

THE JOURNAL

OCTOBER 2019 VOL 137 PART 4



£15.00 (FREE FOR MEMBERS) 4 ISSUES ANNUALLY

Permanent Way Institution The Institution for Rail Infrastructure Engineers



A new design method for geogrid-stabilised trackbed

ANDREW LEES

PAGE 24

RAILWAY EARTHWORK
INSTABILITY, CHITTS HILL
EMBANKMENT



Page 26

COLLECTING ASSET DATA AND
GENERATING INTELLIGENCE



Page 38

WHAT IN THE WORLD?
HUDSON BAY RAILWAY



Page 62



With 3130 members, the PWI community has around
42,100 years of experience at our fingertips!

**That's 42,100 years of meetings, night shifts, problems,
successes, awards and courses!**

Tap into that experience for just £79 for a whole year and connect with our
ever expanding community.

Let's share and gain knowledge, experience and competency together. See you soon!

The PWI - the professional community for rail infrastructure engineering.

CONTENTS

TECHNICAL



- 14 From the Technical Director
- 16 Designs, applications, and performances of asphalt trackbeds in the United States
- 24 A new design method for geogrid-stabilised trackbed
- 26 Targeted asset management approach to mitigating railway earthwork instability - Chitts Hill Embankment, Colchester, Essex
- 38 Collecting asset data and generating intelligence
- 43 Speed restrictions, maximum safe speed and automatic train protection (ATP) speed supervision
- 50 Network Rail Summer Track Engineering Conference
- 58 International Conferences
- 62 What in the world...? Hudson Bay Railway

THE PWI



- 4 From the PWI team
- 8 PWI Contacts
- 9 PWI Fees
- 10 Our new members and fellows
- 76 Obituaries
- 78 PWI Annual General Meeting minutes
- 80 PWI Board meeting minutes
- 84 PWI shop
- 86 Section contacts
- 87 Meetings' calendar
- 88 Section activities
- 98 News

PROFESSIONAL DEVELOPMENT



- 53 Recognition and awards
- 68 Professional Development
- 70 What does a good PDP and CPD record look like?

COPY SUBMISSION DATES

January 2020 Vol 138 Part 1
DEADLINE - November 15 2019

April 2020 Vol 138 Part 2
DEADLINE - February 15 2020

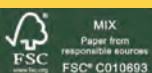
July 2020 Vol 138 Part 3
DEADLINE - May 15 2020

October 2020 Vol 138 Part 4
DEADLINE - August 15 2020

Please send to Kerrie Illsley,
Designer & Journal Production Editor
journaleditor@thepwi.org

ADVERTISING ENQUIRIES

Please send your enquiry to Kate Hatwell,
Operations Director
kate.hatwell@thepwi.org



THE PERMANENT WAY INSTITUTION

The Institution for Rail Infrastructure Engineers

5 Mount Crescent, Warley, Brentwood, Essex CM14 5DB
+44 1277 230 031 www.thepwi.org secretary@thepwi.org

PLEASE NOTE: Every care is taken in the preparation of this publication, but the PWI cannot be held responsible for the claims of contributors nor for the accuracy of the contents, or any consequence thereof.

ISSN 2057-2425 Publishing and layout by Permanent Way Institution



POSTER ENCLOSED

Don't forget to circulate this poster; why not pop it on your notice board at work?

Thanks very much!

From the PRESIDENT

It is only appropriate to begin this article by acknowledging the deaths of Michael Lewis and Gareth Delbridge, when they were struck by a train at Margam, near Port Talbot on 3 July 2019. Gareth was a PWI member of some 39 years standing and our thoughts and condolences go to both families and all those impacted by this tragic event.

Everyone who works in the rail industry has a responsibility towards safety and the PWI is no exception. We make our contribution through knowledge sharing and professional development activities which are applicable to all members, albeit at individual or corporate level. There is an expectation that safety should remain a career long focus and evidenced via CPD. In addition, our Professional Registration process requires all candidates to demonstrate their absolute commitment to the application and continuous improvement of staff and system safety.



Jack Scott receiving his certificate recognising his long service to the PWI

In my July contribution to the Journal, I stated that my areas of focus during my Presidential year would be two fold – individual membership and improving the Sections. Following discussion with the Section Secretaries, Vice Presidents and taking on board the output of the membership survey that was undertaken in 2017, I now believe the two elements are very closely intertwined with each other. We cannot underestimate the importance of our Sections and their relationship with individual members. The Sections are our life blood, sitting at the heart of the organisation with responsibility for delivering our vision and values. For some individual members the Sections provide the only link to the wider PWI organisation.

As part of the Section Secretaries meeting held on 12 July we spent a lot of time discussing the role of the Sections and how they need to adapt to remain relevant to their members. There were some great ideas from the group and the Section Secretaries agreed to reflect on the discussion over the Summer months and come back in October with a few ideas on how their individual Section can be strengthened. We were all agreed that there is an urgent need to attract more young people to take an active part in both the operation of the Sections (through the committee structure) and as audience members; this aspect will form part of the plan.

As my two original areas of focus have now become one, I have added another to my remit; I want to strengthen our relationships with our corporate members. When Steve Featherstone was President, he put a lot of effort into increasing the number of corporate members and I now want to continue that pursuit and make sure both parties are getting the best from the relationship.



We are very grateful to all our corporate members, their support both financial and in kind is invaluable to us; without it we would be unable to deliver the scope and quality of service that our members and the wider rail industry have come to expect. Myself, Stephen and Kate are making arrangements to visit each of our corporate members throughout the Autumn, to listen to their views on how the PWI performs in meeting their needs and where we need to improve. I hope we will then have comprehensive information which will help mould our future direction.

Finishing on a lighter note, I will make reference to a most enjoyable day out at the annual Inter-Section Quiz held on 15 June in Carlisle. Sections from Scotland and the North of England were represented at the event and were subjected to some very difficult and challenging questions drafted by Ian Ellis. The Glasgow team retained the trophy for another year, and it was also a wonderful opportunity to see Russell Kimber award Jack Scott with a certificate recognising his long service to the PWI.

Joan Heery
PRESIDENT

Permanent Way Institution
president@thepwi.org

From the NON-EXECUTIVE DIRECTORS

Your Board met on 18 July noting how hard the team had been working and that much had been delivered in the first two quarters of 2019; with particular reference to the fact that most of the team are part-time, the CEO noted how proud he was of the team and their performance, which was echoed by the President.

The CEO advised that he had recently visited four Sections, with the President visiting a number also. In addition, the CEO advised that following his attendance at the Engineering Council PEI meeting, early indications are that following the Hackett

Review and the ICE Plain Sight report the assurance of CPD is expected to become an increasing focus. This was a topic of discussion during the meeting and it will continue to be so over the coming few Board meetings.

The Board were informed that the financial position was aligned to the plan and that the year-end forecast remains on target and in line with expectations, however it should be noted that six months of the financial year still remain to be delivered. It was noted that year-to-date we had circa 38 professional registrants and that the

Membership Committee and Academic Panel were running well. In addition the Technical Director advised the Board on the emerging position of end point assessments associated with Apprenticeships, which was considered to be a positive position as the PWI continues to grow and develop. The Board noted that the annual Reviewers' Meeting is planned for November 2019 and furthermore, work is now progressing on opening up two additional routes to professional registration.

The Board also spent time discussing the social (continued on page 5)...

From the CHIEF EXECUTIVE OFFICER

Life at the PWI Executive has been hectic through the Spring and Summer. The Institution's stands at Railtex and Rail Live buzzed with lively conversations. It was good to see so many members (and friends) and hear their thoughts on how the Institution has changed and how it could develop in the future. It was also rewarding to meet many visitors who were less familiar with the Institution, and to have the opportunity to explain to them how the PWI is enhancing its capacity to support all those working in the field of railway infrastructure engineering. The Institution puts a lot of effort and resource into these industry events and it's important to acknowledge the part that plays in maintaining open and effective communication between the PWI and the wider industry.

Our presence at the London Section seminar in Spring, and at the later Network Rail Track Engineering Conference provided similar opportunities, albeit to smaller audiences. These events were also a great opportunity for our newer staff members, Liz Turner and Michelle Mabbett, to introduce themselves and their roles face-to-face. In a further move to strengthen the Institution's capability, two Technical Content Managers have been appointed, primarily to support our Technical Director, Brian Counter. I'm really pleased to welcome Andy Packham and Andy Steele to the team: their input will maintain and further enhance the technical content of our Journal, seminars, and website. Other tasks will include developing relationships between the Institution and Universities and Colleges active in the rail infrastructure sector; and developing technical information to support those delivering at the sharp end of asset maintenance and renewal.

The "Summer season" continued with two days in Birmingham, where meetings of the PWI's Membership Committee and Academic Panel (fundamental parts of our professional registration machinery) preceded the Summer Section Secretaries' meeting and the Institution's AGM. The July PWI Board meeting followed a week or so later. Preparing for and following up these events has, to put it mildly, kept the team on its toes.

In her "from the President" piece in this Journal, Joan Heery describes in more detail some of the matters discussed at the Section Secretaries' meeting. It was both encouraging and enjoyable to work with the Section Secretaries looking at how, as infrastructure engineering changes, Section activities should evolve to reflect the needs of members and potential members working in the industry.

At the AGM I was very pleased to welcome our new Deputy Presidents, John Edgley and Nick Millington. John and Nick both come from a permanent way background and have a wealth of railway infrastructure knowledge. Both also bring significant experience of operating at senior level within the UK rail industry. I have worked with both in the past and very much look forward to working with them again over the next four years.

Turning briefly to the international scene, on a recent business trip to Hong Kong I encountered the China Hong Kong Railway Institution. This organisation, which has objectives very similar to the PWI's, owes its origins in part to the previous Hong Kong Section of the PWI. Recent railway developments in both Hong Kong and China have been spectacular and I believe there is considerable scope for sharing experience and learning. I hope to make formal contact with CHKRI in the Autumn.

The President has already referred to the tragic event at Margam in which two Network Rail infrastructure staff were killed. Following on, all too closely, from last Autumn's track-worker death at Stoats Nest Junction near Purley, these fatalities highlight the fragility of the safe working environment on-track. As I write, I learn that our new Deputy President, Nick Millington has been seconded by Network Rail to lead the National Track Worker Safety Task Force for the Rail Industry. Nick will receive goodwill and practical support from PWI members everywhere and from many others in our industry: I'm sure his and others' efforts will drive safer outcomes for infrastructure workers.

