolation from other asset types and general operations), have been developing a tool that might just be the catalyst for a wider operational model. The Precipitation Analysis Tool (PAT) provides a very good example of how various forecasting tools with NR's current forecast service have been blended to create a bespoke tool for Earthwork engineers. Each of the 190,000 earthwork sites poses a potential risk to the running of trains. Earthwork engineers from each Route worked with the forecasters to develop an alert tool that determines the risk of each site based on the forecast of precipitation, as water is the main cause attributable to earthwork failures, whether that be a lack of it or too much of it. Each site is plotted along the line of route using the standard location references within the rail network known as the 'Engineering Line of Reference' (ELR). Radar data, used to illustrate the intensity of the forecasted rain fall, combined with the data that describes the antecedent conditions at each earthwork site along the ELR allow a threshold parameter to be set by the Earth Work Engineer for each site. If the rainfall threshold is breached on any of the individual earthwork assets, the Earthwork engineer will then feedback the risk to control who will apply the correct mitigation. This often results in slowing trains by the imposition of a speed restriction. In the worst case all train movements may be required to stop.

Seasonal Preparation and Continual Improvement (vision)
Since the tragic accident at Stonehaven the development of the Convective Alert Tool (CAT), and more importantly the Operational Route Sections (ORS) created for the tool, has provided the rail industry with an opportunity to manage weather in a more dynamic way compared to the past. The convective rainfall event that led to the accident at Stonehaven was a very localised event and one that is difficult to forecast using the current tools that, as we have seen, forecast for an extensive geographical area. In the case of Stonehaven, the geographical forecast area (Perth) covers an area from the West Highland Coast of Scotland to the East Coast of Scotland, incorporating railway termini from Kyle of Lochalsh in the West to Wick and Thurso in the far North to Aberdeen in the Eastern

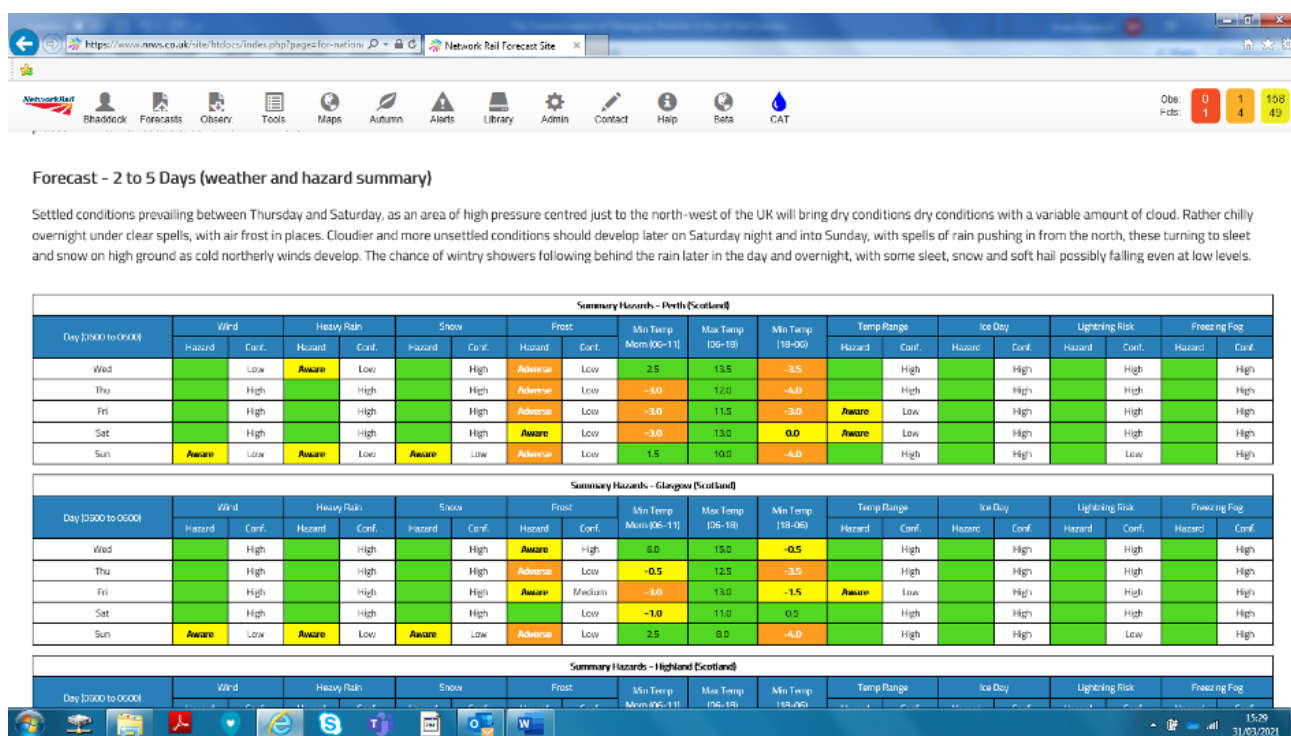


Figure 1: Example of a 2-5 day forecast for Perth and Glasgow forecast areas with a variation of alerts.
Source: Met Desk 31.03.21

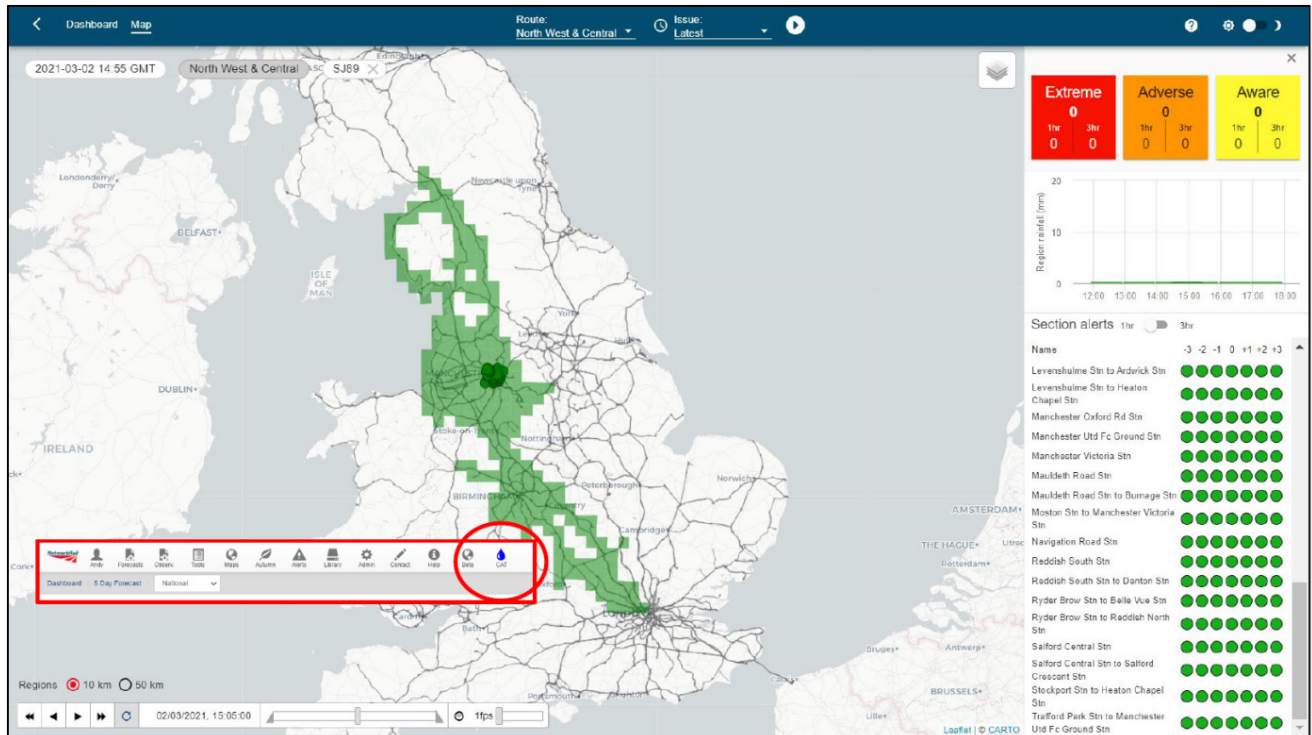


Figure 2: Screen shot of the Convective Alert Tool on NW&C Region. Source: Met Desk

peninsula. All of these locations have orographic and topographic differences that are fundamental to the way in which the weather impacts the area, and more specifically the local rail networks.

Stonehaven clearly demonstrated that a review of not only how the rail network could benefit from new forecasting capabilities but also how the risk is managed at a localised level was required.

Rather than the static 24/7 rolling 2–5-day tabulated forecasts, the CAT utilises the radar data to trigger alerts within an ORS. An ORS is a section of the operational railway broken down into easily recognisable points, (A to B), for the benefit of a driver. Most ORS are based on station-to-station points. Where the distance between two station points is greater than five miles or where a line branches off from the main line then an ORS may be defined using the junctions or some other fixed geographical asset that a driver can easily recognise. An alert within an ORS allows a more localised response compared to the wider geographical response from the geographical forecast areas used for the 2–5-day forecast. See figures 2, 3 & 4.

Historically large areas of the rail network would be placed under a blanket speed restriction when a risk is highlighted across the entire geographical forecast areas, and as we have seen some of these geographical forecast areas are very large and can have a negative effect on performance for more than one service group and for more than one operator. Comparatively, alerts provided by the CAT along a single stretch of rail line, between stations, allows for a targeted imposition of reduced speed over the affected area. This reduces the overall impact on performance for all other services that run over the entire length of line.

The ORSs provide further opportunity to undertake more detailed analyses of the impacts of other weather events to localised sections of the railway, such as the impact of temperature and wind. When these impacts are analysed together, in relation to the local environment, a systemic picture of the vulnerabilities can be drawn for each ORS.

Utilising detailed information of the condition of the assets within each ORS the SARM is being developed by Professor John Beckford in collaboration with Network Rail, which aims to determine the overall system resilience for any particular ORS given the forecast weather event. Depending on the weather forecast parameters the SARM will provide a series of options available to Control regarding the provision of the train service based on the predicted availability of the network, factoring in how the known asset condition will react to the forecast event. Aggregation of how the ORSs will react allows an overview of how an entire service group is likely to be compromised by any given weather event, determining the expected level of available route and the correct service to match the expected availability.

As the accuracy and granularity of weather forecasting science develops, an accurate impact profile for each service group can be provided. Timetables can be developed to reflect the expected availability that provide passengers with travel information prior to the forecasted weather event. As the impacts of weather events are experienced over these service groups lessons learnt, reviewed, and fed back into the modelling will refine the timetable, ensuring balance between safety and reliability.

Accurate, granular forecasting at the ORS geospatial level not only provides the passenger and freight users with pre-planned levels of expected services on areas that are affected, it will also provide information regarding service groups that are not affected or affected to a lesser degree. Currently, as highlighted previously blanket speed restrictions are imposed over large geographical areas aligned to the current 2–5-day forecast. As the tools are developed to assimilate asset and forecast weather data at a localised level targeted imposition of speed restrictions can be deployed where needed, leaving adjacent lines of route to potentially run as normal if they are unaffected. Such a targeted approach means that diversionary routes become available, and the train movements do not have to reduce speed or cease over such a large geographical area.

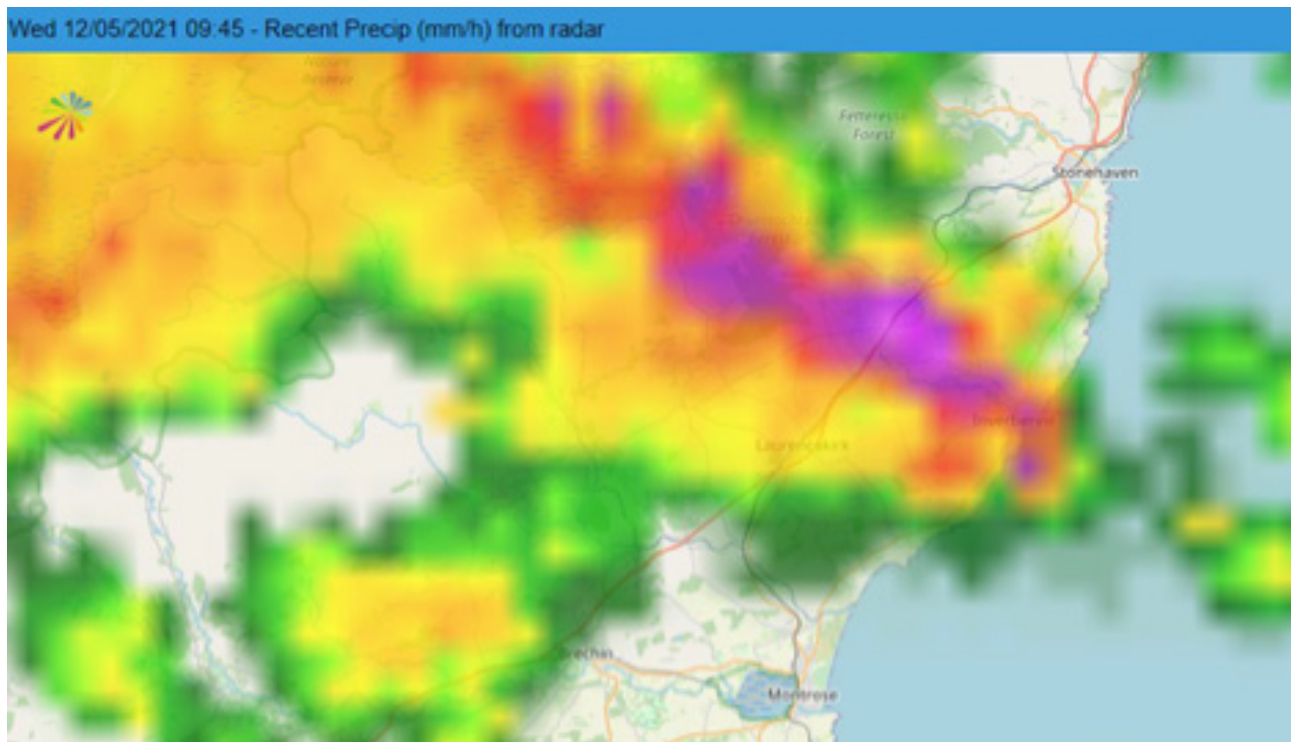


Figure 3: Rainfall Radar at 0945 BST 12.05.21. Laurencekirk site of landslide that day. Source: Met Desk.