It is though, an unfortunate truth that left to their own devices, human beings, no matter how well-trained, well-drilled, and



conscientious, will occasionally make mistakes. We can see via the industry's "near miss" statistics some clear evidence of that continuing human-error rate. Looking more widely at railway operations, the genius of railway engineers (including many PWI members) over many decades, has been to put in place engineered systems and components which either do not permit unsafe situations to arise, or which catch potentially unsafe errors and prevent them leading to dangerous outcomes. Such philosophies have contributed to making rail travel in the UK one of, if not the, safest form of passenger transport.

It is heartening to see that Network Rail is, in the wake of the fatalities, dedicating significant resource to improving the robustness of the safe on-track environment. And given the general improvements in industrial and transport safety made over the last quarter century, there must be a reasonable expectation that on-track working can be made safer in ways that take account of potential human-error. By harnessing 21st century technology and inventiveness, and particularly the opportunities presented by adoption of the European Rail Traffic Management System, surely such improvements can be delivered at a price that is significantly more "affordable" than events like those at Margam and Stoats Nest Junction?

Stephen Barber
CEO

Permanent Way Institution
stephen.barber@thepwi.org

...(continued from page 4) media and digital communications strategy, which is being developed at the present time and is expected to be considered further at future Board meetings.

Membership Subscriptions and Corporate Membership levels were discussed along with Professional Registration Application Fees, which were all agreed.

A review of the Risks and Opportunities Register was undertaken and various aspects and actions were agreed as a way forward. Further discussions took place on the strategy development, including details of the website and virtual presence of the PWI, and aspects of the technical knowledge hub and the competency management system – all of which are topics that require various degrees of

strategy development over the coming months and years. All proposed Fellowship approvals were endorsed.

John Dutton
NON EXECUTIVE DIRECTOR
Permanent Way Institution
jcdutton@btinternet.com

From the MARKETING MANAGER

A digital age for the PWI

As we enter quarter three at the PWI, a quieter time in terms of meetings and events, I have been able to step more into my analysis role and really get stuck into our strategies for the future of the Institution. As a Marketeer, I specialise in brand development and growth hacking, which predominantly involves reducing more traditional forms of communications such as print and press, and increasing the use of digital communications instead.

The benefits can be enjoyed by all. Digital communications are faster, more up-to-date and on-point than printed equivalents, and can be more efficiently mass produced to reach a wider audience. Digital communications also come with far greater trackable data analytics, so that campaigns can be monitored, improved and intelligently finetuned in order to better serve different stakeholder groups.

While the PWI have been utilising online communications to successfully connect with our network for many years, collectively as an Institution there is much more that can be achieved to strengthen our engagement with members, friends and the broader rail industry using modern tools. Embracing this approach, the central team is now working hard to embrace moving the Institution into a new digital era.

A new website is in the process of being sourced; a major project led by Operations Director Kate Hatwell that will provide a more advanced, intuitive and resourceful online experience for the PWI's website visitors. This includes redeveloping the current Technical Hub, which our new Technical Content Managers Andy Packham and Andy Steele will be supporting. The aim is to streamline our technical data, improve its searchability and accessibility, and ensure that members are able to fully leverage the huge pool of knowledge held by the Institution, whether by producing

more video resources and less printed books, or creating interactive online learning modules. Alongside this, myself and Kerrie Illsley are busy enhancing the PWI's social media activities. We recently showcased our plans at July's Section Secretaries meeting, where we talked about general marketing and encouraged the Section Secretaries to "think digital" by further exploring the world of apps such as Facebook, Twitter, Instagram, LinkedIn and WhatsApp.

Kerrie and I will be hosting a voluntary online workshop later this year that will be available to PWI staff and members, offering to support our community on how to utilise the power of social media with confidence and success. This idea was met with enthusiasm when brought to the Board, Executive and Section Secretaries alike, demonstrating the overall hunger for this type of learning within the Institution.

I am also working on a major "mapping" project that will illustrate the PWI's physical network of staff, members, friends and other stakeholders within the rail industry, so that a more focussed communications strategy, including email campaigns, can be established for each group, in order to strengthen engagement and ultimately build our membership base. This involves the sourcing of a sophisticated data interrogation platform called Tableau that will provide a deeper level of analytics.

In the meantime, Kerrie has transitioned effortlessly into her new role as Journal Editor where she is exploring options to deliver a more interactive, digital version of the Journal alongside its traditional printed copy, so that both options are available to members. Kerrie is also working on increasing our use of infographics that can be shared easily online to showcase our huge range of member benefits. Internally, the team are exploring "virtual office" platforms such as Yammer and Microsoft Teams that will allow for faster, more streamlined sharing of updates and



documents between team members. Other efforts include the "thinking green" policy introduced earlier this year, which aims to cut back on printing and other tangible assets, opting for digital and environmentally friendly alternatives wherever possible. The PWI apple giveaways at the last few major events were part of this and went down a treat with exhibitors as an alternative to branded plastic freebies. The overall aim here is to grow together online. While it is important to continue to provide traditional communications, the world of digital engagement is second-nature to those who are entering the rail industry at the start of their careers today, and it is essential for the future of our Institution that we cater for their language and behaviours too.

The PWI has a proud history of supplying unrivalled knowledge and expertise to the rail industry, and our goal is to continue to provide that wealth of knowledge to professionals on their career journey. To do this, we must move with the times, together as an Institution, and be open to learning and pioneering new technologies - which is, after all, at the heart of what we do as engineers.

Michelle Mabbett
MARKETING & COMMUNICATIONS
MANAGER
 Permanent Way Institution
michelle.mabbett@thepwi.org

From the PRODUCTION EDITOR

Thank you all for your support in 2019 in supplying great articles that continue to raise the profile of the PWI. This journal is for you, our valued members. Please keep sending in your fantastic articles, as every issue offers a unique contribution to rail education and sharing best practice amongst rail engineers.

Articles on a diverse range of topics are always welcome: new techniques, methods and products, innovation, and lessons learned from UK and international projects. If you are unsure whether a topic would be of interest, please send me an abstract

and I'll be happy to explore its potential with you. I'd also love to hear about your news and successes, both personal and professional, so please get in touch if you have a story to share for 2020.

Here's to a great Autumn with few #leavesontheline

Kerrie Illsley
JOURNAL PRODUCTION EDITOR,
DESIGNER & MARKETING ASSISTANT
 Permanent Way Institution
journaleditor@thepwi.org





Corporate Membership with the PWI



A strategic partnership designed to benefit the rail infrastructure industry.

We welcome corporate members from all sectors of the rail industry.

Corporate members will be fully involved in the development of the PWI, ensuring that its products and services meet the needs of the rail industry for technical expertise.

Corporate members benefit from:

- Reserved places at our technical seminars
- Quarterly technical board meetings presenting a unique opportunity to discuss issues and challenges that face the whole industry
- Free copies of The Journal and preferential advertising rates
- Improving technical assurance in the industry by supporting the PWI's professional registration initiative for rail infrastructure engineers.

Further information www.thepwi.org
MEMBERSHIP SERVICES TEAM
secretary@thepwi.org 01277 230031

Corporate membership fees can be found on page 9

PWI CONTACTS

REGISTERED OFFICE	The Permanent Way Institution	5 Mount Crescent, Warley, Brentwood, Essex CM14 5DB	
PRESIDENT PAST PRESIDENT DEPUTY PRESIDENT DEPUTY PRESIDENT	Joan Heery Gren Edwards John Edgley Nick Millington	president@thepwi.org gren@edwardsglobal.co.uk john.edgley@networkrail.co.uk nick.millington@networkrail.co.uk	
VICE PRESIDENTS ENGLAND ENGLAND ENGLAND ENGLAND SCOTLAND IRELAND	Paul Ebbutt Andy Packham Phil Kirkland Roy Hickman Mark Taylor Pat Watchorn	paulebbutt1@gmail.com andrew.packham62@live.com phil.kirkland@nexus.org.uk royhickman@live.co.uk mark.taylor5@networkrail.co.uk pat.watchorn@irishrail.ie	
CHIEF EXECUTIVE OFFICER TECHNICAL DIRECTOR OPERATIONS DIRECTOR NON-EXECUTIVE DIRECTORS	Stephen Barber Brian Counter Kate Hatwell Andy Cooper John Dutton Colin Wheeler Andy Tappern	stephen.barber@thepwi.org technicaldirector@thepwi.org kate.hatwell@thepwi.org mrandrewjcooper@gmail.com jcdutton@btinternet.com cj.wheeler@btinternet.com andy.tappern@networkrail.co.uk	
MEMBERSHIP SECRETARY REGISTRATION MANAGER MARKETING MANAGER JOURNAL PUBLISHING EDITOR	Sara Green Elizabeth Turner Michelle Mabbett Kerrie Illsley	secretary@thepwi.org profeng@thepwi.org michelle.mabbett@thepwi.org journaleditor@thepwi.org	
TECHNICAL CONTENT MANAGERS	Andy Packham Andy Steele	andy.packham@thepwi.org andy.steele@thepwi.org	
PROFESSIONAL DEVELOPMENT OFFICERS London, South East, South West, South Wales Midlands, North East, North West, Scotland	Paul Ebbutt Brian Parkinson	developmentofficersouth@thepwi.org developmentofficernorth@thepwi.org	07887 628298 07876 578905
SECTION SECRETARIES BIRMINGHAM CHESHIRE & NORTH WALES CROYDON & BRIGHTON EDINBURGH GLASGOW IRISH LANCASTER, BARROW & CARLISLE LONDON MANCHESTER & LIVERPOOL MILTON KEYNES NORTH EAST NOTTINGHAM & DERBY SOUTH & WEST WALES THAMES VALLEY WESSEX WEST OF ENGLAND WEST YORKSHIRE YORK INTERNATIONAL	Richard Quigley & Timothy Atkinson Lynne Garner & Alastair Roberts Colin White Bob Gardiner Jim Watson Joe Walsh Philip Benzie Thomas Utley Richard Wells Kevin Thurlow Phil Kirkland John Garlick Andrew Wilson Richard Antliff Kenneth Newell Steve Pearson Martin Wooff Gareth Dennis PWI Secretary	richard.quigley@networkrail.co.uk timothy.atkinson@networkrail.co.uk lynnegarner79@icloud.com a.roberts@aegis-cert.co.uk c.white@chaucerrail.co.uk bobrail65@gmail.com glasgow@thepwi.org pwiirishsection@gmail.com p.benzie@yahoo.co.uk thomasutley@tfl.gov.uk richard.wells@tonygee.com kevin.thurlow@networkrail.co.uk phil.kirkland@nexus.org.uk jgees01@btinternet.com southandwestwales@thepwi.org richard.antliff@gmail.com kenneth.newell@btinternet.com steve.pearson@networkrail.co.uk pwi@daelnet.co.uk york@thepwi.org secretary@thepwi.org	07715 132267 07719 993516 07494 753652 07768 210480 07845 316042 07771 828811 07590 929107 00 353 872075688 01704 896924 07885 732231 07817 302652 07802 890299 0191 2033162 07532 071727 07974 809639 07804 329497 07771 668044 07771672603 07487 652622 07951 918236 +4412 77230031
INTERNATIONAL CONTACTS BENGALURU MALAYSIA NEW SOUTH WALES QUEENSLAND SOUTH AFRICA SOUTH AUSTRALIA	Srinagesh Rao Mr K Sukumaran Peter Boonstra Robin Stevens Callie Herselman Mark Pronk	sringagesh.rao@arcadis.com sukumaran@ktmb.com.my secretary@pwinsw.org.au robin.stevens@qr.com.au callie.herselman@transnet.net mark.pronk@sa.gov.au	

PWI FEES

You can pay your subscription by Direct Debit through a UK bank account and this can be set up on our website when you renew your membership.

You can also pay your subscription by credit / debit card via our website or by phoning the Registered Office on: (+44) 01277 230031 (option 1)

We can accept BACS payments to the PWI bank account. **(Please note the sort code change)**
Account number 50712051
Sort code 20 07 89

From overseas:
IBAN GB05 BUKB 2007 8950 7120 51
SWIFTBIC – BUKGBG22

or a European account:
IBAN GB78 BUKB 2007 8989 4214 00
SWIFTBIC - BUKGBG22

Please ensure that you add your full name and / or membership number as a reference if making a bank transfer and send an email to the Secretary.

If PWI membership is directly relevant to your employment and you pay your own subscription, you can claim tax relief on that subscription.

You can find more detail at: <https://www.gov.uk/government/publications/professional-bodies-approved-for-tax-relief-list-3>. Unfortunately, you must organise this yourself, but it can significantly reduce the cost to you, whilst the PWI still benefits from the full amount.

Members aged 80 years or over do not pay subscriptions, so please notify the Secretary if you qualify as not all longer serving members' dates of birth are known. Rates of subscription payable by members of the Overseas Sections are fixed by, and payable to, the Section concerned. The NPS rate reflects the charges that are now being made to the PWI by companies collecting the subscriptions. The member subscription is £1.90 per week (£98.80 a year) and the Fellow subscription is £2.55 per week (£132.60 a year).

2020 INDIVIDUAL MEMBERSHIP ANNUAL SUBSCRIPTIONS

MEMBER GRADES

Apprentice, Student	Free with e-Journal (£20.00 with printed Journal)
---------------------	---

Member	£82.00
--------	--------

Member (65 and a half or older at 01.01.20)	£33.00
---	--------

PWI EngTech Member*	£82.00
---------------------	--------

PWI IEng / CEng Member*	£131.00
-------------------------	---------

FELLOW GRADES

Fellow	£110.00
--------	---------

Fellow (65 and a half or older at 01.01.20)	£43.00
---	--------

PWI EngTech Fellow*	£110.00
---------------------	---------

PWI IEng / CEng Fellow*	£175.00
-------------------------	---------

* 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.

2020 CORPORATE MEMBERSHIP ANNUAL SUBSCRIPTIONS

Small enterprise (Turnover up to £17.5m)	£2,140
--	--------

Medium enterprise (Turnover £17.5m - £200m)	£5,350
---	--------

Large enterprise (Turnover above £200m)	£10,700
---	---------

2020 PROFESSIONAL REGISTRATION FEES

	EngTech	IEng	CEng
Application Fee - New Registrant*	£60	£190	£190

Application Fee - Dual Membership	£30	£70	£70
-----------------------------------	-----	-----	-----

Annual Fees once you are professionally registered through the PWI

2020 Annual EngCouncil Fee**	£19.90	£34.70	£40.90
------------------------------	--------	--------	--------

Professionally Registered Member	£82	£131	£131
----------------------------------	-----	------	------

Professionally Registered Fellow	£110	£175	£175
----------------------------------	------	------	------

* Includes Engineering Council Registration Entry fee

** The annual Engineering Council Registration fee will be collected at the same time as your PWI subscription and will be paid to the Engineering Council on your behalf.

Our new MEMBERS & FELLOWS

Welcome and congratulations

PROFESSIONALLY REGISTERED PWI MEMBERS

Jordan Edwards - Engineering Technician
 Lee Ratchford - Engineering Technician
 Glenn Wilson - Engineering Technician
 Franklin Dokwani - Engineering Technician
 Steve Eastment - Engineering Technician
 Mark Stowell - Incorporated Engineer
 Mike Ashton - Chartered Engineer
 Alastair Hume - Chartered Engineer
 Thomas Flowers - Chartered Engineer
 Jenny Webb - Chartered Engineer
 Shaun Cartledge - Chartered Engineer (Dual)
 Benjamin Haywood - Chartered Engineer (Dual)

FELLOWSHIPS

Dr Mohamed Wehbi - Birmingham
 Paul Mountford - Milton Keynes
 Kevin Hope - Nottingham & Derby
 Tara Scott-Turner - Milton Keynes
 Gareth Evans - Milton Keynes

NEW MEMBERS

We would like to offer a warm welcome to the following people, who have become members of the Permanent Way Institution. You are encouraged to look at the website and contribute to our forums on LinkedIn and the website. If you have any questions, or think you've been missed off the list, our Membership Team will be more than happy to help. They can be contacted either by email at secretary@thepwi.org or by telephone on 01277 230031 (option 1).

Bengaluru

Arun Nittur Shivakumaraswamy

Birmingham

Alkesh Patel, Katerina Kyrkou, Neil Sunner, Daniel Hocknell, Stuart Orange, James Rusbridge, Gary Smith, Mel Toy, Lee Fitzgerald, Tajinder Lakha, Usman Tasiu, Abdurrahman, Sean Leach

Croydon & Brighton

Azu Okoro

Edinburgh

Ahmet Furkan Esen

Glasgow

Sean Mayle, Will Currie, Gregor Bell, Daniel Tetstall

Lancaster, Barrow & Carlisle

Paul Hargreaves, John Collinson, Arran Lennie

London

Steven Symonds, David Adedeji, Regan Lewis, Robert Daffern, Ross Briddon, Simon Edmundson, Jesse Ako, John Prince Johnson, Reuben Mburu, Antonio Carr, Roger Rhoden, Tanveer Ahmed, Chris Hammerton, Benjamin Tarten

Manchester & Liverpool

John Mosuela, Ryan Hill, Younas Mahmood, Steve Crighton

Milton Keynes

Joe Jackson, Sana Wajid, Paul Tubby

North East

Elliott Johnson

Cheshire & North Wales

David Lang, Julian Carter, Michael Addison

Nottingham & Derby

Ian Rawbon, Ian Ambrose, Tom Exton

South & West Wales

James Stevens, Daniel Ingledew

Thames Valley

Laurence Stant, Richard Taylor

Wessex

Robert Sherrin

West of England

Michael James, Garry Keenor, Phoebe Brightmore

West Yorkshire

Brett Hawke, Jackie Butterfield, Andrew Thorpe

York

Ryan Gill, David White, Ian Jenkinson, Tom Rogers, Dane Crompton, Jamie Ferguson, Gary Thompson

Just a little boast about our seminars

Excellent thought-provoking presentations which generated good discussion and gave me things to take back to my role.

Having been to the last five of these seminars, I thought the speakers this time were the best yet, and the content valuable too. Well done!

Data issues in the industry are not new and it was refreshing to see that some effort is being made to improve the situation.

The speakers all had different styles and presented different aspects on the same subject. Good to keep to half hour presentation time. Really enjoyed the key note speech.

Outstanding level of knowledge and experience and the enthusiasm, clarity and dedication of the speakers.

Interesting and diverse subject topics presented professionally by all of the speakers.

Great Q&A sessions with a good rapport between delegates and speakers.

As always at PWI seminars - brilliant networking opportunities and knowledge exchange.

Excellent timekeeping and efficient organisation.

This is my first PWI engineering conference and I really enjoyed the whole experience.

Is your book shelf up to date?

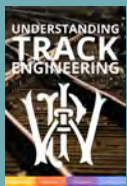
NEW
REVISED
EDITION

Switch & Crossing Maintenance

New revised edition. Published 2018. By Dr D L Cope and J B Ellis, sets out the Network Rail preferred methods of carrying out maintenance of switches and crossings, including RT60 layouts.

An essential document for those involved in switch and crossing maintenance. 400+ pages

Members: £32.00 / Non-members: £54.00



Buy online www.thepwi.org/shop/



Training with the PWI

Professionally recognised track engineering awards

PWI training started over 100 years ago and has more recently been providing high level technical training for engineers and professionals operating at all levels. The courses are designed to develop skills and knowledge in all aspects of track repairs, renewals and projects and can help you on your journey to professional registration.

The courses are delivered by industry experts and use the most up to date standards and materials. Awards are made by the PWI for successful completion of written assessments. These comprise Certificates and a Diploma, which has been professionally validated at University level.

COURSE DATES

PWI TRACK ENGINEERING DIPLOMA

MODULE 1	20 - 23 January 2020 8 - 11 June 2020
MODULE 2	20 - 23 April 2020 21 - 24 September 2020
MODULE 3	11 - 14 May 2020 9 - 12 November 2020

Each module costs: £595 / Accommodation cost: £225

TRACK RENEWAL PLANNING & DRAINAGE

Part A	15 - 18 June 2020
Part B	29 June - 2 July 2020

Course cost: £995 / Accommodation cost: £450

S&C REFURBISHMENT

Part A	6 - 8 October 2020
Part B	20 - 22 October 2020

Course cost: £845 / Accommodation cost: £300

All courses are held at the Derby Conference Centre (London Road, Alvaston, Derby, DE24 8UX). Prices include all training materials & lunch. Accommodation includes evening meal, single room at the venue & breakfast. All prices are exclusive of VAT.