The SARM will in the future provide the options for train service levels. With feedback loops into the SARM the model will learn from experiencing weather events, enabling seasonal and climate variations to be built into the options that it provides the Controls with on determining the level of service. The SARM will also highlight the systemic vulnerabilities within each ORS and will be able to measure the aggregated impact of these across the service group, informing asset engineers of where renewals and maintenance should be targeted to improve the experience of passengers and freight users.

Future seasonal management will be informed by the aggregated service group risk and leading indicators between operators and the infrastructure owners can be developed to measure the continual reduction of impact each season has to the reliability of the network.

The SARM is pivotal to the development of a ten-year weather strategy that has been agreed at an Industry level to deliver the vision of:

A safe and seasonally agnostic railway by putting passengers and freight users first.

The industry vision will be delivered through three goals. Goal one of the strategy is to minimise the seasonal bump. Goal two is to excellently implement key route strategy and Goal three is to avoid or excellently manage out-of-control events. Essentially all three goals lead to a review of our current processes and drive the 'input' measures of the model at a local level, down to individual ORSs.

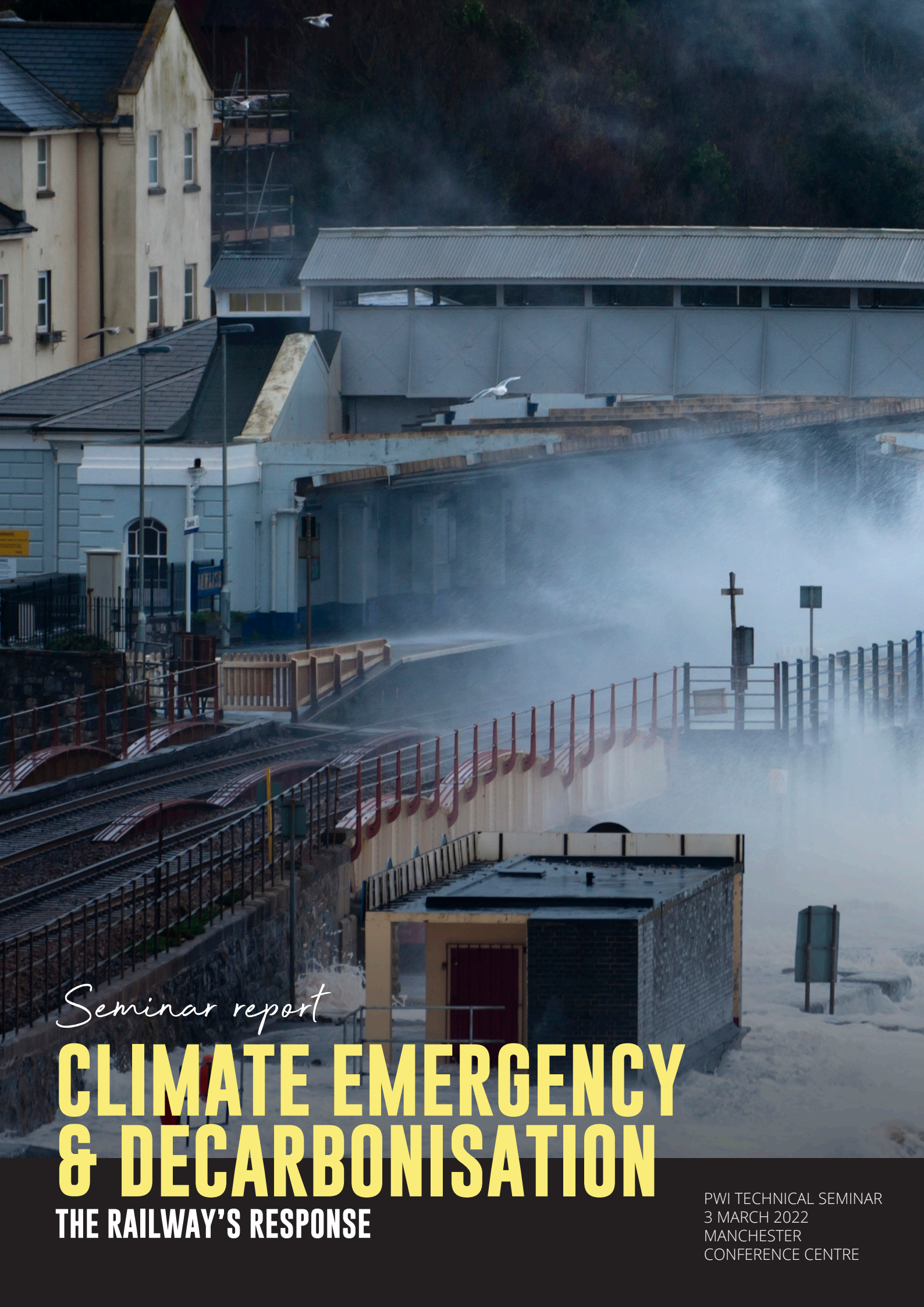
Currently the SARM is being developed between Reading and Newbury on the Great Western Railway with input from technicians, Route Asset Managers and engineers that own this part of the network.

As the SARM develops a greater understanding of the asset condition and how it is affected by various weather types, at a local level it helps to inform the seasonal management teams of individual tasks that require attention and priority for each season. These are being evolved through machine learning within the SARM to enhance and systematise the EWAT process providing the controls with options for train service provision.

Over the course of the next few months Network Rail will be working in partnership with Professor Paul Davies from the Met Office as part of the Weather Advisory Task Force in running a research and development proposal of weather data through the SARM. Network Rail are also working with Professor John Beckford and Loughborough University to validate and stress test the SARM as it develops into a full blown decision support tool.



Figure 4: CAT Alerts triggered at 0945 BST. Source: Met Desk.



Seminar report

CLIMATE EMERGENCY & DECARBONISATION

THE RAILWAY'S RESPONSE

PWI TECHNICAL SEMINAR
3 MARCH 2022
MANCHESTER
CONFERENCE CENTRE



AUTHOR: Chris Parker

Chris is a Chartered Civil Engineer, and a Fellow of the PWI and ICE. He has worked in the rail industry since 1972 retiring in 2004. His experience covered track and structures, design and maintenance and infrastructure management. After retiring Chris has remained active as a technical writer as well as writing reports for the PWI Journal and other organisations.

CHAIRS AM: JOAN HEERY - PWI MEMBERSHIP DIRECTOR | PM: PETER DEARMAN - PWI DEPUTY PRESIDENT

WELCOME JOAN HEERY - PWI MEMBERSHIP DIRECTOR

The seminar morning session was opened by Joan, who is Chair of the PWI Climate Change & Adaptation Committee (CC&AC). She reminded delegates that the whole of the seminar was being recorded, and will be available to view through the new Institution website, which went live in early February.

After thanking those responsible for the seminar, particularly the sponsors and the PWI NW Section, Joan moved on to discuss the reasons for the day's agenda, which was obviously a response to the climate crisis that we all face. She spoke too about the CC&AC that she chairs, further details of this are also available on the website. Joan then introduced the first speaker of the day, Tricia Williams, inviting her to make her Keynote Address.

THE PATHWAY TO NET ZERO, AN OPERATOR'S APPROACH

TRICIA WILLIAMS
CHIEF OPERATING OFFICER - NORTHERN TRAINS

Tricia leads the team responsible for the whole of the day-to-day delivery of the train service by Northern Rail. She joined the company in the middle of the pandemic, coming from a background of other regulated industries, including Manchester Airports Group and United Utilities. She began by describing who Northern are and what drives their strategy, saying that their train fleet of 400 units is the core of the business. One third of their trains are electric and a quarter of the network on which they run trains is electrified. There are four big maintenance depots.

Options for the future fleet are hybrid units, battery units or units powered by alternative fuels. They already have a few hybrid, retrofitted units, today. Currently their emissions are 364,774 t pa carbon dioxide equivalent. They have switched to LED lighting, use zonal heating at traincare centres & are working with suppliers, who are responsible for 28% of the current emissions.

Their approach addresses Scope 1, 2 and 3 emissions, which covers respectively: (i) direct consumption (fuel etc), (ii) bought in energy, (iii) emissions generated outside the company (by suppliers etc). Tricia emphasised that so far there is no industry standard definition of "net zero" so they are working to their own understanding of this pending an industry agreed protocol. They are aligning their trajectory with the Paris Agreement timescales, and also measuring and benchmarking against other transport modes. She noted that EMUs compare very favourably with electric cars on emissions per passenger mile, but DMUs, while far better than internal combustion engine (ICE) cars, are not good measured against electric ones. Tricia saw several risks and challenges, including the development of an industry standard, the question of the delivery of further rail electrification, the feasibility of other net zero energy sources, the ability of the supply chain to decarbonise and concerns about the availability of the required expertise.

Next steps she envisaged included: business plan commitments, development and agreement of a clear roadmap and science-based targets, and finally the agreement and implementation of an action plan. Tricia reminded us that surveys show that 61% of their customers want sustainability.

THE RAILWAY IN 2050 – A YOUNG PERSON'S PERSPECTIVE

BISOLA AKONI
TRACK ENGINEER (NW&C) - NETWORK RAIL (NR)

Bisola set the scene for her presentation by speaking about the targets that have been agreed for limiting temperature rise, by considering the shocking state of affairs that will exist in 2050 if we do not act effectively, and by thinking about what this means for the railway. Floods, slips, track buckles, falling trees, sea level rise and human stress are among the many things that can be expected to affect the rail system.

She spoke about asset management in a warming world, foreseeing that maintenance skills and prediction of asset behaviour would be very important. Business plans have to incorporate climate change

issues. Ballast will require greater attention. Risks to the other systems that railways rely upon will need to be managed. Challenges on the road to 2050, she said, include the fact that 28% of the workforce is currently older than 51. Economic, social and technical factors all need to be taken into account. Asset deterioration continues and there are limits to the resources available, both human and material.

Bisola had a vision for rail in 2050 despite these worries: decarbonised using electrification, battery power or other technologies. Resilient infrastructure. Effective use of technology and innovation such as 3-D printing and new energy sources. Application of effective sustainability solutions. Attracting talent and customers by being seen as effective and efficient in delivery of needs. She ended her presentation with a picture that she felt summed up where she hopes the rail system will be by 2050. Take a look at this via the website.

DECARBONISING MATERIALS

DARREN SHARP - PRINCIPAL ENGINEER, TECHNICAL AUTHORITY, TRACK AND S&C, NETWORK RAIL
BRIAN WHITNEY - ENGINEERING EXPERT - TECHNICAL AUTHORITY, TRACK AND S&C, NETWORK RAIL

Darren opened this presentation, speaking of NR's drive to decarbonise and its work on the CO2 emitted during track renewals. He referred, like Tricia Williams, to Scope 1, 2 and 3 emissions. For track renewals, the biggest of these is Scope 3 emissions, those emissions coming with bought-in services and materials. This all matters, because of the climate crisis obviously, but also because there are government targets to be met. The DfT has set phased reduction targets for emissions by project value for each of the 3 emission scopes. Major projects (>£500m) are subject to targets that came into place in February 2022 and smaller ones (>£50m) are caught by enforcement from July the same year.

PAS 2080 "Carbon Management in Infrastructure" shows a systematic way for managing the whole-life carbon in infrastructure delivery. It covers the life cycle of infrastructure before use, during use and end of life. Darren described the Rail Carbon Tool that has been developed to enumerate the carbon implications of rail infrastructure. Currently it is only in use on the construction phase, but it will be extended to whole-life in due course. It shows that 41% of the carbon from track construction comes from the rail currently, 24% from sleepers & 15% from the use of locomotive power. Amusingly, Darren contextualised this by saying that a concrete sleeper is responsible for the same emissions as 39 cheeseburgers and 1 metre of CEN60 rail equates to 52!

He went on to discuss briefly some of the strategies for reducing the carbon emissions from the top 3 track renewal items. Low carbon manufacture of steel for rails is obviously a key issue and a challenge. Current examples included using composite sleepers made from recycled plastics, which is expected to lead to a reduction of 18% in emissions compared to G44 concrete sleepers. Full product acceptance is imminent. Other alternatives are being considered for sleepers, and work is going on to develop more carbon reduction through recycling rail pads, insulators & clips.

Next Darren described the present position with respect to whole-life track carbon. Figures yet to be formally validated suggest that Category 1 concrete sleeper track with a life of 30 years has a carbon dioxide emission equivalent of 31.2kg/m pa. If this could be changed to composite-sleepered track with reduced carbon-emission rail steel & the service life extended to 50 years by such means as using under-sleeper pads (USP), this emission rate might be reduced to only 10.72kg/m pa.

NR has a sleeper strategy that demands reduced carbon emissions and a sustainable design, they are looking to achieve circularity and are engaging with suppliers to drive down their emissions. They are striving to minimise waste and maximise the efficient use of materials. Future steps include: improved specifications, improved awareness, better re-purposing of site materials, validating carbon tools, strategizing track in line with NR Carbon Zero 2050 and nudging suppliers to think greener. At this point, Darren handed over to Brian Whitney.

Brian began by stating the importance of collective action. Singly we can do little, but together we can achieve enormous change. He reminded us that we ignore the weather at our peril. He pointed out that in 2018, as energy production reduced its carbon emissions through green initiatives, transport became the UK's greatest carbon dioxide emitter. Network Rail is a huge purchaser of energy, either the largest or second largest in the UK. The carbon dioxide emissions for concrete sleepered track renewal are about 100t carbon equivalent for every 250m of relay. That's roughly the same as 3 domestic air flights of over 500km. To reduce this, the service life of installed track needs to be increased by better design and construction. Brian gave some examples. Possibilities include using composite sleepers, use of low carbon steel production methods for rail, use of under sleeper pads (USPs).

He discussed some indicative levels of greenhouse gas emissions for various transport modes, and emphasised the imperative to get people out of cars and onto public transport, particularly rail. Even existing diesel trains, with reasonable occupancy rates, have lower emissions/passenger kilometre than internal combustion engine cars, and there is similarly a benefit to switching freight from road to rail. Brian discussed the differences between "initial carbon" and "whole-life carbon", saying that it was a complex business to properly account for emissions in either case. The use of "carbon tools" to assess the emissions implications of any given proposal needs to be approached with care in order to avoid false conclusions.