Further information and booking
www.thepwi.org

secretary@thepwi.org 01277 230031 option 1
technicaldirector@thepwi.org



Permanent Way
Institution

PWI TRACK ENGINEERING DIPLOMA

The aim of the programme is to give delegates an understanding of the principles, theory and practice of track engineering in the UK. It is comprised of three consecutive modules and involves 100 hours of taught study all mapped to HE Level 6. Upon successful completion of all three modular assessments, candidates will be awarded the PWI Diploma in Track Engineering.

These courses are aimed both at newly qualified and experienced engineers, and will give delegates the knowledge and skills needed for professionals in track engineering.

MODULE 1: TRACK MAINTENANCE

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

Focuses upon track design for projects and enhancements. Develops 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, through design case studies and exercises.

MODULE 3: ADVANCED TRACK ASSET ENGINEERING AND RENEWALS

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.

PWI TRACK RENEWAL, PLANNING AND DRAINAGE TRAINING COURSE

Delegates on this two-part course will gain an understanding of track renewal engineering for Plain Line and S&C

- Develop the knowledge, skills and behaviours that lead to efficient, safe and productive track renewals
- Review the various types of plant and methodologies for work execution and also how to plan a track renewal effectively
- Review how to undertake the seven key stages of any renewal
- Understand the importance of drainage and how to design and install systems
- Develop an understanding of the importance of track drainage in optimising the life cycle of the track structure and the trackbed
- Improve engineering knowledge of how to survey, design, install and refurbish new or existing drainage systems efficiently and safely

Delegates will have to pass a formal assessment at the end of the course and will be awarded a PWI certificate in Track Renewal Planning and Drainage on successful completion.

PWI S&C REFURBISHMENT TRAINING COURSE

Delegates on this two-part 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.

From the TECHNICAL DIRECTOR

OUT AND ABOUT

I finished the last Journal talking about flooding in June and a review of the worldwide increase in climatic events and the importance of railway preparedness. Just after Edinburgh in early July, where I presented my paper on Climate Change and track maintenance, the UK beat its all-time temperature record with 38.7°C in Cambridge.

June and July were full of PWI activities including Rail Live, the Section Secretaries' meeting and AGM in Birmingham, a very lively Network Rail Track Conference and a Technical Board in London.

CONFERENCES AND EVENTS

Rail Live in Warwickshire was a great event for the PWI; make sure you go next year, the dates are 17-18 June 2020. It was good to meet so many members and see amazing new plant, systems and materials.

We focussed our attention on the two-day event with two stands, one kindly hosted by Bridgeway Consulting who also helped with PWI stand transport (**image 1**). Hopefully, we will have recruited new members but we made a serious impact and supported our corporate members by showing them the major part we play in the rail industry.



Image 1: Mark Lindahl (Bridgeway) and Tony Morgani (Murphy) flying the PWI flag at Rail Live

At Edinburgh, in early July, the PWI was well represented at REC2019, the biennial international rail infrastructure conference organised by Professor Mike Forde. We had a stand kindly manned by Russell and Glen from the local Section. I chaired two sessions and presented a paper on the climate change impact of track maintenance. There were many excellent papers from Universities and companies some of whom were PWI corporate members. We have partnered with this conference for some time and it is a good source of papers for the Journal.

I was pleased to formally thank Edna Forde (**image 2**), the REC2019 conference director, for her contribution to the PWI where she has promoted the Institution and we will continue to work as partners for marketing. There was a large amount of interest from the international rail community. There were some eminent speakers from all over the world including China. **Image 3** is a slide from Professor Bian showing the massive high speed network in China.

The Network Rail Track Engineering Conference, (NRTEC), was held in July at the IET in London and was well supported with some excellent papers and good publicity with a speech from Joan Heery, PWI President. Steve Featherstone presented PWI Registration and Diploma awards.

It was good to meet up and chat with new and old members and colleagues at our latest national events. We have held three excellent PWI seminars and had a major presence this year at Railtex and Rail Live. We have one more event to look forward to soon; the prestigious High Speed Rail seminar in the Great Hall at Birmingham University. Our local Section meetings start soon so please try to find time to participate in and meet the "PWI Community".

PROFESSIONAL REGISTRATION

We have registered 41 engineers so far this year and continue to process applications. Well done to those who were successful in the latest round of reviews. Their names are published in the Journal. The next reviews are in the Winter, so get on with it! You know who you are! Please ask for help and support.

Progress is being made on our latest new routes. The pilot for the Experiential Learning Route has started where degree holders or pre-1999 HNC/D holders can progress to CEng with a short report. The other route now fully open allows those with the PWI Track Engineering Diploma and an HND or Foundation degree to progress to IEng.

The message that professional qualifications "matter" is getting out and about and some companies are making them mandatory for key "safety of line" posts. We still wish to see many more people registered who I know are



"entitled" through their experience to have these qualifications. Competence frameworks are mapped against the Engineering Council framework.

APPRENTICE / GRADUATE TRAINING AND EDUCATION

It was good to see the PWI Diploma being awarded in July at the Network Rail Track Engineering Conference at Savoy Place in London. We are looking forward to welcoming delegates back in October and November to our PWI Track Engineering Diploma course to complete modules two and three. The PWI S&C Refurbishment course is also taking place during this period and has a good take up from across the country.

In 2020 our module 1 starts again in Derby from 20 to 23 January with modules two and three taking place in April and May, (see **page 12** in this Journal).

A number of Universities and Colleges have taken railway engineers onto their civil engineering degree apprenticeships starting in Autumn 2019. We have had meetings with some about 2020 starts for the rail specific ones; I will keep you informed in future Journals.

The Colas Level 3 Rail Technician apprentices have now submitted their paperwork for EngTech to the PWI. We look forward to processing these and extending this service to other companies particularly Network Rail and TfL.

We are very grateful for our volunteer PWI professional reviewers who do a great job in progressing members to Chartered Engineer, Incorporated Engineer and Engineering Technician. We will be holding a reviewer training session and the PWI annual reviewer meeting on Thursday 14 November in London.

We are currently working towards a 2020 start as a full member of the JBM (Joint Board of Moderators) who jointly accredit degrees in civil, structural and highway engineering. This will enhance our standing in UK Universities and raise our profile significantly.

TECHNICAL INFORMATION SHARING - JOURNAL, TEXT BOOKS AND HUB

We have now appointed two engineers for the new PWI post of Technical Content Manager who will job share. They are Andy Packham and Andy Steele and we will get them to introduce themselves in the next Journal. Their role is to assist me in sourcing technical

articles for the Journal and presenters for PWI Seminars. The whole subject of sharing knowledge through an updated website and hub will be a major part of their remit too.

I am also looking to investigate a new way of providing technical information through the website as it seems purchasing formal textbooks is becoming increasingly less popular.

PWI TECHNICAL BOARD

The last meeting was 16 July hosted kindly by AECOM in London with presentations from ORR, NSAR and the University of East London. The whole aspect of skill shortages and training provoked some lively debate amongst the PWI corporate members.

We promised to continue working with and persuading Universities to do more railway engineering on their courses. The next meeting is in October with Quattro Plant hosting at their Essex depot.

AND FINALLY.....

Weather continues to dominate our railway performance and new records of extremes are regularly being made. The wires came down and speeds were imposed all over the country in July and we had major flooding on the West Coast Main Line in August.

In my Edinburgh paper, I focussed upon temperatures in the UK and their impact on track maintenance. What a surprise (?) to find that on 25th July 2019, we would have our highest recorded temperature of 38.7°C in Cambridge, beating the August 2013 high of 38.5°C in Kent.

INTERESTING UK WEATHER FACTS:

July 2019 a high of 38.7°C Cambridge
Feb 2018 a low of -14.5°C Kent
Feb 1995 a low of -27°C Scotland
Feb 2019 a high of 20.6°C Scotland

Let's just get a bit technical to finish. There are always some Eureka moments when we have our conferences and I was very interested in some work being done by Brian Whitney from Network Rail. He indicated that we have reduced rail breaks significantly through better inspection and monitoring to establish defects but had not fully investigated long term fatigue from bending.

Network Rail have a target of not more than 50 broken rails by 2030. The current thoughts are that when rail has worked for over 30 years in a testing environment, perhaps it is reaching the end of its full serviceable fatigue life. This could mean that it is getting to the point where it is becoming unpredictable and should be changed or cascaded.

Please see **images 4 and 5** for some information we share on the PWI courses.