Discussing the opportunities for improvement, Brian emphasised that it is important to act early. Once an asset has been installed, it is too late. Trying to alter things after the event is likely to involve yet more emissions, and scrapping an asset before it is life expired means throwing away embedded carbon. Brian finished with a series of conclusions, including: initial carbon and initial cost are often in conflict, but whole-life cost and carbon tend to be well aligned over appropriate timescales, assessment timescales need to be correctly selected, system analysis is vital. We must extend the life of the ballast, for example, by using USPs. Modal shift must be encouraged. We need to work better as a system to cut costs and emissions. His final words were "We cannot afford to ignore climate change".

TURNING TODAY'S WASTE INTO TOMORROW'S TRACK INFRASTRUCTURE

WILLIAM MAINWARING - SICUT ENTERPRISES LTD

William commenced by considering the drivers for change, particularly for changing sleepers. Environmental concerns and sustainability requirements, the NR Environment Strategy 2020/2050 and economic pressures are all included in these drivers. Sleepers and rail pads account for about 29% of the carbon dioxide embodied in track, so there is potential for significant emissions saving. NR has a strategy for the use of composite materials, and the new NR Standard TRK/039 for polymeric (composite) sleepers follows from the new ISO Standard for these.

Sicut composite sleepers are already in use in over 20 countries across the world and have been used in Europe since 2013. They are made in Middlesbrough from recycled plastic and glassfibre, and have been independently tested to international standards. Transport for London (TfL) has been using them since 2015, and NR was expected to give them full Product Acceptance by the end of March 2022 for Category 3-6 Track.

The advantages William claimed for the sleepers included durability, longer service life, reduced manual handling risks, and the absence, in most applications, of any requirement for special tools or resources.

Moving on to the decarbonisation question, he showed figures for the embodied carbon dioxide of the sleepers and of installed track, demonstrating that their use could save about 200t/track km by comparison with the use of concrete sleepers. Further reductions are there too: the lower weight and reduced depth of the Sicut sleepers means logistical reductions, lower ballast depth is necessary owing to the reduced sleeper depth, and the sleepers may be reused or recycled when the track in question is taken out of use. Finally, there is the great benefit of using UK plastic waste directly in the UK and the avoidance of the use of timber or concrete.

William asked what was the cost of this carbon reduction and the other benefits? NR has carried out whole-life cost/benefit analysis indicating a whole-life saving of £40/sleeper pa. He said that the whole-life cost per kilometre of hardwood sleepers is £4.4m, with a carbon dioxide cost of 1,200t.

QUESTIONS & ANSWERS WITH THE SPEAKERS

The Q&A led to significant discussion of how we become more agile as an industry, with contrasts being offered between the UK/EU rail industry and that in the USA, where composite sleepers have,

it was said, been in use since the 1990s. This led on to discussion of the differences in standards between the UK & the USA, and the reasons for these. A further discussion centred on how we can attract more talent into rail.

RAIL FREIGHT RESURGENT – THE OPTIMUM ZERO CARBON TRUNKING MODE

JULIAN WORTH - CHAIR, RAIL FREIGHT FORUM - CILT

Julian recommended the adoption of a “can do” mentality. Rail freight can do it, as shown by recent non-coal freight traffic statistics, the highest on record. Intermodal traffic is 40% of all UK rail freight, driven by supermarkets, among others. Construction traffic makes up 20%, with other bulk traffic, like steel and biomass another 30%. Rail traffic growth has been driven by the decarbonisation of supply chains, abetted by the HGV driver crisis. Businesses are publicising their use of rail to get public approbation for their decarbonising efforts.

Julian said that there is a new model of logistics, involving trunk haulage by rail and local distribution by battery electric truck. There are now 37t battery HGVs with a range of 100km. However, he sees no credible alternative to diesel for long distance trunk haulage by road (say >200km), hence the use of rail for such traffic. Hydrogen (even if green, by no means certain) uses three times the energy of electric power. Electrified road service (ERS) he sees as operationally a non-starter, and battery electric vehicles are not practicable with current technologies over trunk haul distances. In contrast, 2/3rds of the trunk rail network is already electrified, leaving only around 800 route miles to do.

He challenged the common view that the scope for modal shift is limited, citing DfT statistics. The key is aggregating HGV loads to form trainloads. With most HGV routes running on core road corridors that parallel rail routes, this is not difficult to envisage. Few customers besides Tesco have trainload volumes to shift, so aggregating loads will be needed.

Key flows will be those between 200 and 300km, and realistically this amounts to around 200m tonnes pa. This implies trebling current trunk rail haulage. Julian calculated that, assuming a 13 hour day, we would need to shift about 26 trains each way/hour using 775m intermodal trains and 2000t bulk trains.

The challenges in this were considered, including: WCML (S) which needs HS2 to free up capacity, WCML(N) that needs new, long passing loops and flighting of trains, Felixstowe to the Midlands & North (F2M&N), which requires doubling between Felixstowe & Soham and Ely, and the cross-London route, that needs the implementation of the London Freight Strategy. There are a few other smaller issues like the upgrading of certain junctions, eg, Didcot.

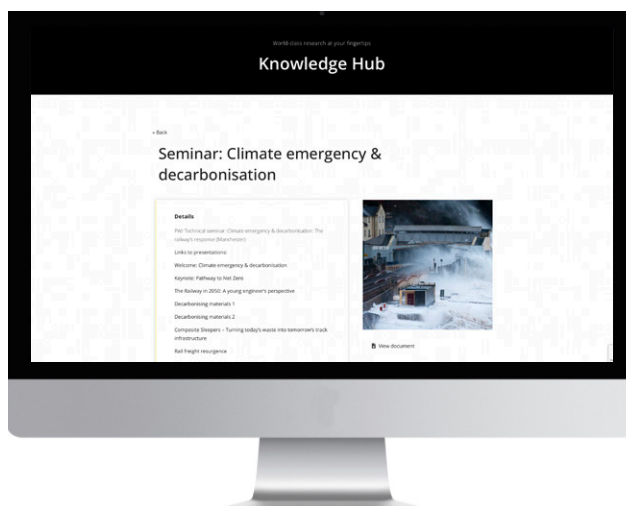
Julian suggested that to deliver all this, we need to consider the use of OLE to a lower specification for freight and regional passenger services at <75mph, as well as a general significant reduction in costs.

Finally, he spoke about the required strategy for terminals. He said that the “golden triangle” in the East Midlands is looking good, with strategic freight terminals, and the position generally with national distribution centres is also acceptable. Where real work is needed is with the regional distribution centres, and work is needed to create and improve these. Getting these right will be the key to future rail freight growth.

Julian's conclusions were:

- Battery HGVs for regional distribution (61-74% HGV tonnes)
- More than 1/3rd of HGV tonne kms well suited to rail
- Together 90% of HGV trips doable with existing technology. ERS not required
- Modal switch of trunking to rail – additional 200m tonnes rail traffic
- +2 paths/hour on most routes, +3 or 4 WCML and F2M&N
- Latent spare capacity, due to fewer passenger trains post Covid
- Grade separation of key junctions, plus ETCS
- HS2 release of capacity on WCML(S) – freight guarantee
- F2M&N/WCML(S) capacity enhancement
- 750-800 route miles of (lower cost) freight electrification

All the above is achievable if we start now, both capacity and wiring.



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THE ROLE OF MODAL SHIFT & RAIL IN TRANSPORT DECARBONISATION

PETER COLES - TRANSPORT FOR THE NORTH (TFN)

Before starting his presentation, Peter did put in a comment about the previous talk, saying that he hoped that we will not totally discount hydrogen, and giving brief reasons for this. He moved on to his own presentation, saying that what he was about to present relates to the North of England.

He told us that others have said “decarbonisation is not about stopping people doing things, it’s about doing things differently”. He proceeded to examine this statement by looking at different possible decarbonisation strategies and their effects upon CO2 emissions. This analysis, he said, suggests a significant gap between the decarbonisation trajectory already agreed and any of the possible scenarios over about 20-25 years. This means we “bust our budget” for emissions. Discussing some possible paths to decarbonisation, Peter said that we need a reduction in car mileages, by modal shift, of around 14% and a similar cut in HGV mileages. Modal shift is essential.

Inequality of impact is a big concern around decarbonisation. People with disabilities seem to suffer the most, but other groups are also affected. TfN research is examining the issues and causes; one of the most significant factors seems to be the lack of car access, combined with the degradation of bus services. A graphic Peter displayed showed household energy footprint by household income group. Reducing carbon can actually reduce exclusion, for example, by improving public transport and widening its use.

Peter told us that he wished to rephrase the quotation that he mentioned earlier, so that it becomes “It’s not about stopping people going to places, it’s about doing different things to access those places”.

This will require change on a personal level for us all. The “big Cs” are cost and convenience, and these must be got right. He talked about road pricing, and said that the Transport Select Committee report on 25/02/22 was not good enough. This said that motoring costs should not be increased overall. Public transport costs are presently far too high compared with motoring costs, and this must be rebalanced. That is likely to involve increases in motoring costs, not just cuts in the cost of public transport.

Peter reminded of some key facts, for example, that rail travel is already one of the least CO2 intensive means of transport, even on non-electrified trains. Almost 1/3rd of all miles travelled are on trips of over 50 miles, and of that 1/3rd, half are for leisure.

The biggest opportunity for decarbonisation comes through modal shift now, not through further decarbonisation of rail transport. We need to move from road to rail, especially for longer trips, rail must cater to the leisure market and rail freight has to be increased at the expense of road. The use of off-peak passenger services for rail freight has to be considered to assist here.

Challenges to overcome include: intra-regional leisure travel isn’t adequately catered for, similarly, the first & last miles of journeys. Carriage of baggage and pets needs to be considered and made easier.

The objective has to be to change the psychology of leisure travel so that people no longer say “let’s go out in the car today” but rather “where shall we go today?”.

Peter ended by considering some issues for the leisure market in the North. He offered the example of “The Alpine Pearls”, saying we should look it up online. Then he described some examples of “first and last miles” solutions; the Derwent Valley Car Club, the Lake District Travel Pods, ebikes and instant car hire schemes were mentioned.

QUESTIONS & ANSWERS WITH SPEAKERS

There was discussion of rail freight enhancements vs passenger ones. It was said that the enhancement of freight had been going comparatively well until the Henty Review, but after that it stopped.

The importance of outputs rather than inputs was underlined. A switch from HGV transport on the road to diesel rail will save 66% of the CO2 emissions. A second discussion asked how to stop the very wealthy simply buying their way out of things. There were no easy answers to that!

AFTERNOON SESSION

CHAIR: PETER DEARMAN - PWI DEPUTY PRESIDENT

Peter introduced the afternoon with some brief comments about the importance of reducing the costs of electrification, quite rightly one of his favourite themes. He then proceeded to hand over the floor to the first speakers of the afternoon.

IMPROVING WEATHER WARNING SYSTEMS & RAILWAY RESILIENCE

PROF. BRIAN HADDOCK - HEAD OF SEASONAL & WEATHER RESILIENCE - NETWORK RAIL
PROF. PAUL DAVIES - CHIEF CLIMATOLOGIST - THE MET OFFICE

Brian Haddock began this presentation, speaking about the Convective Alert Tool (CAT), a tool developed to improve NR’s response to weather by predicting convective storms of the type that contributed to the crash at Carmont/Stonehaven. It forecasts such events in real time using weather radar precipitation data, alerting Route Control should a convective storm occur near a line of route. A formalised process then follows, to impose speed restrictions in the area potentially at risk. This has been one of the outcomes from the work of the Weather Advisory Taskforce (WATF), chaired by Dame Julia Sligo and instigated after Carmont.

Paul took over from here, beginning his section of the presentation with some history of the Met Office, which was founded following a disaster at sea. This exemplifies how such events have resulted in changes historically, as with Carmont.

Next, he described the Weather Forecasting Science and the Data Decider Tool. These offer NR access to the latest forecasting capabilities in order to explore and exploit them and improve decision making. It is expected, inter-alia, to advance the understanding of links between past earthworks failures and weather, rainfall intensity and duration and antecedent conditions. The Met Office is procuring the world’s largest supercomputer that will facilitate such activities. The Decider Tool is a prototype, kilometre scale forecasting system for the rail network. It is intended to forecast where weather will not make a route unsafe, as well as where it will do so. The final piece in the plan is the people. The WATF proposes creating an Academy that will act to transform the culture of decision making within NR, necessarily a collaborative exercise, Paul said.

NATURAL CAPITAL LABORATORY

TONY MARSHALL - ECOLOGY LEAD - AECOM

Thanks are due to the presenter here, who had come in at short notice when his colleague, Robert Spencer, was unable to attend the seminar.

The Natural Capital Laboratory (NCL) is a 100-acre site called Birchfield at Whitebridge, near Inverness. A joint venture between the private owners of the site, AECOM, the University of Cumbria and Lifescape, is managing and monitoring the site. The intention is to rewild the site whilst collecting data and monitoring using innovative technologies. Natural capital accounting is to be undertaken, and a key objective is to communicate the outcomes widely.

The natural capital accounting is to be performed by digital means. It will account for all stocks/assets, physical flows and monetary flows. The normal approach to this typically involves Excel spreadsheets giving static results for a technical audience, and requiring regular manual updating. In contrast, here AECOM has developed the first digital interactive natural capital accounting system for the NCL. Data collection uses innovative technologies such as repeatable

drone video fly-throughs, multi-spectral cameras, RTK positioning and a digital twin of the site.

An example of the workstreams going on is that monitoring the aquatic ecology. An initial baseline of data was set up, and subsequent repeated surveys have monitored changes. An innovative tool being used is the eDNA sampling of water on the site. Life-forms interacting with the water leave traces of their DNA, so that analysis of water samples can identify them and indicate their presence. This has shown the existence of a number of life-forms on the site whose presence had never previously been known.

Visualisation is being developed using a 3-D site model and building virtual reality (VR) models with sound. These will be developed for both present and future conditions, to show how things change. These VR models are excellent for stakeholder engagement. The University is monitoring biodiversity at ten stations throughout the site, using such equipment as camera traps and audio monitoring.

Future work planned includes monitoring of peatland in a raised bog area, artistic residences, the identification of "missing" species and expanding the NCL to link to a network of similar sites across the country and the world.

LEEDS FLOOD ALLEVIATION SCHEME – A PROJECT CASE STUDY

HANNAH DODD - MOTT MACDONALD
PETER CHARLESWORTH - MOTT MACDONALD

Peter opened this presentation, saying that this project exemplified the delivery of multiple benefits through collaborative working across several organisations.

The scheme was initiated following the occurrence of a series of floods in Leeds. Seven occurred, over a five year period, starting with the Boxing Day flood in 2015. The agreed way forward involved a project board representing multiple stakeholders, with the intention of carrying out both screening and monitoring of the relevant catchments and the construction of civil engineering works, all to prevent or alleviate future flooding. The business case was developed around capital expenditure of £112m to deliver benefits of £450m.

Project measures included soil and land management, developing woodland in catchment areas and other "soft" techniques in addition to "hard" engineering. An app was developed that pulls together all manner of information about the scheme and issues that affect it. Work is now well under way on the scheme, with, for example, about 300,000 trees planted out of a total of 2 million proposed.

Hannah continued the presentation, speaking about the requirement to justify the carbon emissions implicit in the civils works. The project team worked with the University of Edinburgh to determine the carbon emissions effects of floods, to see whether the avoidance of

such emissions as a result of stopping future floods could be offset against the project's emissions.

The University team collected data from the 2015 flood, which enabled them to demonstrate that the emissions from flooding would be many times those of the proposed project works. Thus, the avoidance of just one similar flood to the 2015 one would more than justify the emissions of the proposed works. The success of this approach has resulted in the development of another app for use in similar exercises.

Peter described in some more detail the sort of work that the project is now undertaking. These include flood walls and glazed panels, embankments, pumping stations and upstream flood storage with a flood control structure. This is all designed to protect against a 1 in 200-year flood.

Before the scheme commenced it was possible to identify many additional benefits, beyond the flood protection aspect. While carrying out riparian works, it was possible to enhance habitats, install nature-based solutions like green walls and enhance certain existing infrastructure to the benefit of people and wildlife. The carbon management approach employed used a "bill of quantities". Emissions factors were applied, carbon footprints were evaluated, a target setting workshop was held and carbon hotspots were identified. Optioneering and target setting ensured optimal results. So far, the project has as-built carbon data for the first sub-zone of the scheme, and can show a carbon reduction of 34%.

In conclusion, Peter listed the success factors: collaboration, strong top-down leadership, delivery team engagement and collaborative planning.

SOUTH-WEST RAIL RESILIENCE PROGRAMME

SARAH FRASER - NETWORK RAIL WALES & WESTERN

The storms on the south-west coast of England in 2014 will not be forgotten for a long time, and their consequences for that part of the country and its rail link are continuing today. Sarah said that based on current understanding, this kind of storm is estimated to have a return period around 80 years. What is more, sea level rise and beach erosion imply that this may be an over-optimistic estimate.

In addition to the well publicised sea wall collapse and associated wash-out of the track near Dawlish, one month after the storm a cliff collapse occurred near Woodlands Avenue, Teignmouth. NR obviously responded immediately to clear the railway and restore the train service, but a long-term solution was imperative that would prevent similar events in future, or significantly reduce their likelihood.

A study was undertaken with clear aims. It took a 100 year climate-change view using 2016/17 UKCP09 data, considering medium risk scenarios, with high risk ones used as a sensitivity assessment tool. Sarah did not go through the findings in detail, but they are listed

in her full presentation. Five priority sites were identified, and the project has now dealt with three of these. One of the remaining two has proved to be too complex to be dealt with fully for now, and so some interim actions have been introduced to mitigate the worst risks. Work continues on the other.

Sarah described the phases of the works in some detail, and it is worth reading her presentation or viewing the recording to see the full story. Some relevant highlights include the use of low-carbon concrete in suitable locations (it is not appropriate to use in direct exposure to the sea, apparently), the construction of an "avalanche shelter" structure below an unstable slope on Phase 3 adjacent to the North Portal of Parson's Tunnel and the use of "pure" geotechnical solutions like soil nailing and mesh on Phase 4, between Dawlish and Holcombe. Most of these works are on very confined sites, often access is poor or near impossible, and there are environmental factors like protected species (Cirl Buntings and Sea Lavender, for example).

Part way through the works, on 7 December 2021, Storm Barra intruded. The infrastructure performed as expected, but three trains did not, failing and causing delays.

The priority site that is proving so difficult to resolve is Phase 5, Parson's to Teignmouth. This stretch has 1/3rd of all the high risk sites for instability. The rail corridor here is extremely narrow, between the beach and the cliff. The proposal was to create new land and sea wall outside the existing sea wall, so that the railway could be sluiced away from the cliffs. Room would then be available to buttress the cliffs and stabilise them. Unfortunately, there was strong opposition at public consultation, because of the loss of beaches implicit in the proposal. Network Rail has withdrawn for now, to gather more data and reconsider.

It is hoped that new ideas can be developed that reduce both environmental impacts and the carbon footprint.

QUESTIONS & ANSWERS WITH SPEAKERS

There was discussion about the possible abandonment of the coast route at Dawlish, but the suggestion from the floor was not seen as practicable given that so much of the Okehampton route has been sold and built over.

Peter and Hannah had described Leeds City Council as an innovative client, and they were asked about this. Peter said that

they had looked at innovative ways to build a business case, and had also been willing to compress timescales by allowing construction to begin before design completion. Other issues discussed included the relevance today of storm return periods, the use of "natural capital accounting" in schemes and working with local rail partnership groups.

One delegate ended the Q&A by recommending that everyone should go home, and if they haven't already done this, work out their own CO2 footprint, then "check on yourselves".

CLOSING REMARKS

PETER DEARMAN - PWI DEPUTY PRESIDENT

Peter kept his remarks short, thanking the PWI NW team for their hard work in creating & running this event, asking those who have not already done so to join the PWI and finally, recommending the PWI conference in Glasgow on 21st April 2022, "Electrification – the Business Case".



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Update

TECHNICAL BOARD

We had a combined face-to-face and virtual meeting kindly hosted by RSSB in London last month, involving over 30 people.

Nick Millington gave a safety update from Network Rail regarding track worker safety. Fantastic progress is being made towards zero use of unassisted lookouts, although there are still alleged near misses which cause concern. We will continue to monitor progress at future meetings.

Joan Heery, acting for the CEO, updated the Board on the business performance and strategic work of the PWI, and congratulated everyone who was involved in the March Practical Trackwork Challenge in Staffordshire. She also updated us on the work of the Climate Change and Decarbonisation Committee and thanked those involved in the successful March seminar in Manchester. I was able to confirm great progress on professional registration and training, particularly electrification where we have now completed Module 3 and will be awarding diplomas soon.

We had an excellent mixture of presentations at this meeting. I was delighted to welcome our Plasser colleague Bernhard Antony who travelled specially from Austria to present "The new Intelligent Tamping machine". This can make a big difference to quality and sustainability and lends itself to a more practical technically managed approach, it was also good to welcome colleagues from Network Rail maintenance.

Duncan Wier's talk on TfL's track asset management and decision support was very relevant and it was pleasing to hear that this focus has improved overall track performance significantly with reduced in-service failures and broken rails. Anup Chalisey, our host who is the RSSB Head of Infrastructure introduced us to a revised plan for standards development which will help reintegrate the railway under GBR.

It was good to review the format of our Technical Board and the members were keen to continue in the present format but perhaps also regularly facilitate hybrid meetings. We will be visiting Huddersfield University in July to view their new rigs. The autumn meeting will be in London and the first meeting of 2023 will be hosted by HS2 in Birmingham.



Seminar report

ELECTRIFICATION

DELIVERING THE BUSINESS CASE

PWI TECHNICAL SEMINAR
21 APRIL 2022
GLASGOW

“Electrification - Delivering the business case” was the particularly apt title of the PWI’s electrification seminar in Glasgow in April. The 140 delegates present know that electrification is required, yet convincing the Westminster Government requires electrification to be demonstrably affordable. Although various speakers described actual and potential cost reduction measures, the cost of electrification remains high at a reported £2 million per single track kilometre (stk) in Scotland, and £3 million per stk in England.

These figures compare with £0.5 million stk for German and Swiss electrification as shown in the Railway Industry Association’s Electrification Cost Challenge report. Some of these high costs are outside the control of delivery teams such as high overheads, project process issues and the lack of a rolling electrification programme. The frustration of those who had built up experienced electrification delivery teams only to disband them at the end of each project was particularly notable. Bill Reeve, Transport Scotland’s Director of Rail and Alan Ross, Director of Engineer and Asset Management for Network Rail Scotland explained why Scotland has a rolling programme and how it is being delivered.

SCOTLAND’S RAIL DECARBONISATION PLAN

The Scottish Government considers rail electrification to be an essential part of its national transport strategy. Since 2010, it has funded 325 stk of electrification. Currently electric trains carry 76% of rail passenger traffic and haul 45% of rail freight in Scotland. Its Scottish Rail Services Decarbonisation Action Plan, launched in July 2020, will decarbonise rail passenger services by 2035.

Bill Reeve explained that this plan is an instruction to the industry to electrify all Scottish main routes. He noted that battery and hydrogen trains will have a role but not for the core railway or for freight as electric traction is essential to provide the longer, faster trains needed to meet rail freight growth targets, for which gauge clearance is co-ordinated with the electrification programme. Regardless of the decarbonisation imperative, Bill explained that electrification is needed to make rail competitive as electric trains are cheaper to operate, more reliable, offer faster trains and additional services. They are also cheaper to buy than diesel trains which will need to be replaced in the not-too-distant future. For all these reasons Scotland can’t afford not to electrify. Bill also explained that a competitive railway is needed to attract the modal

shift from cars if Scotland is to meet its decarbonisation targets, which includes a 20% reduction in car kilometres by 2030. Bill noted that simply changing cars from petrol to battery powered “won’t cut it.” Hence Scotland is committed to a rolling electrification programme derived from a whole-system approach that considers the optimum infrastructure and rolling stock solutions to deliver the required timetable. This also gives the supply chain confidence to develop its workforce and capabilities. Bill concluded by stressing that all this depended on cost effective electrification delivery.

Alan Ross then explained how the decarbonisation programme is being delivered. He also stressed the need for a rolling programme to drive costs down but accepted that this requires trust and commitment. In this way, rather than individual projects, electrification is delivered as a programme which offers opportunities for optimising logistics, packaging feeder station delivery and procurement savings with early purchase of raw materials. He emphasised the need for a “sweet spot” to optimise delivery volumes which, for Scotland, is the annual delivery of around 90 stk of electrification and 30 structures clearances.

Although the Scottish electrification generally been delivered within its cost envelope at around £2 million per stk, costs still need to be further reduced. This requires transparency to ensure all cost drivers are understood, the need for a culture that embraces continuous improvements and a production focus. He recognised that Network Rail had to respond to the supply chain’s concerns, particularly in respect of access strategies. Alan also described Scotland’s whole system approach to determine the best overall solution. For example, the need to withdrawn diesel units in the next few years requires an interim strategy of discontinuous electrification with EMUs fitted with batteries that can be removed in future. Such an approach provides incremental benefits prior to full electrification.

Scotland’s electrification has many challenges of which its most iconic structure is one. Alan considered that Forth Bridge electrification is “challenging but doable.” There are also significant gauge clearance issues, particularly on the Highland Main Line. He also noted that power supply in remote areas is also a challenge for both Network Rail and the National Grid. Delivering more electrification than ever before over a 13 year period with ongoing cost savings is a significant challenge. With everyone playing their part, Alan felt this was achievable.

STIRLING ALLOA DUNBLANE (SDA)

Warren Bain, PBH Rail's Technical Director, explained how the recent SDA Scottish electrification programme started in January 2016 with its first OLE Form A. It had to be completed by December 2018 so that new Hitachi class 385 EMUs could replace the class 170 DMUs that had to be released to south of the border. SDA provided 110 stk of new electrification which included 2,200 new structures with an expanded feeder station and two new Track Section Cabins.

For SDA, PBH rail developed a single section pile up to 8 metres in length to avoid splicing the high percentage of piles that were longer than the standard 5.5 metre length. These piles were developed in consultation with the fabricators after confirmation that piling rigs and trailers could lift and transport these piles. A particular challenge of this project was the 600 metre Kippenness tunnel, that had a low uneven roof in which OLE structures could not be installed at the low points.

PRODUCTION BASED ELECTRIFICATION

Rob Sherrin of Leeps Consulting has no doubt that electrification needs a production rather than a project philosophy. He quoted cost savings from repetitive programmes such as windfarms that are expected to generate electricity more cheaply than gas-fired power stations in 2023, and Network Rail's Southern power supply upgrade was around £800m against its £1 billion budget. The need for such a production approach was highlighted by a questioner who asked why the GRIP language of projects is used for electrification which should be a continuous process. There was no satisfactory answer to this powerful question.

Rob advised that English electrification was currently costing about £3 million per stk, and that this must be reduced with a relentless focus on costs and the efficiency of repetitive tasks. He considered that the overheads and prelims must be reduced as these were often many times the cost of the actual work. Also, innovation needs to focus on cost and eliminate complexity, the access regime needs to allow efficient production and multiple packages of work will provide competition. Rob also felt that the authorisation regime needed to be challenged, as the Common Safety Method should be applied on the basis that there are no new fundamental risks from railway electrification schemes.

Amey's engineering manager, Anne Watters, reinforced many of Rob Sherrin's points. She explained how a 50% increase in possession time (from 4 to 6 hours) could double working time (from 2 to 4 hours), and therefore cancellation of the first and last trains of the day needed to be considered. She also considered the practicalities of using different types of machinery. High Output trains had their advantages, but needed to be able to store sufficient material for an 8-hour shift. Road Rail Vehicles (RRVs), are useful in complex areas but may not be efficient if their access points are miles apart.