Brian Counter
TECHNICAL DIRECTOR
Permanent Way Institution
technicaldirector@thepwi.org



Image 2: Brian Counter presenting the PWI award for outstanding technical contribution to Edna Forde at the Edinburgh Railway Engineering Conference, on the left are Mike Forde and Niall Fagan

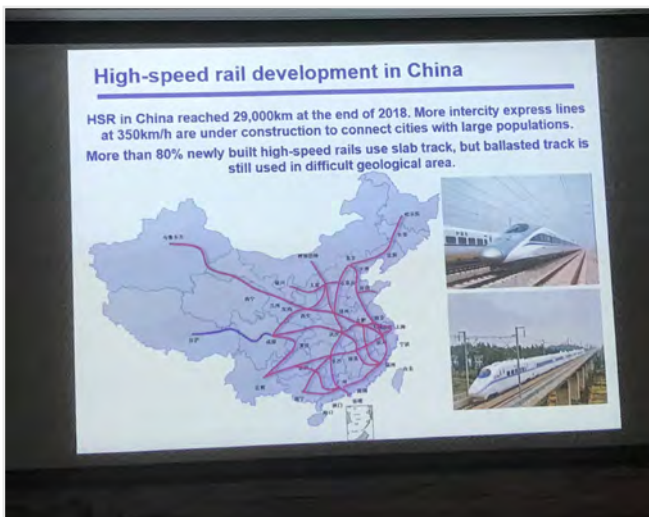


Image 3: REC2019 conference - a slide from Professor Bian showing the massive high speed network in China

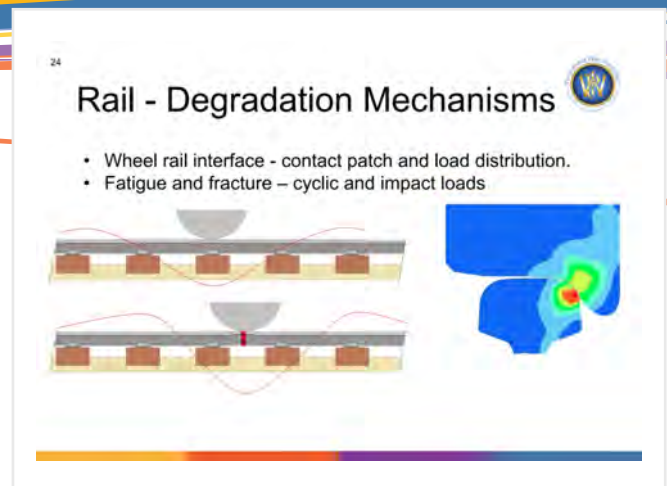


Image 4: PWI Course material rails and rail welding prepared by Richard Johnson (copyright PWI)

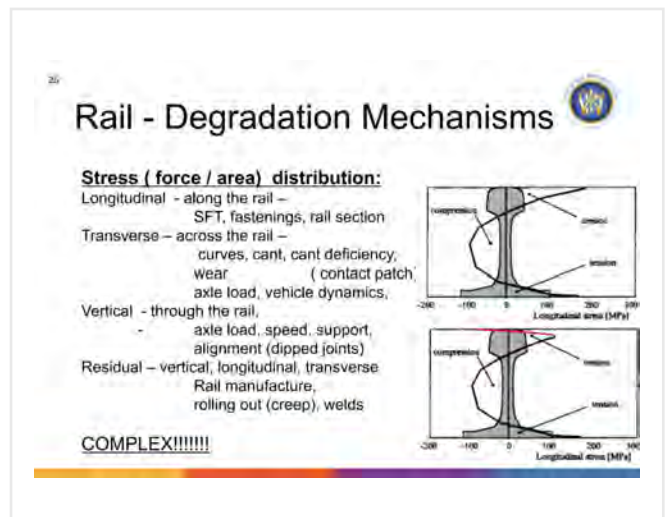


Image 5: PWI Course material rails and rail welding prepared by Richard Johnson (copyright PWI)

Designs, applications, and performances of asphalt trackbeds in the United States

AUTHOR:

Jerry G. Rose
Professor of Civil Engineering
University of Kentucky

INTRODUCTION

Railway trackbed design and construction techniques have steadily evolved throughout the world from the initial 1830's designs; consisting of two parallel rails, consisting of wood or wood with metal straps, positioned on widely spaced wood cross ties laid on the natural ground. It soon became obvious that the quality of the support under the ties should be improved.

Natural stone aggregate (later known as ballast) was deemed necessary and desired for placement around and under the ties to restrain excessive horizontal and vertical movements and displacements; thereby providing an improved track structure. Thus, the classic All-Granular support trackbed was defined; also termed the 'ballasted' trackbed.

As wheel loads, train frequencies and speeds further increased, attention was given to specifying larger rail size and improved material quality, selecting larger size ties spaced closer and specifying a certain quality and width/thickness of ballast around and below the ties. The ultimate objectives were to reduce the imposed loadings to within the

bearing capacity of the natural subgrade material, thereby providing uniformly strong support. Drainage was realised early-on as being very important, since most subgrade materials tended to lose considerable load-carrying capacity when wet or saturated. Thus, draining surface water from within the track and directing water away from the track as expeditiously as possible were prime objectives then and remain so today.

A further refinement of the support structure was the introduction of a specified thickness of a granular 'subballast' material between the ballast and subgrade. Typically, this was a locally available aggregate material that had smaller top size than typical ballast and contained considerably more fine-sized particles. It would compact to a very low void content with very low permeability and was similar to the aggregate base material widely used for highway construction.

Its main purposes were and still are to provide support for the ballast, further distribute the loadings and provide a certain level of waterproofing for the underlying subgrade. This improves the quality and load-carrying capability of the track structure. This all-granular trackbed design has no additional

cementing or binding materials incorporated in the various support materials and layers.

The classic investigation of the factors affecting the design of track structures and the resultant guidelines emanating from the study were initially published in seven Bulletins of the AREA- ASCE Special Committee on Stresses in Railroad Track between 1918 and 1940. The study was under the Chairmanship of the noted University of Illinois Professor A. N. Talbot. These reprinted reports covering the 25 year long study were re-published as a collection in 1980 by the American Railway Engineering Association, (AREA 1980).

The reports, largely based on in-track experimental tests, were reasonably current for the time period. Mechanistic designs applicable for assessing a variety of trackbed designs have been developed during the past few years and currently have limited but increasing utilisation.

In recent years, U.S. freight railway traffic volumes, revenue ton-miles, axle loadings and tonnages have grown to unprecedented levels. Levels of service expected by customers have risen as well. This has prompted a resurgence of research to evaluate new technologies to provide higher quality and longer lasting track and support structures. Numerous capacity improvement projects are already in service and many more are being planned, designed, and constructed to meet the increasing demands for efficient freight transport. These trends are expected to increase significantly as more reliance is placed on economical, fuel-efficient and environmentally-friendly railway transportation.

In addition, increasing emphasis is being placed on expanding rail passenger lines within commuting distances to the larger urban areas of the U.S. Many of these projects are ongoing. However, the expected concentration of efforts will be providing rapid-rail, (high speed), passenger services radiating out from the larger metro areas to connect cities within approximately 300 km, (185 mi). This noble ambition will require large investments in new and upgraded rail lines designed and constructed to the highest structural and geometric standards. This is

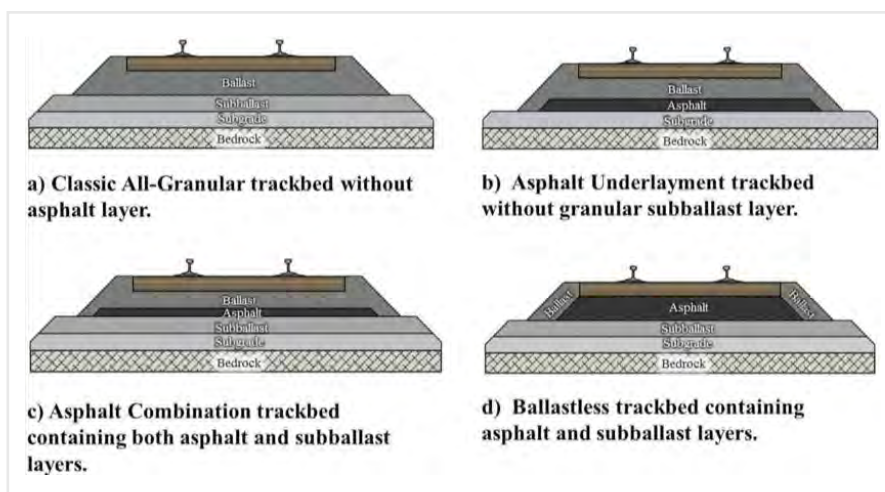


Figure 1: a) Classic All-Granular trackbed without asphalt layer, b) Asphalt Underlayment trackbed, c) Asphalt Combination trackbed, and d) Ballastless trackbed containing asphalt and subballast layers.



Figure 2: Core drilling asphalt, subballast, and subgrade on a CSX new bridge approach at Bridgeport, Alabama (top) and on the Burlington Northern Santa Fe Railroad (BNSF) Southern Transcon in Oklahoma (bottom).

necessary to provide a system that is capable of accommodating high speeds while achieving safe operations and acceptable passenger comfort levels.

In the early 1980s, several U.S. railroad companies saw the impending need for higher quality and longer lasting track and support structures. The railway industry consulted with the asphalt paving industry to develop designs and applications for using hot-mix asphalt within the track structure to replace a portion of the conventional granular material^{7&8}.

The initial emphasis was primarily on heavy-tonnage freight railroads, employing asphalt for trackbed maintenance applications and solving instability problems in existing trackbeds. These trackbed solutions included selectively installing a layer of asphalt during the rehabilitation of turnouts, railroad crossings, bridge approaches, defect detectors, hump tracks, tunnel floors and approaches, highway crossings and loading facilities where conventional trackbed designs and support structures had not performed satisfactorily. These asphalt maintenance installations currently number in the thousands. Based on its proven performance as a maintenance solution, asphalt is now specifically specified or selectively considered as an option on new mainline tracks, yards and terminal construction in the U.S.

Similar cooperative efforts in several European and Asian countries have been primarily directed at high-speed passenger lines. This involves the construction of new segments or complete rail lines using asphalt. (frequently termed bituminous), trackbeds. The international engineering and construction approaches are relevant in the U.S. today because it is believed that the next large expansion of the U.S. rail system will be for the construction of new high-speed passenger lines. This is in addition to the continued improvements to improve capacities of the heavy-tonnage freight lines. Both types of rail lines require excellent quality trackbeds to adequately support the loads and maintain required geometric standards.

ASPHALT TRACKBED TECHNOLOGY

Figure 1a depicts the classic or traditional 'All-Granular' trackbed design. For high type trackbeds the quality of the materials and associated dimensions of the materials and layers are specifically selected and specified. It is assumed that proper attention is given to providing surface drainage to minimise the possibility of standing water seeping into the track structure, thus weakening the subballast or subgrade. The high traffic mainline tracks require higher quality and thicker layers of ballast and subballast to resist the loadings and to effectively distribute the loadings to the underlying subgrade layer. Variations of this design have been common for the majority of the trackbed construction since the late 1800s and is currently the predominate design of railway track structures throughout the world.

Since the early 1980s, the U.S. railroad industry has been selectively utilising Hot-Mix Asphalt in the track structure as a support layer¹¹. Applications have been gaining favour in other countries as well. The layer of asphalt, similar in composition to that commonly used for highway construction, distinguishes the track structure from the classic all-granular trackbed.