She also stressed the importance of developing the workforce and that this related to the access regime, as excessive reliance on Saturday night working increased the need for "weekend warriors." A continuous programme also facilitates apprentice schemes, avoids efficient teams being disbanded and is needed if there are to be sufficient OLE construction trainers. Anne also considered other benefits of a rolling programme were a long-term look ahead of route clearance work, enabling it to be done first, and consistency of standards. She noted that she had spent hours discussing standards for station foundation designs.

The respective M&EE professional heads of Swietelsky and Babcock, Calumn Oates and Nick Wilkinson explained how Swietelsky Babcock Rail had developed specialist electrification plant. Their self-propelled Kirow 250 Rail Crane can be fitted with a side mounted tube driving system that can drive up to five piles per hour at a maximum 16 metre reach. They explained how their cranes can also be used to install masts and gantries. A continuous programme is needed to make the best use of this impressive, though expensive plant.

PREPARING FOR ELECTRIFICATION

Alan Kennedy, Lead OLE Engineer for SPL Powerlines, considered pre-work measures to maximise efficient delivery. He considered that digital twins are a real step change, as they reduce the requirement for on-site surveys as well as improving design and constructability reviews.

Another promising development is ground penetrating radar (GPR) to reduce the need for trial holes. This enables around 25 locations to be surveyed in a shift which would otherwise allow for the digging one or two trial holes, though GPR does not completely remove the need for trial holes. Instead, it allows them to be targeted as required. He explained how GPR is being trialled on the Haymarket to Dalmeny (H2D) scheme that should have its first piles driven at the end of June. He also described trials undertaken at a local quarry to determine the best method of rock piling and its effect on possessions. Methods tested included down-the-hole (DTH) hammers, micro-piling and coring or auguring.

"Reducing boots on ballast" and maximising time on track are key principles of efficient electrification. This can be achieved by off-track OLE construction and pre-registered cantilevers attached at site. Alan advised that this reduces site visits from three to one prior to wiring. However, this approach requires mature design and space for fabrication. It also needed a gap programmed between foundation and OLE work to make it efficient. Alan also explained how maximising span length at Almond viaduct on the H2D scheme might save £250,000 as the viaduct was not suitable for attachments. Although still to be confirmed, it was expected that the required 88-metre span would be feasible. Certainly, this approach has wider benefits in similar locations.

Alan's presentation reinforced many of the points made in earlier presentations including the need to optimise access strategy, keep things simple, the need for a more appropriate assurance regime and the development of the workforce.

Another issue that needs to be considered early in any electrification scheme is its heritage implications. Michael Ponting, Overhead Line Solutions Lead for Jacobs in York explained what this entails. There are potentially many stakeholders involved with any affected stations, overbridges, and heritage assets close to the railway. Early engagement with such stakeholders is essential.

Although electrification normally requires standardised approach to maximise efficiency, heritage impact mitigation may require a bespoke solution to be agreed with stakeholders, at an early stage of design. Michael also emphasised the importance of challenging standards to, for example, minimise heritage impact.

He referred to the useful guidance in Network Rail Standards NR/GN/CIV/100/02 "Station Design Guidance and NR/GN/CIV/100/05 "Heritage: Care and Development." These show that there are over 200 listed stations in the UK, all of which require conservation management plans to be prepared in consultation with the Railway Heritage Trust.

DESIGN

Garry Keenor, Professional Head for Electrification at Atkins, gave a presentation focused on design cost reduction by digital design and challenging standards. With typically 2,000 structures for 100 stk of electrification, design was a volume game that needed to be automated as far as possible using the latest digital design tools. He noted the importance of defining minimum viable product and emphasised that design development is the time to reduce costs, though this needs planning further ahead.

He noted that some standards may be out of date and that the historic reasons for them may not be clear. Hence there was a requirement for intelligent rule breaking to challenge standards using an evidenced based, first principles approach. He gave two examples where there had been a successful challenge: allowable uplift and wire gradients.

Until recently the design uplift for contact wire bridge arms was 70mm. Garry explained how novel measurement techniques of OLE mounted equipment that required no track access had demonstrated this could be reduced to 45mm.

A study of wire gradient was the result of it not being possible to demolish Steventon bridge during the GW electrification works. As this bridge was 400 metres from a level crossing, bi-mode trains had to operate on diesel power underneath it. This was because the then standards required a 60mph speed restriction of electric trains on the resultant 1 in 202 gradient and a maximum 1 in 625 gradient to operate at 125mph. After modelling and test train running undertaken by Atkins, it was demonstrated that electric trains could run at 110mph on a 1 in 175 wire gradient. Garry felt there needed to be a cultural change to encourage intelligent challenge and interpretation of standards. He encouraged Network Rail and its contractors to follow the E&P Technical Advice Note Ref 12-21-001-V1 "Bridge parapets electrical risk assessments" which introduced a risk assessment methodology to determine the required parapet works.

He emphasised the need for simplicity, both of design and process, and made the tongue in cheek observation that Britain requires more paperwork per electrification stk than any other country in the world.

Atkin's Technical Director, Paul Hooper consider what UK electrification might look like in 2050. Although Scotland is implementing its rail decarbonisation plan, the Westminster Government has yet to commit to an overall plan of rail decarbonisation. It has also not responded to Network Rail's Traction Decarbonisation Network Strategy (TDNS) which recommends 11,700 stk of electrification with battery and hydrogen trains respectively operating on 400 and 900 stk of track with currently no clear technical choice for 2,300 stk.

He noted that there were various proposals for discontinuous electrification though this was not suitable for freight. This is to be a permanent solution for Transport for Wales as the South Wales Valley lines are electrified. Paul considered that this will require an ultra-reliable system for pantograph raising and lowering. It will also need battery size to be optimised which may result in bespoke trains.

In Scotland the plan is for interim discontinuous electrification which needs to be planned around nine new feeder stations and take account of the need to provide power for both traction and battery charging. He noted that a rolling programme needs a 5 year look ahead, especially in respect of power supplies. New technology such as intelligent infrastructure, digital twins and static frequency converters can reduce costs. However, Paul emphasised that the electrification programmes should not await future innovations but be planned on what we know now.

Mott MacDonald's Head of Rail Systems, David Wilcox also considered the traction mix recommended by TDNS and explained this in terms of how far a train can travel per kilowatt hour. It might be obvious that electrification is the optimum traction and decarbonisation solution, however it is essential to win the hearts

and minds of politicians. He considered that a whole system approach needed to be taken to maximise performance and minimise energy consumption. To illustrate this, he considered a bridge on a 1 in 200 gradient on the Borders Railway with a 60mph speed restriction on a 1 in 80 gradient. He wondered how long it would take to recoup the cost of eliminating this restriction from the resultant fuel and performance savings.

David echoed the points made by previous speakers about challenging standards, data driven design and digital twins and wondered how long it might be before drawings were not needed.

LOOKING TO THE FUTURE

Decarbonising the railway with a rolling electrification programme that provides cheaper, faster trains to attract traffic from less carbon-friendly transport is a vision for the future that is being delivered in Scotland. Hence Glasgow was a good venue for the PWI's electrification seminar which highlighted examples of good practice in Scotland and elsewhere.

With many speakers stressing the importance of developing the workforce, the presentation by Megan Schofield on attracting young engineers to the industry was particularly well-received. Megan started her railway career with Arup just over two years ago as a graduate OLE engineer. In her first job she worked on platform extensions at London's Liverpool Street station. This was a small job involving all disciplines which she felt provided a good learning experience. She is now working on the Trans Pennine upgrade.

She advised that, at university, her fellow students did not consider rail as a career and instead looked to the automotive, aerospace and oil and gas sectors. Hence, she posed the question of what the industry can do to attract more engineers. She also felt that it was important to get more young people into engineering at an early stage. Megan emphasised that mentoring was important and advised managers to inspire those less experienced than themselves by spending quality time with them. She recognised the importance of networking and felt it important to have strong female leaders in engineering teams.

In the following Q&A session it was noted that Megan had clearly shown the importance of learning by doing and that mentorship was not a one-way process. One senior engineer acknowledged how much he had learnt from young engineers.

In summing up the conference, its chair, Peter Dearman, considered that it was uplifting to hear that in Scotland, Bill Reeve, representing Government, and Alan Ross of Network Rail were talking the same language. Yet he cautioned that the UK has the highest infrastructure cost base in Europe and that, even if material cost was zero, UK electrification would still be more expensive than Europe with much of this due to high overheads.

Regardless of the Scottish example, much still needs to be done to convince the Westminster Government of benefits of electrification and that the industry can deliver at an affordable cost.



WATCH THIS SEMINAR IN THE KNOWLEDGE HUB, IT'LL COUNT TOWARDS YOUR CPD!



AUTHOR: DAVID SHIRRES

David is a Chartered Mechanical Engineer. He retired from Network Rail in 2009 after a 38-year railway career that included rolling stock engineering, asset management and infrastructure projects. In 2010, he became a writer for Rail Engineer magazine and, in 2016, became the magazine's editor. He has also written for other publications. He is actively involved in the IMechE Railway Division in Scotland having been Chair and Secretary of the Division's Scottish Centre.

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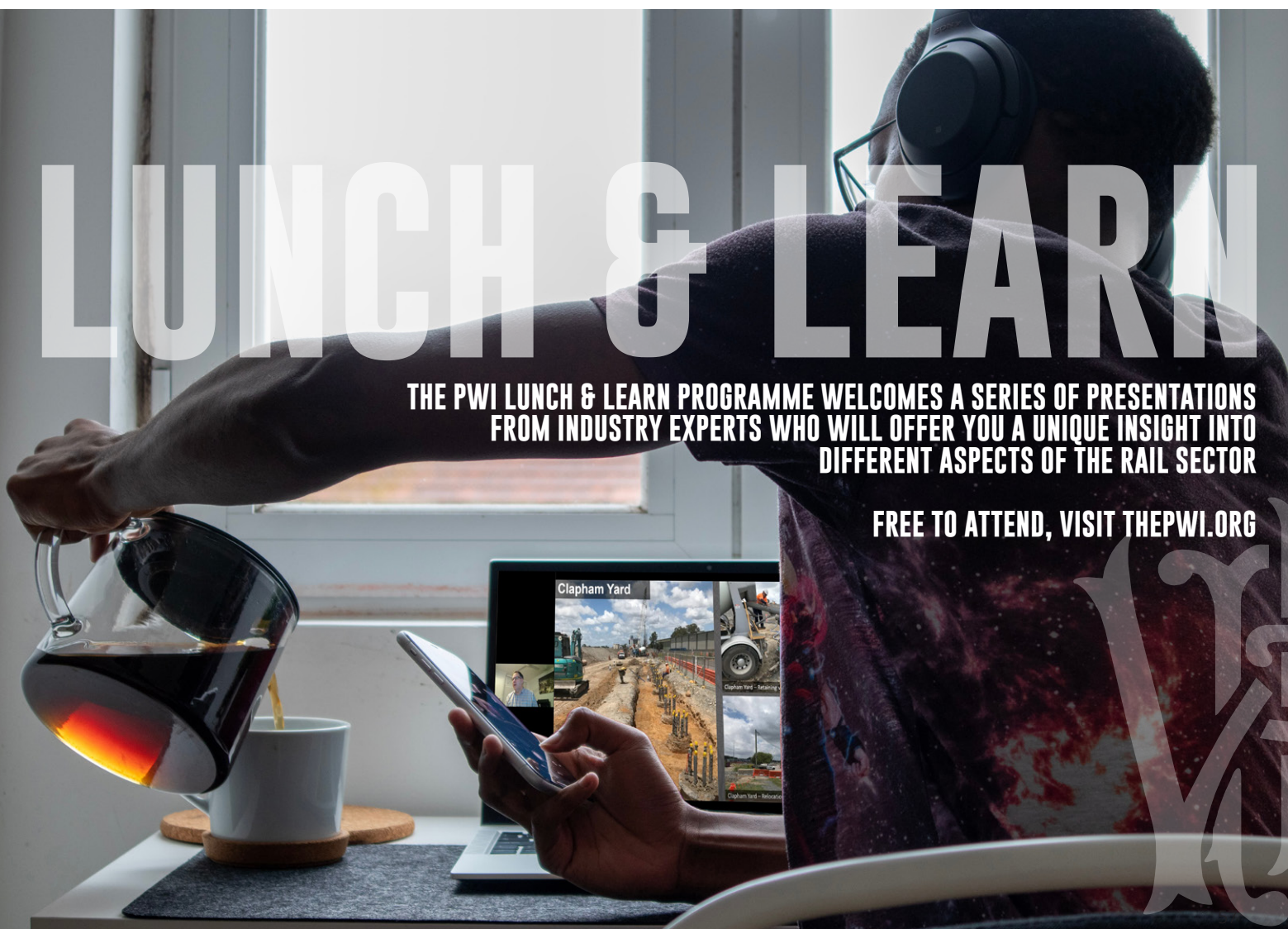
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LUNCH & LEARN

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Working in rail...

There are lots of opportunities for a rewarding career in the rail industry, whether it be in design, maintenance, asset management, or a different area entirely.

We spoke to ORR Civil Engineer Matt Gillen, CIRAS Membership Manager Kerry Dolan, Tensar Major Projects Design Lead Peter Matthias, and Network Rail Project Manager Sara Fraser about their current roles.

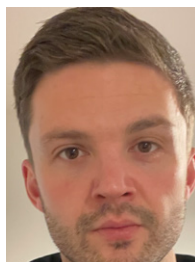
MATT GILLEN
ORR Civil Engineer



KERRY DOLAN
CIRAS Membership Manager



PETER MATTHIAS
CIRAS Membership Manager



SARA FRASER
Network Rail Project Manager



WHAT DOES AN AVERAGE DAY LOOK LIKE?

MATT

It can vary a lot! I can have quite a diverse workload, which can range from liaising & supporting my safety & economic colleagues, analysing vast cost/volume/performance data, assessing authorisation submissions to going out on site visits or undertaking assurance work.

KERRY

Each day is different which is why I enjoy my job so much! My favourite part of the job is when I get to speak with our members - whether it is answering membership queries, signposting people to our resources or giving presentations like the PWI Lunch and Learn. I also lead the membership team which includes our three stakeholder managers who engage with our members at a regional level. Our finance and membership administrator and our business development manager. If I can solve a problem or provide help and support, then I feel like I have made a difference each day.

PETER

Design management on Rail projects from feasibility stage through to detailed design and subsequent delivery on site which combines office and site working. Where time allows, I deliver CPD Seminars/design software tutorials to clients, design consultants and contractors - sharing knowledge and experience to identify project opportunities where product systems can be applied effectively.

SARA

Sometimes I work with teams in Network Rail on assurance and funding, sometimes I work with our delivery partners on site to resolve technical challenges and drive project progress and sometimes I meet with passengers, lineside neighbours and stakeholders to talk about the work we are doing and why we are doing it. No day is the same as another and that is both a delight and a challenge.

WHAT ARE SOME OF THE BIGGEST CHALLENGES OF YOUR CURRENT ROLE?

MATT

Balancing of workload and effective prioritisation is often a challenge. Operating in a relatively small team, we often must challenge ourselves if things are the best use of time.

KERRY

One of the biggest challenges we face right now is that the industry is undergoing a period of transition and change. During times of change, safety can be impacted if there is a shift towards priorities such as reducing costs or changing systems.

PETER

Managing client expectations with finite design resource, throughout the process communication is key.

SARA

There are huge technical challenges in understanding the complex geology of the cliffs between Dawlish and Teignmouth and making sure that we implement the best options to protect the railway, mitigate the impacts of climate change, increase resilience and provide value for money for passengers and taxpayers.

WHAT'S THE BEST BIT OF ADVICE YOU HAVE FOR SOMEONE LOOKING TO WORK IN THE RAIL INDUSTRY?

MATT

In my experience, getting out and getting practical experience were some of the best development opportunities. Gaining an appreciation for other aspects in a process and understanding the needs of stakeholders always proves beneficial.

KERRY

The rail industry is so diverse and there are so many different routes your career can take. If you can build your networks, then this will help open up these opportunities for you.

PETER

Engage with the rail community and take every opportunity for continual professional development as there are so many aspects to appreciate.

SARA

Never underestimate the variety of things you can do and the difference you can make.

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Making the right connections

pbh rail group

P-way / OLE / Surveys / Track Engineering

TRACK ENGINEERING CAPABILITIES

- Provide engineering assurance on all aspects of P-Way design
- Provide CEM/CRE & DPE/PE cover on track and all other disciplines
- Support CSM requirements and Project Hazard management
- Produce Track Monitoring Plans and CRT management plans inclusive of RA requirements set out in NR/L2/CIV/177
- Undertake and manage CRT including Hot weather arrangements – patrolling, ESRs etc including designs.
- Undertake and prepare track condition assessments and reports.
- Provide construction management cover on Core Works
- Provide tech support cover on P-Way Core Works for Plain Line and S&C works – Setting out Eng, Excavation supervision, Tamping
- Complete all post installation works including provision and installation of Datum/Geometry Plates
- Provide hand-back Engineers - up to level 4
- Stressing Engineers up to Level 3
- Provide TGS/TQS support for Tamping works (Bothe Plasser & Matissa competent)
- Provide Laser Dozer 3D modelling, including files and site tech support

OLE CAPABILITIES

- GRIP 1-3 Feasibility and Option Selection.
- GRIP 4 Outline Design; Site Surveys, OLE condition assessments, Heights and Stagger analysis
- GRIP 5 Detailed Design including; Wiring layout design, Cross-section production including Bonding plans, Isolation documentation updates, Material Bills of Quantity, Construction methodology and planning, Testing and Commissioning documentation, Section proving testing
- Basic design production including foundations, main steelwork and SPS.
- Support services including Technical specifications, In-house expert CAD services



P-WAY DESIGN CAPABILITIES

- Track Alignment Design for New Routes, Stations and Sidings
- Track Alignment Design for Conventional and High Output Renewals
- S&C Design enhancement & renewal
- Full ClearRoute Assessment
- Platform Extension Design
- Track Drainage Design
- Feasibility and Optioneering Studies
- Linespeed Increase and Route Improvement
- Traditional Hallade and Theo Design

SURVEY CAPABILITIES

- Control Networks
- Coordinated Topographical / Track Survey
- Detailed S&C Surveys
- Hallade & Levels Surveys
- 3D High Definition Laserscanning
- Overhead Line Height & Stagger Surveys
- Gauge Clearances Surveys

DISCUSS YOUR NEEDS

P-WAY DESIGN

E: Mark.Bonner@pbhrrail.com
 T: 01904 279 494

TRACK ENGINEERING

E: Wayne.Feery@pbhrrail.com
 T: 07445 237 324

OLE DESIGN

E: Warren.Bain@pbhrrail.com
 T: 01904 279 469

SURVEYING

E: Matt.Chilton@pbhrrail.com
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62

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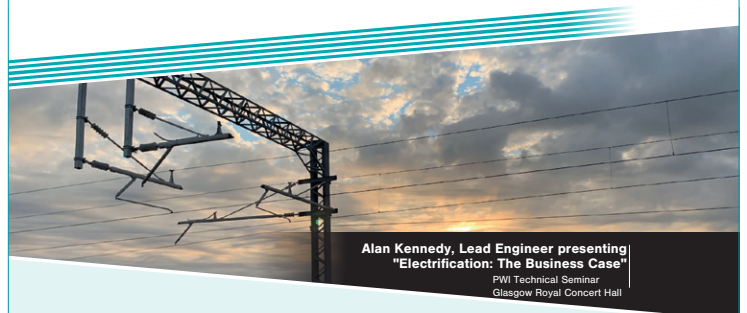
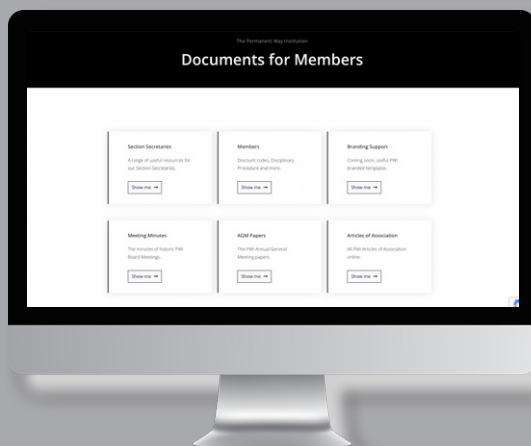
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HELPFUL DOCUMENTS FOR MEMBERS

Did you know that there's documents for members on the PWI website?

Here you'll find branding support, Board meeting minutes, AGM papers, and more.

Find this page here:
www.thepwi.org/member-documents/



Alan Kennedy, Lead Engineer presenting
"Electrification: The Business Case"
PWI Technical Seminar
Glasgow Royal Concert Hall

SPL Powerlines UK Limited is the leading overhead line electrification provider, with both a Principal Contractors Licence and a Plant Operators Licence

SPL Powerlines UK provides turnkey OLE capabilities from design through installation and commissioning to final testing. We currently offer the following services across the UK:

- OLE Design – High, Medium, Low Speed Systems
- Isolations and Planning
- OLE Installation
- Testing and Commissioning of OLE Systems
- Supply of plant
- Full project management OLE services
- Labour resource of rail personnel
- Surveying
- Power & distribution

SPL Powerlines UK has a vast portfolio of work, both as a Principal Contractor and Sub-Contractor that demonstrates a proven track record of delivering projects to time and to budget, while maintaining safe standards of work.

SPL Powerlines UK is a subsidiary of Austrian based Powerlines Group, one of Europe's leading system providers in railway electrification as well as a long-standing, reliable partner in the construction of energy transmission infrastructure in German-speaking countries. Powerlines Group is an EQUANS company, a world leader in multi-technical services.

www.powerlines-group.com

LEARN WITH US

THE PWI IS HERE FOR YOUR ENTIRE CAREER JOURNEY

PWI training started over 100 years ago and has been providing high level technical training for engineers and professionals operating at all levels ever since. Our courses are designed to develop skills and knowledge in all aspects of rail infrastructure repairs, renewals and projects – and can help you on your journey to professional registration. Not only will you gain an understanding of the underlying theory, you will develop an appreciation of the real-life challenges facing engineers from our team of experienced rail infrastructure lecturers.

CAREER TRAINING UPDATE

PWI Training provision has beaten all records with 15 courses delivered and 11 to be completed by the year end. The team are off to Perth in August to run a special S&C Refurbishment course for Network Rail Works Delivery in Scotland. Our key achievement was the completion of the first Overhead Line Electrification Module 3 in April and we're delighted to be awarding the PWI Electrification Diploma to 15 delegates this month. Other notable areas were Hong Kong Track Mass Transit Railway virtual Track Module 2 and doing all the courses for Network Rail graduates in both track and electrification. It was good to hear that Network Rail is happy with our services and they also now wish to have some bespoke PWI Railway Civil Engineering training.

New training courses for 2023

NEW

EARTHWORKS, DRAINAGE & OFF-TRACK ENGINEERING COURSE

This course provides delegates with the detailed knowledge, understanding, and insights necessary to manage the risks presented by earthworks and associated 'off track' railway infrastructure assets.

Delegates will learn about track formation, earthworks, drainage and water management, vegetation, level crossings, line-side security, and their relationships with interfacing engineered systems such as track. Weather-related effects will be examined and the potential longer term impact of climate change explored. Through theory, worked examples, case studies, and exercises, attendees will gain an appreciation of good practice in the design, installation, and ongoing safe management of critical 'off track' assets.

13 - 17 February 2023 Derby (5 days)
15 - 19 May 2023 London (5 days)

Course cost: £985 Accommodation cost: £365
See www.thepwi.org for full details

NEW

ADVANCED TRACK TECHNICIAN COURSE

The aim of this course is to give delegates advanced technical knowledge and understanding of track systems, and their associated methodologies and plant. Practical skills will be developed in plain line and S&C surveying and inspection, rail and rail defect management, mechanised alignment maintenance, and rail stressing.

Delegates will learn how innovations in survey, design, maintenance, renewal, and project work can be harnessed to help make safe and efficient plans. Diversity and sustainability issues will be explored, as will the interdependencies between the various engineering functions and train operations, so that key management skills including decision making, prioritisation, record keeping, data analysis, and report writing are developed. There will be additional support throughout the course for those attendees wishing to achieve EngTech registration. Subject to a satisfactory application and review, delegates will be awarded the EngTech title upon completion of the course.

MODULE 1: 27 Feb - 3 March 2023 Derby (5 days)
MODULE 2: 27 - 31 March 2023 Derby (5 days)
MODULE 3: 24 - 28 April 2023 Derby (5 days)

Module cost: £695 Accommodation cost: £365
See www.thepwi.org for full details



I encourage people to do training to gain confidence to tackle new areas and prepare for professional status. Almost everyone who attends PWI courses could easily be EngTech MPWI.

Brian Counter

TECHNICAL DIRECTOR - PWI
technicaldirector@thepwi.org

ELECTRIFICATION ENGINEERING DIPLOMA

The aim of the programme is to give delegates an understanding of the principles, theory and practice of Overhead Line Electrification engineering in the UK. Delegates will be taught by experienced rail infrastructure engineers who will share their wealth of experience and provide individual support to ensure every attendee gains maximum value from the course.

The Diploma is comprised of three modules and involves 100 hours of taught study all mapped to HE Level 6. Delegates will receive a technical textbook and comprehensive course materials with worked examples to support their learning. Upon successful completion of all three modular assessments, candidates will be awarded the PWI Diploma in Electrification Engineering.

This course is aimed at both newly academically qualified people and experienced engineers, and will give delegates the knowledge and skills needed for professionals in electrification engineering.

Courses run Monday to Thursday in Derby

MODULE 1: SYSTEMS AND MAINTENANCE

5 - 8 December 2022 / 8 - 11 May 2023
27 - 30 November 2023 / 20 - 23 May 2024
2 - 5 December 2024

Gives delegates a knowledge of OLE system types and the interfaces with the pantograph. Provides an understanding of the essential interfaces with other rail infrastructure including earthworks, structures and clearances. Develops knowledge of inspection, maintenance, servicing and repair processes. Gives an understanding of the concept of the UK rail system, operations, timetables, and legislation.

MODULE 2: DESIGN

18 - 21 July 2022 / 23 - 26 January 2023
3 - 6 July 2023 / 22 - 25 January 2024
15 - 18 July 2024

Focuses upon electrification design for projects and enhancements. Gives an understand design categories and processes. Develops skills in design of electrical, mechanical and civil engineering aspects including construction design and bonding design. Includes design case studies and exercises.

MODULE 3: ADVANCED ASSET ENGINEERING, CONSTRUCTION AND RENEWALS

7 - 10 November 2022 / 17 - 20 April 2023
2 - 5 October 2023 / 8 - 11 April 2024
21 - 24 October 2024

The study becomes more strategic and delivery oriented with advanced asset management techniques and applications. Gain a deep understanding of UK OLE construction and renewal processes including commissioning, OLE system testing and handback to service. Provides an understanding of ethical and sustainability aspects of OLE work and future proofing for climate change.

Course cost: £750 Accommodation cost: £275
See www.thepwi.org for full details

“ I learned aspects of OLE that I have never come across in my OLE career; this will benefit me in the future.
Stephen Bamford Story Contracting

S&C REFURBISHMENT TRAINING COURSE

24 - 28 October 2022 / 20 - 24 February 2023 / 23 - 27 October 2023 / 18 - 22 March 2024
14 - 18 October 2024 (All in Derby)

Delegates on this course will gain comprehensive detailed knowledge of S&C and how to undertake refurbishment safely, efficiently and to the required engineering quality. The course will cover both the track assemblies and the trackbed under S&C.

Participants will undertake detailed analysis and inspection of layouts so that they can scope and specify work correctly to provide the necessary life extension of the layout. The course will then ensure that delegates understand the various maintenance interventions suitable for S&C and its components and can plan those required in the correct sequence. Modules include: S&C Components Design and Analysis / Site Survey and Measurement / Scoping and Planning.

Delegates will have to pass a formal assessment at the end of the course and will be awarded a PWI Certificate in S&C Refurbishment on successful completion.