This development is in response to the impending challenges to provide higher quality and longer lasting track and support structures to accommodate the unprecedented growth in rail traffic volumes, revenue ton-miles, axle loadings, and tonnages being experienced throughout the world. Primary emphasis has been placed on developing and evaluating the asphalt trackbed technology for heavy-tonnage freight railroads in the United States and more recently for high speed passenger railways in other countries.

TYPICAL SECTIONED LAYERED CONFIGURATIONS

Three basic types of asphalt trackbeds are being utilised. Two of them incorporate the traditional ballast layer as a portion of the support. The termed 'Asphalt Underlayment' trackbed is similar to the classic all-granular trackbed; the difference being the substitution

of the asphalt layer for the granular subballast layer. The typical cross-section is shown in **figure 1b**. The 'Asphalt Combination' trackbed includes both the asphalt layer and the granular subballast layer. The asphalt layer thickness may be lessened somewhat since a relatively thick subballast layer exists below. **Figure 1c** depicts this design.

The 'Ballastless Asphalt Combination' trackbed consists of ties, or slab track, placed directly on a relatively thick layer of asphalt and a relatively thick underlying layer of granular subballast. These thickened sections compensate for the absence of the ballast layer. The exact design and configuration of the ties, monolithic or two-block slab track if used and profile of the asphalt surface, varies significantly as a function of preferential specifications. The application of cribbing rock, or some other means, is necessary to restrain the ties from lateral and longitudinal movement. **Figure 1d** contains a generalised view of the ballastless asphalt trackbed. Certain designs with unique features and configurations including concrete slab tracks are typically covered by patents.

TYPICAL TRACKBED LAYER DIMENSIONAL DESIGNS

Asphalt underlayment and to some extent the asphalt combination trackbed designs represent the bulk of asphalt trackbed utilisation on U.S. railroads. The ballastless trackbed design is not as readily adaptable to current U.S. railroad construction and maintenance practices as is the ballasted designs. This discussion of typical U.S. practices relates to asphalt applications containing a ballast layer.

Asphalt underlayment design and construction practices for railways typically follow recommendations set forth by the Asphalt Institute^{3&4}, and the latest AREMA Manual for Railway Engineering². The typical asphalt layer is approximately 3.7 m (12 ft) wide and is approximately 125 to 150 mm (5 to 6 in.) thick. For less than desirable trackbed support conditions and high impact areas, a 200 mm (8 in.) thickness is commonly used. Thickness of the overlying ballast ranges from 200 to 300 mm (8 to 12 in.). Thickness of a granular subballast layer, if utilised, is usually 100 to 200 mm (4 to 8 in.) thick.

TYPICAL ASPHALT MIXTURE DESIGNS

The typical asphalt mixture specification is normally the prevailing dense-graded highway base mix in the area having a maximum aggregate size of 25 to 37.5 mm, (1 to 1 1/2 in.). The asphalt binder content can be increased by 0.5% above that considered optimum for highway applications. This will provide a low to medium modulus, (plastic), mix, having design air voids of 1 to 3%. This mix is easier to densify to less than 5% in-place air voids and therefore facilitates achieving adequate strength and an impermeable mat.

Rutting of the plastic mix is not a concern in the trackbed since the pressures are applied through the ballast over a wide area. Bleeding and flushing are also of little concern since the track does not have direct contact with the asphalt layer and the temperature extremes in the asphalt layer are minimised in the insulated trackbed environment.

TYPICAL TRACKBED LAYER INSTALLATION PRACTICES

The equipment required for installing the asphalt layer varies depending on the size or length of the installation. For short maintenance/rehabilitation projects, the asphalt is normally back-dumped on grade and spread with a track hoe, small dozer, bobcat, etc. already on site, prior to compacting with a conventional vibratory roller.

This process requires that the old track panel be removed. Thus, the cost to place the asphalt is minimal, basically no more than placing conventional granular subballast. The cost of the asphalt material delivered to the job site adds a small percentage to the total track removal and replacement costs but is basically insignificant, since it replaces the granular subballast. The majority of the costs involve equipment, labour and track materials. The added time to place asphalt is insignificant, provided the track and the underlying existing ballast/subballast are to be removed and replaced.

For larger out-of-face projects, mainly new construction with a prepared subgrade, the asphalt is more efficiently placed with conventional asphalt laydown, (paving), equipment and compacted with large vibratory rollers. The procedure is similar to highway construction.

The cost of the asphalt may be less than the cost of granular subballast if quality granular subballast has to be transported long distances due to insufficient quality or quantity in the immediate area.

Normally, asphalt is compatible with a wide variety of aggregates. The thickness and width of the asphalt is less than that of granular subballast; thus about one-half or less material is required, which is also a cost advantage for asphalt. The asphalt can be placed with highway paving equipment as rapidly as highway paving with much less handwork and concerns with appearance and smoothness.

TESTS AND EVALUATIONS

During the intervening years, since the initial applications of asphalt trackbeds on U.S. railways, moderate amounts of follow-up testing and performance evaluations of selected installations have been conducted and reported in the literature. Summations of these studies follow; more detailed discussions are included in several references.

TRACKBED MATERIALS TESTS AND EVALUATIONS

Numerous in-service trackbeds have been subjected to materials sampling and core-drilling to ascertain the properties of the subgrade and asphalt materials. The primary purpose was to determine if any weathering or deterioration of the materials was occurring in the trackbed environment which could conceivably affect long-term performance¹⁰.

Typical views of core drilling trackbeds to obtain samples are shown in **figure 2**. Summary discussions of the findings follow:

Material characterisation evaluations were conducted on asphalt cores and subgrade/roadbed samples from eight asphalt trackbeds distributed over five states. The trackbeds were from 12 to 29 years old when sampled and tested. The inherent conditions varied significantly from site to site. These included asphalt thickness and composition, ballast thickness, trackbed support and traffic. Previous characterisation evaluations were available for several of the projects and the results were included for comparisons with the more recent evaluations¹¹.

The significant finding, relative to the materials, (old roadbed/subgrade), directly under the asphalt layer, is that the in-situ moisture contents were very close to laboratory determined optimum values for maximum density of the respective materials. The asphalt layer was not performing as a membrane to collect and trap moisture, thus weakening support. Since the in-situ moisture contents were at or near optimum for maximum density, the strengths and load carrying capacities of the underlying materials are also at or near optimum.

Furthermore, average moisture contents remained essentially unchanged, at or near optimum, for the two projects from which previous data was available. For design purposes, it is reasonable to base strength or bearing capacity values at optimum conditions, (moisture content and density), for the material under the asphalt layer. Using strength or bearing capacity values determined for the soaked condition, common for highway designs, is inappropriate for asphalt trackbed designs. The unsoaked, optimum moisture content condition is consistent with in-service trackbed conditions.

An equally significant finding, relative to the asphalt cores characterisations, was that the asphalt binders and asphalt mixes did not exhibit any indication of excessive hardening, (brittleness), weathering, or deterioration even after many years in the trackbed environment.

This is considered to be primarily due to the insulated effects of the overlying ballast which protects the asphalt from excessive temperature extremes and oxidation and hardening of the asphalt binder. These factors will contribute to a long fatigue life for the

asphalt layer. There is no indication that the asphalt layers were experiencing any loss of fatigue life based on resilient modulus test on the extracted cores.

The typical failure modes experienced by asphalt highway pavements are;

1. rutting at high temperatures
2. cracking and fatigue at low temperatures
3. stripping/raveling under the suction of high tire pressures on wet pavements
4. progressive fatigue cracking due to inadequate subgrade support, generally augmented by high moisture and improper drainage.

These conditions do not exist in asphalt railroad trackbeds. For example, the temperatures were not sufficiently high to promote rutting. Conversely, the temperatures were not sufficiently low to promote low temperature cracking and decreased fatigue life. The asphalt binder only indicates minimum, if any, weathering or hardening in the insulated trackbed environment which will minimise tensile cracking and extend fatigue life. Obviously, the tendency of the asphalt mix to strip or ravel is essentially eliminated in the trackbed environment since there is no rubber suction action prevalent on highways. Also, the moisture contents of the underlying subgrade/roadbed support materials are maintained at or near optimum for maximum density and support strength.

TRACKBED PRESSURE/STRESS, DEFLECTION, AND MODULUS MEASUREMENTS

Trackbed pressure, (stress), measurements have been obtained at prevailing speeds under heavy tonnage railroad loadings. Pressure measurements were recorded using hydraulic type earth pressure cells imbedded in the track structure above and below the asphalt mat. Peak pressures occur directly below the tie/rail interface¹².

Typical peak dynamic vertical pressures, on top of the asphalt mat, typically range from 90 to 120 kPa (13 to 17 psi) for a typical 6-axle diesel electric locomotive, wheel load approximately 16,000 kg (35,000 lb), traveling at 64 km/hr (40 mph) as noted in **figure 3**. The asphalt mat pressures are reduced to 15 to 30 kPa, (2.2 to 4.4 psi), under the empty freight cars, as is also noted in **figure 3**. The beam action of the track, which distributes the concentrated wheel loadings over several ties and the confined, high modulus ballast layer, serve to effectively reduce the heavy axle loadings. The trackbed pressures for the typical locomotive are further reduced to 35 to 50 kPa, (5 to 7 psi), under the asphalt layer at the subgrade interface as noted in **figure 3** based on tests at TTCI¹³.

By comparison, an 82 kg person will exert about 40 kPa, (6 psi), pressure while standing on a level surface. Furthermore, typical tyre pressures imposed on highway asphalt

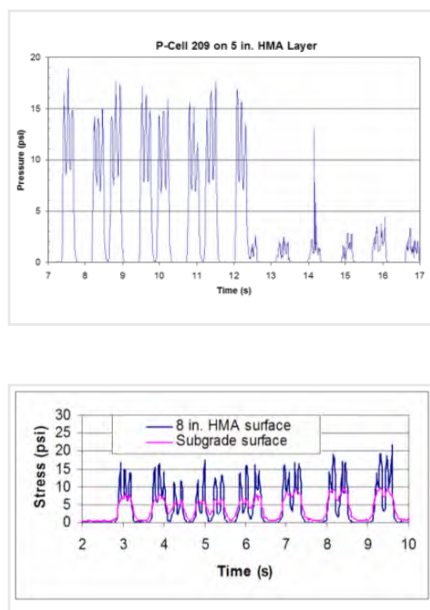


Figure 3: Pressures at ballast-asphalt interface on CSX mainline for locomotives and empty coal train (top) and Pressures on top and below asphalt layer at TTCI test track (bottom).
(10 psi=69 kPa, 1 in.=25 mm.)