Course cost: £985 Accommodation cost: £365 See www.thepwi.org for full details

“ I gained a huge amount of insight during the practical and now feel more confident around S&C. I would highly recommend this course especially if you want to gain knowledge of S&C to a high level from very knowledgeable people. **Jacob Fay** Network Rail

TRACK ENGINEERING DIPLOMA

Top-up qualification
to IEng for HND /
Foundation
Degree
Holders

The aim of the programme is to give delegates an understanding of the principles, theory and practice of track engineering in the UK. Delegates will be taught by experienced rail infrastructure engineers who will share their wealth of experience and provide individual support to ensure every attendee gains maximum value from the course.

The Diploma is comprised of three modules and involves 100 hours of taught study all mapped to HE Level 6. Delegates will receive three technical textbooks, comprehensive course materials and coursebooks with worked examples to support their learning. Upon successful completion of all three modular assessments, candidates will be awarded the PWI Diploma in Track Engineering. This course is aimed at both newly academically qualified people and experienced engineers, and will give delegates the knowledge and skills needed for professionals in track engineering.

MODULE 1: TRACK MAINTENANCE

12 - 15 September 2022 (Virtual) / 14 - 17 November 2022 (Derby)
6 - 9 February 2023 (Virtual) / 5 - 8 June 2023 (Derby) / 13 - 16 November 2023 (Virtual)
5 - 8 February 2024 (Derby) / 10 - 13 June 2024 (Virtual) / 4 - 7 November 2024 (Derby)

Gives a basic understanding of track engineering and its theory and context. Develops a knowledge of track types and features, its interfaces with other rail infrastructure including earthworks, structures and clearances, and track maintenance including ballast, drainage, stressing, grinding and welding.

MODULE 2: TRACK DESIGN

18 - 21 July 2022 (Derby) / 31 Oct - 3 November 2022 (Virtual) / 16 - 19 January 2023 (Derby)
8 - 11 May 2023 (Virtual) / 9 - 12 October 2023 (Derby) / 12 - 15 February 2024 (Virtual)
13 - 16 May 2024 (Derby) / 30 Sept - 3 October 2024 (Virtual)

Focuses upon track design for projects and enhancements. Through design case studies and exercises, develop skills in track design of plain line and switches and crossings, component knowledge and configurations, layouts, innovations and life extension, route evaluation and trackbed design.

MODULE 3: ADVANCED TRACK ASSET ENGINEERING AND RENEWALS

26 - 29 September 2022 (Derby) / 5 - 8 December 2022 (Virtual) / 6 - 9 March 2023 (Derby)
18 - 21 September 2023 (Virtual) / 11 - 14 December 2023 (Derby) / 22 - 25 April 2024 (Virtual)
16 - 19 September 2024 (Derby) / 9 - 12 December 2024 (Virtual)

The study becomes more strategic and delivery oriented with advanced asset management techniques and applications. Gain a deep understanding of UK track renewal planning, plain line, S&C, existing and future methods, rail renewal scenarios and optioneering, and learning from accidents. Understand advanced technical rail management issues, rail sustainability and strategic track asset management.

Module cost: £750 (Virtual or Derby) Accommodation cost: £275 See www.thepwi.org for full details

“ I found the three modules thoroughly enjoyable and valuable in developing my understanding of railway maintenance and its interdependencies. I am now interested in becoming an Incorporated Engineer. **Chris Fuller** Network Rail

A CATCH UP WITH BRIAN APPRENTICES & OTHERS ON THEIR JOURNEY TO BECOMING A CHARTERED ENGINEER

AS THEY USED TO SAY YEARS AGO, "THE WORLD IS YOUR OYSTER"!

I am really pleased by the developments in rail apprentice recruitment and development, and it is natural to expect that all Technician (Level 3) Apprentices will qualify as EngTech MPWI when they complete their end point assessment. We do need to catch up with those who did their apprenticeships prior to 2019 and help them to be EngTech qualified.

WHAT ABOUT THE REST?

People are now realising how important it is to use the EngTech route as a first stage to becoming a professional and externally recognised engineer in the Rail Infrastructure sector.

This includes all those who did not go to college but have loads of rail experience and take their safety related jobs seriously. They should be proud to call themselves a "professional" with equal status to those in industries such as gas, emergency services and healthcare. So, read the step by step guidance on the website and get qualified in six weeks!

OTHERS READING THIS ARE PROBABLY THINKING "WHY DO ENGTECH WHEN I AM WORKING TOWARDS INCORPORATED OR CHARTERED STATUS?"

Well, because you can get professional recognition with EngTech sooner. It can take several years to get IEng or CEng status but after 1-2 years of suitable rail experience you can get EngTech MPWI after your name and start on your journey. This also applies to those who are in college doing higher qualifications or working towards the Experiential Learning or Technical Report routes.

You may have a HNC or degree and potentially bags of experience but you cannot call yourself a "professional" engineer because you are not registered. This may prevent you from undertaking some rail safety duties either now or certainly soon in the future. We await the final outcome of the Grenfell Tower report and future national competency rules.

We are also helping people who want to attain EngTech with the PWI now, even though they wish to get IEng or CEng through another broader institution such as ICE, IMechE or IET.

WHAT ARE COMPANIES DOING TO RECRUIT EXCELLENT NEW TECHNICIANS?

We have been working with companies who have formal apprentice schemes that bring in an EngTech review as part of the end point assessment. These include a day or block release at college and they obtain a Level 3 NVQ or BTech as well. Probably the largest single recruiters being Network Rail and TfL in the UK.

However smaller companies are now finding it very beneficial to their business to employ apprentices, and commonly get the pick of the bunch of school and college leavers and entice them to make railways their career.

Brian Counter

TECHNICAL DIRECTOR
technicaldirector@thepwi.org



Apprentices from On Track Technicians Northern Ireland attending a Railvac demonstration at the Midland railway in Derbyshire - Left to right: Brandon Oliver, Josh McAteer, Jonathan Pursley, Cole Annesley-Smyth. (Photo: Brian Counter)

DOWNLOAD THE APPLICATION FORM & LOOK OUT FOR OUR WORKSHOPS – START NOW NOT TOMORROW! [SHORTURL.AT/DMPVB](https://shorturl.at/dmpvB)

CONNECTING COMMUNITIES

BAM is proud to support vital infrastructure development, improving rail journeys throughout the UK.

Driving economic benefit across the country, we're connecting communities through better railways, roads and environments - at a time when we all need it most.

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VOLTAP
RAIL POWER CHARGER



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VOLTAP is the new building block of an electric charging revolution, supporting hybrid and battery trains.

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Our people

NEW MEMBERS

We're honoured to have you on board and are thoroughly looking forward to working with you. We'll keep you updated on news and events via our monthly newsletter as we don't want you to miss a thing. We have a thriving social media network and we'd love to see you get involved! We're here to help, so if you have any questions, then shout out!

Ashford: Mark Prescott, Wioletta Ciszewska. Birmingham: Eoin O'Neill, Ellen Wintle, Joe Richmond, Kevin Bryant, Joseph Johnson, Jithin Arakkatt Shaji, Lewis Hattersley, Aaron Clewer. Cheshire & North Wales: Jonathan Telesca, Brandon Brown, Neil Young, Stuart Wilde, William Roberts, Dr Rubina Greenwood. Croydon & Brighton: Jean Didier Mondji, Alex Widdowson, Pawel Ptak. Edinburgh: James Kindberg. Exeter: Helston Railway, Andy Spencer, Gary Hall. Glasgow: Calum Watson, Adam Benwell, Rhona Marsland, Jack Wade, Peter Gibbons, Ali Rajabi, Emma Percy, Chipu Madzikwah, Hamzah Mahmood, Jordan Boyle, Steven Bruce, David McLaughlin, Eliot Clark, Andrew Wilson, Connor Fitzpatrick, Arpit Rai, James Kelly. International: Stanley Shimishi, Hamza Adem, Maqsoodur Khan, Ariel Jimenez, Rajeev Kumar Sadasivan, Dennis Young. Irish: Brandon Oliver, Jonathan Pursley, Ryan Murphy, David Peden, Agnieszka Swierzevska, Andrew Lucas, Elizabeth Keane, Neil Mulholland. Lancaster, Barrow & Carlisle: James Lewis. London Perfect Ekengwu, Karl Wellbelove, Damjan Kitanski, Amandip Singh Samra, David Smith, Antoinette Davey, Alexander McLean, Katie Frost, Huw Edwards, Sonny Ray, Zabihullah Ebad, Robert Earles, De Wet Kruger, Simon Templer, James Bayley, Tom Ingre, Dean Choules, Finn McKeown, Saeed Wafa, Munaf Ally, Alan Horton, Danny Samson Fongo, Adam Titmas, Robert O'Regan, Brian Gibbs, James Freemantle, Kilian O'Malley, Paul Thompson, Hakam Al-Bustami, Bhavishka Seewoo, Zachariah Ashton. Manchester & Liverpool: Warren Gower, Brian Armstrong, Jermaine Jallow, Joseph Hickman, Tanzeel Mahmood, Wesley Crompton, Michael Armistead, Rahees Ramzan, Peter Matthias, Stephen Mahoney, Michael Beckett, Asfandyar Shahid, Karim Sahibzada, Andy Colvin, Samuel Duddy, Hannah Nodwell, Jonathan Walesby, David Barden. Milton Keynes: Krzysztof Kozbiel, Adam Carlin, Thomas Edwards, Shahab Fazal, Frank Evans, Hannah Swain, Christopher Doyle, Abdulaziz Alotaibi. North East: Ethan Allen, Ashley Wilson, Joshua Hudson, James Barron, Nathan Beaumont, Matthew Lynn, Daniel Heath-Holmes. Nottingham & Derby: Simon Skinner, Jo Boocock, Midland Railway-Butterley, Dean Frazer, Balázs Gócza, Carl Lawley, Karen Ruff, Kyle Bridges, Steven Lawton, Arron Sharp, Richard Cumberlidge. South & West Wales: Gary Hurn, David Deeley, Alex Pugh, Krzysztof Falkowski, Luca Franzosini, Mohammad Munir Azam Khan, Luke Taylor, Ryan Leach, Henry Newman. Thames Valley: David Pasika. Wessex: Harry Duddy, Joe Bethell, Ian Hodson. West of England: Donna Reigate, Martin Taylor, Rory Evans-Beale, Christian Palmer, Francois Caublot, Jody Reynolds, Catherine Lough. West Yorkshire: Thomas Moulds, Ryan Matthews, Ivan Sanderson, Zak Morgan, Ikram Moshi. York: Kyriakos Tochniti, Robert Cairns, Emily Levy, Warren Bain, Philip Haigh, Martin Smith, Phillip Wilson, Bryan Vinueza Davila, Rhiannon Easton, John Booth, Liam Rounthwaite

OBITUARIES

The full version of obituaries can be found on the PWI website.

James Donald FPWI London Section
John Morgan HLM Croydon & Brighton Section
John McCall MPWI Glasgow Section

FELLOWSHIPS

West of England – Andy Crago
Milton Keynes – Ian Griffiths
South & West Wales – Gary Hurn
Ashford – Mark Prescott
Glasgow – Liam McQuat
Birmingham – Eoin O'Neill
Manchester & Liverpool – Johan Strydom
South & West Wales – Gwynfor Rees
West of England – Donna Reigate
Exeter – Andy Spencer
Nottingham & Derby – Jo Boocock
Wessex – Colum Cavanagh
London – Kenneth Lambert
West of England – Billy Graham
Birmingham – Ellen Wintle
West of England – Martin Taylor
South & West Wales – David Deeley
York – Robert Cairns
London – David Smith
West of England – Andrew Bartlett
London – Antoinette Davey
London – Katie Frost
London – Huw Edwards
West of England – Mark Kidd
Nottingham & Derby – Dean Frazer
York – Johanna Priestley

PROFESSIONAL TITLE

A huge well done to our members who have gained a professional title since the last Journal. This is an amazing achievement.

Daniel Anderson - Engineering Technician
Alexander Rhodes - Engineering Technician
Alasdair Robertson - Incorporated Engineer
Andrew Steele - Chartered Engineer
Claire Monaghan - Chartered Engineer
Russell Licence - Chartered Engineer
Adam Owen - Chartered Engineer
Howard Jones - Chartered Engineer (Additional)
Adam Collett - Engineering Technician
Jamie Kelly - Engineering Technician

PWI DIPLOMA

Adam Harper, Matthew Hendry, James Fenton, Matthew Lock, Thomas Roy, Guy Silberrad, Richard Dunn, Lee Herron, Daniel Sears, Richard Price, Anthony Dixon, John McGregor, Anthony Tranter, Nathan Atkins

PWI S&C REFURBISHMENT

Tina Leibrick, Adam Smith, Matt Crompton, Jaydan Manyan, Steve O'Brien, Frank Reilly, Sam Barribal, Daniel Keay, Graham Hooker, Jake Davies, Michael Beasley



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Luke Goude
Marketing Executive
marketing@thepwi.org

THE PWI TEAM

Here to help

TECH TALK



Tech Talk is a private forum where members can discuss, debate and share views on all things related to rail technology. Members can ask questions and make comments about the technical articles that are published in the PWI Journal, as well as react to our technical seminars, Boards and relevant news.

We encourage healthy debate and differences of opinion, but ask that contributions remain friendly and respectful at all times. Simply request to join!

www.linkedin.com/groups/8862498/

YOUNG ENGINEERS SECTION



This virtual Section has been formed on LinkedIn and provides a central location for all the younger members of the rail community to engage whilst remaining a member of your regional home Section.

The Young Engineers Section is a place to exchange thoughts, ideas, views and challenges you may be experiencing in your role as a young person working in the rail industry. It's a place to gain and offer support, to meet likeminded individuals, and to participate in social activities as the group becomes more defined. Simply request to join!

www.linkedin.com/groups/8865220/

AMBASSADORS

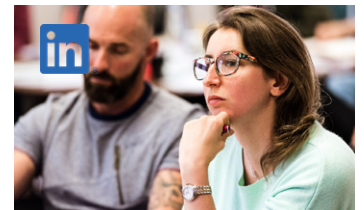


This forum connects PWI Ambassadors to discuss ideas, suggest collaborations and to receive updates and announcements from the central team.

PWI Ambassadors are free to post comments, ideas and suggestions to fellow Ambassadors or for the attention of the PWI central team. We continue to seek new Ambassadors and Young Ambassadors, and aim to appoint at least one Ambassador for every Corporate Member. If you wish to volunteer or nominate a colleague, please contact: marketing@thepwi.org

www.linkedin.com/groups/8913254/

PROFESSIONAL REGISTRATION



This group is for all those embarking on their Professional Registration journey, as well as those who have already completed the process. Connect with each other, raise questions, discuss challenges and gain support from your peers.

We encourage members to treat this as an alumni network for PWI Professional Registration, allowing you to make friends and stay engaged with others who have undertaken the same journey, and to offer your experiences and mentorship to others when possible. Simply request to join!

www.linkedin.com/groups/8976547/

200+

SECTION MEETINGS A YEAR!

PWI Section meetings are great places to learn about rail projects and new technical developments, and network with other rail professionals.

CENTRAL ENGLAND VICE PRESIDENT Mark Downes vpcentral@thepwi.org

BIRMINGHAM Secretary: Tony Morgani birmingham@thepwi.org Venue: 2nd Floor, Network Rail, Baskerville House, B1 2ND

MILTON KEYNES Secretary: Kevin Thurlow 07802 890299 miltonkeynes@thepwi.org Venue: Auditorium, The Quadrant, MK9 1EN

NOTTINGHAM & DERBY Secretary: John Garlick 07532 071727 nottingham-derby@thepwi.org Venue: Aston Court Hotel, DE1 2SL / Jury's Inn Hotel, NG2 3BJ

IRELAND VICE PRESIDENT Cathal Mangan cathal.mangan@irishrail.ie

IRELAND Secretary: Joe Walsh 00 353 872075688 pwirishsection@gmail.com

NORTH EAST ENGLAND VICE PRESIDENT Phil Kirkland vpnortheast@thepwi.org

NORTH EAST Secretary: Phil Kirkland 07899 733276 northeast@thepwi.org Venue: Newcastle College Rail Academy, NE10 0JP

WEST YORKSHIRE Secretary: Martin Wooff 07487 652622 westyorkshire@thepwi.org

YORK Secretary: Louise Walley york@thepwi.org Venue: Network Rail Meeting Rooms 0.1, George Stephenson House, YO1 6JT

NORTH WEST ENGLAND & NORTH WALES VICE PRESIDENT Lynne Garner vpnorthwest@thepwi.org

CHESHIRE & NORTH WALES Secretary: Peter Veryard cheshire@thepwi.org Venue: Online until further notice

LANCASTER, BARROW & CARLISLE Secretary: Philip Benzie lbc@thepwi.org 01704 896924 Venue: Station Hotel, PR1 8BN / Network Rail, CA28 6AX / Network Rail, CA1 2NP / Network Rail, Warton Road, Carnforth LA5 9ET

MANCHESTER & LIVERPOOL Secretary: Richard Wells manchester-liverpool@thepwi.org 07817 302652 Venue: Manchester Metropolitan University, Room E0.05, M1 5GD

SCOTLAND VICE PRESIDENT Hannah Persson vpscotland@thepwi.org

EDINBURGH Secretary: Mark Taylor edinburgh@thepwi.org 07710 959630 Venue: The Scots Guards Club, EH12 5DR

GLASGOW Secretary: Angus MacGregor glasgow@thepwi.org 07775 544509 Venue: WSP Offices, 7th Floor, G1 3BX

SOUTH CENTRAL ENGLAND VICE PRESIDENTS Anup Chalisey & Darren Sharp vpSouthcentral@thepwi.org

LONDON Secretary: Sean Tarrant london@thepwi.org 07764429211 Venue: RSSB, 1 South Place, London, EC2M 2RB

THAMES VALLEY Secretary: Richard Antliff thamesvalley@thepwi.org 07804 329497 Venue: Network Rail Offices, Hawker House, 5-6 Napier Court, Napier Road, Reading, RG1 8BW

WESSEX Secretary: Paul Meads wessex@thepwi.org 07771 668044 Venue: The Eastleigh Railway Institute, SO50 9FE / Network Rail Offices, Waterloo Station, SE1 8SW

SOUTH EAST ENGLAND VICE PRESIDENT Jonathan Bray vpSoutheast@thepwi.org 07976 199011

ASHFORD Secretary: Colin Burnikell ashford@thepwi.org 07801 913562 Venue: Online until further notice

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LONDON Secretary: Sean Tarrant london@thepwi.org 07764429211 Venue: RSSB, 1 South Place, London EC2M 2RB

SOUTH WEST ENGLAND & SOUTH WALES VICE PRESIDENT Andy Franklin vpSouthwest@thepwi.org 07901512293

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EXETER Secretary: Mark Woollacott exeter@thepwi.org 07920 509011 Venue: Mercure Exeter Rougemont Hotel, Queen Street, EX4 3SP

SOUTH & WEST WALES Secretary: Andrew Wilson southandwestwales@thepwi.org 07974 809639 Venue: Network Rail Offices, CF10 5ZA / Clayton Hotel Cardiff, St Mary Street, Cardiff, CF10 1GD

INDIA

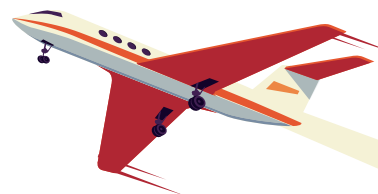
BENGALURU Secretary: Srinagesh Rao bengaluru@thepwi.org Venue: Arcadis Sez Office, Bengaluru, Karnataka 560045, India

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NEW SOUTH WALES info@pwinsw.org.au

QUEENSLAND Robin Stevens robin.stevens@qr.com.au



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**WITH THE HELP OF MY
COLLEAGUES AND THE PWI,
I FOUND THE APPLICATION PROCESS
STRAIGHTFORWARD AND INTUITIVE.**

GRAEME BLEACH ENGTECH



RUSSELL LICENCE TALKS ABOUT PROFESSIONAL REGISTRATION WITH THE PWI

“ After 20 years in the rail industry, I decided it was time to progress my aspirations for professional accreditation. I knew I needed this to progress into more senior positions, but more so for me to be formally recognised as a professional Engineer. I chose the PWI as it felt more pertinent and aligned to my experience over other institutions. I had only achieved up to BEng academically, yet I felt as though I had enough experience to demonstrate CEng so I chose to go down the Technical Report route, rather than look to a Master's degree.

In September 2021 I submitted my Technical Report application with the PWI, and the process was faultless. I had already done most of the pre work before applying (ie a draft technical report to gauge the level with my Sponsor) which made the process much quicker. Within a few weeks I was advised it had met the required academic level and was invited to Technical Report Interview. The interviewers were great: I gave a 15min presentation on the report at the start and immediately felt at ease during the session. It felt more like a conversation with people who were genuinely interested to hear what I had to say about the project. Late December 2021 I received notification I had successfully passed the Technical Report stage and was invited to submit for professional review.

Over January 2022 I finalised my professional review report and evidence mapping and submitted it. It was good news again – it had met the requirements and I was invited to professional review interview. I was much more nervous about this interview, as despite already thinking I had enough experience, I certainly had imposter syndrome – I was nearly at CEng status! In March 2022 the interview day came, but I needn't have worried – the interviewers were fantastic and very experienced railway people. They made me feel welcomed and asked me some excellent questions on my review. It never once felt like they were testing me, it felt like they wanted to understand more about the situation and why I made the decisions I did. Four weeks later I received the news I had been successful in achieving CEng status with the PWI!

I would highly recommend the PWI as a community to support professional accreditation at all levels, and my only regret is not achieving Engineering Technician or Incorporated Engineer much sooner on my journey to CEng!

Russell Licence BEng (Hons) CEng MPWI
Senior Engineer - Track, Switches & Crossings
Asset Enhancement Team, Network Rail



PROFESSIONAL REGISTRATION

Professional Registration is an important step in pursuing a career in engineering and it lends itself to a ready-made career path, progressing through the grades as your experience broadens and deepens.

Putting those letters after your name (EngTech, IEng or CEng) instantly tells employers, clients and wider society that your competence and understanding of engineering principles has been independently assessed, that you have the knowledge, skills and professional attitude they value, and that you are committed to developing and enhancing your competence. It sets you apart from your non-registered colleagues.

The right professional registration title for you is based on your academic and professional competence: here's a general guide...

EngTech

Engineering Technicians apply proven techniques and procedures to the solution of practical engineering problems.

They hold Level 3 engineering/technology qualifications and 2-3 years industry experience, OR 3-5 years industry experience.

IEng

Incorporated Engineers maintain and manage applications of current and developing technology, and may undertake engineering design, development, manufacture, construction and operation.

They hold Level 6 (Bachelors) engineering/technology qualifications and 3-5 years industry experience, OR 5-10 years industry experience.

CEng

Chartered Engineers develop solutions to complex engineering problems using new or existing technologies, and through innovation, creativity and technical analysis.

They hold Level 7 (Masters) engineering/technology qualifications and 3-6 years industry experience, OR 10-15 years industry experience.

PROFESSIONAL REGISTRATION WITH THE PWI PROVIDES YOU WITH A GLOBAL BENCHMARK OF ENGINEERING EXCELLENCE, AND INDEPENDENTLY VALIDATES YOUR COMPETENCE AND COMMITMENT.



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The PWI team is working hard to pass on the message about the value, importance and usefulness of being registered with the Engineering Council.

The PWI now has 286 registered engineers of which 173 are Engineering Technicians and we are actively promoting registration for Level 3 ex-apprentices throughout the industry. We are working with Network Rail on Level 3 rail technician apprentice end point assessment (EPA) activity and we are looking to be their preferred partner for track and electrification.

The other news is that the University of Birmingham is working with us for Chartered Engineer registration on their Level 7 MSc rail apprenticeship which involves around 40 candidates per year. We are also expecting to qualify around 100 Incorporated Engineers on BEng(Hons) Level 6 degree apprenticeships with rail companies, through London South Bank and Sheffield Hallam Universities.

The government agency, the Institute for Apprenticeships and Technical Education suggest that in rail there are around 650 apprentice starts each year.

The Joint Board of Moderators' work which now involves PWI has been progressing well with myself and Liz Turner involved in a number of visits and not surprisingly there is major interest in covering more rail at JBM accredited universities. There is a lot of work planned to liaise and assist universities and colleges and recruit more student members.

Liz Turner, our Professional Registration Manager is always available and would be delighted to get a phone call (0300 373 6000 option 2) or email profeng@thepwi.org – give her a try!

Brian Counter

TECHNICAL DIRECTOR - PWI
technicaldirector@thepwi.org

The PWI is here for your journey and we would love to support you in your career aspirations.

Professional registration is open to any competent practising engineer or technician.

Different levels and pathways to registration are available, depending on your experience, training and qualifications.

FIND YOUR ROUTE TO
REGISTRATION ON THE WEBSITE

www.thepwi.org
profeng@thepwi.org

CPD AUDIT 2022

You may hear from us soon!

Participation is optional for members, but mandatory for registrants.

AWARD

BARBRO AWARD – PWI STAR OF THE YEAR

The Barbro Award - PWI Star of the Year has been created in memory of longstanding PWI Member and Marketing Director Alison Stansfield, in honour of her passion for people's life journey and their ability to better themselves as individuals.

It is an annual award to the PWI member who has shown outstanding personal development and taken real ownership of their chosen career and personal development.

SCAN ME



Scan this QR code or head to the website to download the nomination form and send it to profeng@thepwi.org

www.thepwi.org/award-barbro-award-star-of-the-year/



NOMINATE A COLLEAGUE TO WIN THE BARBRO AWARD!

Nominations are welcomed from all within the rail infrastructure sector and nominees will be reviewed against the following criteria:

- Outstanding personal development and progress within the industry. A description of the role undertaken by the nominee and how the individual has developed over time will be required.
- Demonstration of leadership or leading by example in the following areas, with examples provided in the supporting citation: safety, sustainability, diversity and inclusion, or development of others.
- Contribution to industry events or outstanding support to the PWI eg presenting at a technical forum or publication of a technical article, or through a local Section or committees.
- Demonstration of personal societal contribution, promoting the benefits of working within the rail infrastructure sector eg undertaking STEM events or volunteering with local communities.

Nominees must be a current member of the PWI, but can be nominated by anyone in the industry. The nomination must include a maximum 1,000 word citation evidencing the relevant criterion and why it is felt the nominee should receive the award. Supporting evidence is encouraged but must not exceed six sides of A4 – eg industry commendations, certificates, PDP and CPD records.

The deadline for nominations is 30 September 2022.

Award event - 15 November 2022, Birmingham.

WITNESS THE FITNESS

#PWIWF

CALLING INDUSTRY NEWCOMERS!

Are you new to the rail industry as a student, graduate, or apprentice?

You might feel like you have a long, uphill career journey ahead of you, but today, as an industry newcomer, your role is invaluable - you are already one of tomorrow's leaders TODAY.

That's why at the PWI we've launched the new Witness the Fitness scheme designed to best support industry newcomers as you transition from the formal learning environment into industry, and to help you optimise your ability to make an early positive impact on your career. Our Witness the Fitness scheme will help you establish your influence as the next generation of leaders and ensure you are noticed, listened to, and encouraged to stand out with confidence. You may not yet have a lot of hands-on industry experience, but your academic knowledge is as up to date as it comes, and that knowledge is essential to the success of today's (and tomorrow's) rail infrastructure.

WHAT DOES #PWIWF ENTAIL & HOW DO I ENTER?

PWIWF gives those starting out in our industry an opportunity to meet top rail industry influencers and discuss topics relating to career development. The programme lasts for one year and, in that time, participants will have the opportunity to attend five Leadership Talks led by five different senior industry engineering managers. Talks will be delivered to groups of 10 and will last approximately 1 hour.

The WF scheme is open to all student, apprentice, and graduate members of the PWI, and comes with all our usual membership benefits for career starters, including significant discounts on tickets for the PWI's technical seminars and PWI textbooks, and access to our supportive community of like-minded rail engineers.

In addition, join the PWI between 01/07/22 and 30/10/22 to be entered into a competition to access exclusive Leadership Talks, where one lucky winner will be offered 10 one-to-one discussions with senior experienced engineering managers, plus a guided site visit to see railway engineering in action. The winner will also have opportunity to feature in our first Journal of 2023.

So, join the PWI today and kick start your career with #PWIWF!



THE PWI

THE INSTITUTION FOR RAIL
INFRASTRUCTURE ENGINEERING