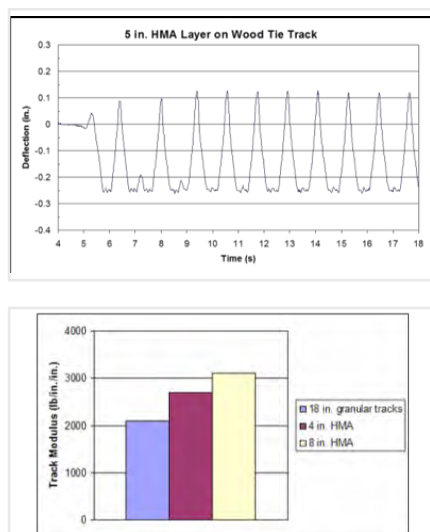


Figure 4: Track deflections on CSX mainline for a loaded coal train (top) and Track Modulus for wood tie track at TTCI track (bottom).

$$(1 \text{ in} = 25 \text{ mm}, 1000 \frac{\text{lb}}{\text{in}} = 4.48 \frac{\text{kN}}{\text{in}})$$

surfaces under loaded trucks range from 700 kPa, (100 psi), to over 1400 kPa, (200 psi), depending on the magnitude of loading and tire configurations. Therefore, the pressures exerted on the asphalt mat in the track structure are only a fraction in magnitude of the pressures exerted by automotive and truck tyres on an asphalt highway pavement surface.

Dynamic track deflections have been recorded in conjunction with the pressure measurements using linear variable displacement transducers referenced to a fixed datum. Rail deflections under 1282 kN, (286,000 lbf), loaded freight cars average 6 mm (0.25 in.) for wood tie track, as noted in **figure 4**, and around 1 mm, (0.04 in.), for concrete tie track. These are considered optimum for both track types¹².

LONG-TERM SETTLEMENTS OF RAIL/HIGHWAY AT-GRADE CROSSINGS

The evaluation of long-term settlements of at-grade crossings was determined for both asphalt supported and all-granular supported crossings. Top-of-rail settlement measurements were taken for 24 crossings over a three-year period. Measurements were taken at frequent intervals within the common crossing area and along the track approaches. The crossings underlain with asphalt settled 41% of the amount for the all-granular supported trackbed crossings. In addition, the crossing areas underlain with asphalt settled 44% of the abutting all-granular, (existing), supported track approaches. The statistical t-test validated the significance of the differential findings^{9&13}.

UNITED STATES RAILWAY APPLICATIONS

Freight railroads in the United States have been selectively using asphalt trackbed maintenance applications since the early 1980s and more recently for new construction, particularly for line capacity improvements and re-alignment projects. The majority of the early installations involved the rehabilitation of short trackbed sections that historically had required substantial maintenance. These involved a wide range of applications including railway/highway crossings, middle-of-street crossings, special trackworks such as turnouts and rail crossings, bridge approaches, tunnel floors and portal approaches, wheel-impact load detectors and open track applications. Selected projects encompassing these applications are subsequently described⁶.

RAILWAY/HIGHWAY AT-GRADE CROSSINGS

With the exception of a few early research trackbed installations, perhaps the initial emphasis was primarily directed at using asphalt trackbeds for at-grade crossing rehabilitation projects. Railways and highways are typically designed very differently structurally for the common areas at crossings. The all-granular railroad roadbed and track system is designed to be flexible, deflecting as much as 6.5 mm, (0.25 in.), under normal railroad traffic. The highway pavement structure is designed to be essentially rigid, deflecting a minuscule amount even under heavy trucks. Rapid abrasion and wear of the crossing surface and support materials and the surface often fails prematurely due to deterioration and settlement of the crossing. One of the initial highway crossings underlain

with asphalt was in 1985 on a then SBD Railroad mainline through downtown Cynthiana, KY. A 400m, (1300 ft), length of track, including three downtown crossings spaced one block apart, was underlain with a continuous layer asphalt to solve a chronic unstable trackbed condition by improving the drainage and improving support for the track. The performance and surface life of the crossings have improved significantly. **Figure 5** is a current view of the area. During the intervening 33 years the crossing surfaces have been replaced twice during major programmed track maintenance activities. The crossings have remained free of mud and pumping and the crossings have remained smooth and serviceable.

A similar success story that has been monitored is the CSX crossing at Ashton, WV. This crossing was renewed in 2001 using a 2-day highway closure. The crossing has not required any maintenance during the intervening 17 years; it remains in perfect condition and has been continuously smooth and serviceable. A current view is shown in **figure 5**. These are two of many thousand similar success stories scattered all over this nation's railroad lines. It is standard practice for certain agencies and railroads based on the prevailing conditions at the particular site.

MIDDLE OF THE STREET CROSSINGS

A unique type of a railway/street jointly shared facility is the situation where the railroad track occupies the middle of the street for a considerable length. This is basically a continuously closed crossing so the street vehicles have continuous access beside and across the track. Drainage from within the crossing is difficult to achieve and maintain which can adversely affect the load carrying capability of the track. If the track settles and requires maintenance, it is time consuming and expensive to access the track structure to correct the situation. The Portland & Western Railroad in western Oregon has over 4.7km (2.9 miles) of middle-of-street crossings scattered over six cities. Renewing the crossing surfaces and installing asphalt underlayments to restore adequate support for the poorly performing crossings began in 2009 as shown in **figure 6**. Since then mid-street crossings in three cities have been renewed with asphalt underlayment totalling 1980 m, (6500 ft), and this multi-year program continues. Performance to date has been entirely satisfactory.

Perhaps the most significant middle-of-street project is the 1000m, (3300 ft), long renewal on Main Street in West Brownsville, PA, as shown in **figure 6**. The NS crossing on a heavy-tonnage coal line was renewed in four sections over a four-year period from 2011-2014 to rectify a previous chronic maintenance expense due to having to renew portions of the crossing at frequent intervals. The crossing is performing extremely well, showing no indication of distress or deterioration, and requiring no maintenance.



Figure 5: Railway/Highway At-Grade Crossings; CSX crossings in Cynthiana, Kentucky renewed in 1985 with the crossing surfaces only exchanged twice since then and remaining remarkably serviceable (top) and CSX crossing on WV 2 at Ashton, WV placed in 2001 with no maintenance in the 17 years and still as smooth as when it was installed (bottom).

SPECIAL TRACKWORKS

Considerable research and development has been accomplished to improve the performance of special trackworks under switches and frogs at turnouts, crossovers, and rail crossings. These track features must withstand heavier axle loads and other high-impact and dynamic loadings than open track typically must withstand. Optimising foundation stiffness is considered important for controlling track settlement and maintaining alignment to achieve required geometrics. Obtaining optimum foundation damping is considered important for minimising vertical dynamic loads, thus minimising the detrimental effects of high dynamic loadings.

These special trackworks are traditionally high impact areas due to the wheels traversing the flangeway gaps in the rails. Adequate drainage is often difficult to obtain, particularly in the switch point and frog areas. Also, the ballast is difficult to tamp and consolidate in the maze of rails and track components. Asphalt underlayment has been shown to increase trackbed strength while enhancing drainage thereby providing adequate support to obtain high ballast modulus to withstand the added vertical impact forces particularly in the switch point and frog areas. Literally hundreds of



Figure 6: Middle-of-Street Crossings; Low-budget crossing on the Portland & Western Railroad in western Oregon (top) and 1000 m (3300 ft) concrete crossing on a Norfolk Southern (NS) coal line in West Brownsville, PA (bottom).

rail crossings, crossovers and turnouts have been underlain with a mat of asphalt during the replacement of the special trackwork. For example, CSX has used asphalt underlayment for the replacement of numerous rail crossings in the Chicago area since 1995. CSX's B&O line east of Chicago had 30 rail crossings underlain with asphalt in northern Indiana and Ohio during the B&O double-track project. There are 12 rail crossings on the CSX and CSX/NS lines in Fostoria, OH underlain with asphalt.

Additional rail systems using asphalt underlayment for special trackworks include Caltrain and Metrolink in California. It is a standard procedure for both systems with multiple crossovers and turnouts underlain with asphalt.

Normally, special trackworks have to be renewed "under traffic" during a short time track closure. Adequate planning is of utmost importance. It is even common to restrict the operations to weekends, particularly on lines having commuter and passenger traffic. Equipment and personnel are selected to accomplish the project in a minimum amount of time. Normally, the track can be opened to traffic within 9 to 10 hours for a 4-diamond rail crossing. Single crossing and smaller size turnout replacements can be accomplished within 6 to 7 hours if properly planned. Minimal tamping and surfacing are required provided the ballast is pre-compacted and care is exercised in positioning the special trackwork unit on the compacted ballast bed.

In 2012, NS replaced four No. 20 wood tie equilateral turnouts on the Heartland Corridor line near Kermit, West Virginia. Each turnout was changed out during a 16-hour traffic curfew. The concrete tie replacement turnouts were about 90 m, (300 ft), long and pre-assembled in four sections. Two cranes were used to place the sections. The total time allocated for placement and compaction of the 150 mm, (6 in.), thick asphalt layer was 1.25 hours. The asphalt was placed with a typical paver in two 75 mm, (3 in.), thick lifts. A recent view is shown in **figure 7**. The performances of the turnouts have been excellent requiring minimal maintenance during the six years of service.

Recently a No. 15 turnout was renewed with asphalt underlayment on a NS mainline in southern Indiana near Crandall, Indiana. Removing the 60 m, (190 ft), track panel and excavating the existing roadbed required 80 minutes. An additional 50 minutes was required to dump, place, and compact the asphalt. So within slightly over two hours the replacement of new ballast and new track panel began. It is common practice on the territory to use asphalt subballast when renewing turnouts. Track time is considered a premium on this line, so the various activities during track outages must be planned to minimise time requirements. **Figure 7** shows a portion of the asphalt underlayment and the portion of the roadbed remaining to be covered with asphalt during the renewal process.

BRIDGE APPROACHES

Minimising settlement and the effect of track stiffness variations at bridge approaches, particularly at open-deck bridges, are foremost in maintaining requisite track geometric parameters to minimise impact stresses and excessive wear of the track components. Asphalt trackbeds are being used to transition track stiffness and facilitate drainage providing consistent structural support in the immediate approach area. A new 450 m, (1475 ft), long heavy tonnage bridge across the Tennessee River Slough at Bridgeport, Alabama was built in 1998 to replace an existing bridge. This required re-alignment of approximately 425m, (1400 ft), of mainline track for both approaches.

Asphalt underlayment was selected to improve track substructure strength and reduce future maintenance. A 125 mm, (5 in.), thick mat of asphalt was placed on 150 mm, (6 in.), thick granular subballast. Granite ballast, 250 mm, (10in.), thick, concrete ties and RE 136 CWR rail completed the track section on the two approaches. **Figure 8** is a view of the asphalt underlayment prior to placing the ballast and track.

The CSX line also carries NS traffic. The total annual tonnage over this heavy tonnage and traffic line is about 70 MGT. During the twenty years since the bridge has been opened to traffic, the approaches have required minimal track maintenance and the speed has been increased from 16 to 48 km/h, (10 to 30 mph).

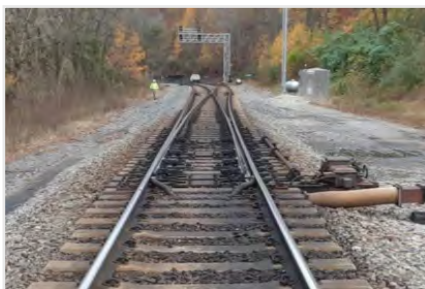


Figure 7: Turnout renewals; No. 20 equilateral concrete tie turnout on a NS mainline at Grey Eagle, West Virginia placed in 2012 and essentially maintenance free (top) and asphalt underlayment being recently placed prior to installing a No. 15 lateral wood tie turnout on NS mainline at Crandall, Indiana (bottom).

During the past ten years the Paducah & Louisville Regional Railroad in western Kentucky has replaced three large bridges using asphalt underlayment on the approaches. The initial application was for the 950m, (3100 ft), long bridge across the Tennessee River at Kentucky Dam (**figure 8**). Asphalt was placed on the 1800m, (6000 ft), lengths of approaches. Following the excellent performance of the approaches to the relocated Kentucky Dam Bridge, similar approach designs were chosen for the approaches to two additional new bridges built off-line to replace two long, high trestles near Louisville.

Several railroads have been successful with quick-fix bridge approach projects by merely removing about 15m, (50 ft), of track on both ends of the bridge, excavating to the desired depth, and placing a layer of asphalt prior to adding new ballast and new track panel. Normally this can be accomplished within a four hour track outage.

TUNNEL FLOORS AND PORTAL APPROACHES

Maintaining a consistently high-quality trackbed support system in tunnels is vital for optimum operating conditions. A properly designed and maintained trackbed system provides adequate support for the track and facilitates drainage.



Fig 8 Bridge approaches; Portion of the 425 m, (1400 ft), CSX Tennessee River bridge approaches placed in 1998; note the paved shoulders between wingwalls to intercept water (top) and similar project on Paducah & Louisville Railroad showing asphalt paving for the east approach to the new bridge across the Tennessee River in far West Kentucky (bottom). The bridge approaches have required minimal maintenance.

Maintenance costs and operational interferences are reduced and higher levels of service and safety are attainable.

Intercepting and controlling drainage are highly important factors for achieving near maintenance free tunnel trackbeds. Materials comprising many tunnel floors slake and weaken when they become wet; not capable of providing a uniformly stable support for the track.

Pumping, ballast contamination and associated track irregularities ensue, particularly on an all-granular trackbed, which is more prone to ballast / floor intermingling.

Asphalt underlayment has been used as a means to level the floor and improve drainage in tunnels and approaches to tunnels. The surface of the asphalt provides uniform support for the ballast and positive drainage from within the tunnel to the exits at the portals.

During the mid-1990s, CSX Transportation rehabilitated three tunnels on a mainline in east Tennessee and portions of several additional tunnels on mainlines in the eastern Kentucky/ Tennessee area. Each one had historically been a "wet" tunnel exhibiting similar characteristics; soft support and inadequate drainage in low areas which "ponded" water

contributing to rapid loss of acceptable track geometry. The adversely affected track geometry resulted in slow orders, excessive maintenance costs and operational interferences. Previous efforts, such as undercutting the track and adding various fabrics had not been considered effective.

The performance of these tunnels, (**see figure 9**), during the intervening twenty or more years has been significantly improved. CSX has utilised this procedure for additional tunnels. The prevailing problem is being able to obtain an adequate time frame to accomplish the work.

Normally a 10 to 12 hour possession is required for changing out an equivalent of 3 to 4 panels.

A particularly notable application was the use of asphalt in three tunnels that were being enlarged in 2010 as part of NS's Heartland Corridor Capacity Improvement project to accommodate double-stack container cars. The three tunnels had a long history of soft support and attendant drainage problems requiring frequent maintenance interfering with normal train operations on NS's mainline. The decision was made to accomplish this work during a 72-hour total shutdown of the line as the last major activity for the two-year project of enlarging 28 tunnels to increase clearances. Multiple contractors performed the work simultaneously on the three tunnels. The project was completed ahead of schedule and the first double-stack container train passed through the tunnels within a few hours, (**see figure 9**). A recent inspection revealed that the tunnel trackbeds are providing significantly improved levels of service with no trackbed pumping in these tunnels with previous histories of excessive maintenance to maintain adequate operating conditions.

WHEEL IMPACT LOAD DETECTORS

During recent years, the use of asphalt underlayment has become a standard practice for new installations and re-habilitating wheel impact load detectors (WILD). This is particularly the case with the two large Eastern US railroads; NS and CSX. The majority of the WILDs on the NS and CSX have asphalt underlayments. The primary purpose is to gain the advantage of consistent trackbed support provided by the structural and imperious layer of asphalt. Therefore, deviations in measurements are due to variations in wheel smoothness without undue influence from variable support affecting the prevailing impact forces and track movement. Two WILDs are shown in **figure 10**.

A major consideration for the track support structure for WILD installations is that it should be reasonably stiff and maintain a consistent stiffness along the length and width of the installation during the year.



Figure 9: Tunnel floors and portal approaches; Vasper, one of three CSX mainline tunnel projects performed in the mid-1990s on mainline in East Tennessee (top) and Grey Eagle, one of three tunnels NS paved with asphalt as part of the Heartland Corridor project in 2010 near Kermit, West Virginia (bottom).

One of the main factors influencing the maintenance of consistent track stiffness is the existing moisture content, and variations of the moisture content of the subgrade/subballast layers.

In addition, the ballast layer must have consistent and uniform support so that it can develop maximum density/compaction to behave linearly elastic achieving maximum shear strength for distributing pressures whilst still maintaining a reasonable degree of elasticity.

OPEN TRACK

Asphalt trackbeds have been selectively utilised for numerous open track applications. Many of these have involved reasonably routine double-tracking and capacity improvement projects consisting of new roadbed construction for variable lengths. The asphalt can be placed rapidly and efficiently with conventional highway asphalt paving equipment.

Additional projects involve rehabilitating short sections of in-service tracks to enhance load carrying and drainage properties of the trackbed support. Depending on the lengths of the sections rehabilitated, track closures can range from 6 to 18 hours with adequate pre-project planning and successful project execution.



Figure 10: Wheel Impact Load Detectors; NS WILD using the Salient process installed on heavy tonnage mainline at Flat Rock, Kentucky in 2009 (top) and CSX WILD using the Schenck process on mainline at Webster, Indiana (bottom).

Following are descriptions of two significant capacity improvements projects on the BNSF and UP railroads in the central portion of the U.S. Both of these required maintaining traffic during the construction processes. A multi-benefit application for asphalt trackbeds was incorporated into the design of the Wichita, Kansas Central Corridor Railroad Grade Separation Project. This 4 ½ year long project, recipient of national recognition and several awards, was completed in 2009. The track was raised 3.2 km, (2 miles), above the roadway providing five new bridges to carry trains over the five arterial streets below. Between the bridges, the tracks were elevated on a 7.5 m, (25 ft), high embankment supported by precast concrete T walls.

The primary benefits were to mitigate issues related to highway traffic congestion, delays, and vertical clearances for trucks while minimising train-induced noise. The safety aspects for both highway and train traffic were enhanced by improvements provided by elevating the train tracks above the street and providing enhanced clearances for the street traffic. The elevated track also served to minimise noise from the 40 plus daily trains. Context sensitive solutions were incorporated throughout the project. A completed view is shown in **figure 11**.

The performance of the paved trackbed over the past nine years has been excellent. This is viewed as a specific benefit of the asphalt layer by increasing the load carrying capabilities of the trackbed and decreasing water intrusion into the underlying trackbed support. No



Figure 11: Open track applications; In-service asphalt paved track used for elevated BNSF/UP grade-separated track through Wichita, Kansas, placed in 2009, (top) and construction of asphalt paved track for re-alignment and triple tracking of BNSF/UP mainline east of Kansas City Near Eton, Missouri, placed in 2010, (bottom).

specific track maintenance has been required other than normal programmed surfacing. The track geometry has consistently maintained conformance to the FRA requirements for Class 4 track with no track-related slow orders. An interesting application of an asphalt trackbed, based on engineering evaluation, was for a short section of a 13km (8mi) third track addition and curve reduction capacity improvement project on the BNSF Transcon mainline east of Kansas City, Missouri. The track along the Missouri River between Congo and Eton Junction, near Eton, contained this section of track that had historically required frequent track maintenance.

Track surfacing was extensively utilised, at times nearly continuously, to maintain the required geometric parameters. This was due to the native shale in a cut area exhibiting poor quality engineering properties. In addition, there were several 6-degree horizontal curves that required 55 km/h, (35 mph), speed restrictions on this very heavy traffic 115 km/h, (70 mph), BNSF and Union Pacific (UP) combined trackage line.

Studies indicated that a third track was needed to increase capacity for efficiently accommodating the projected increased BNSF and UP traffic in this area. Also, a solution was sought to mitigate the adverse performance of the shale, assumed to be an even more significant problem with newly exposed materials.

In addition, the horizontal curves resulted in reducing train capacity and performance while accruing added track maintenance costs which included frequent curve rail replacement. There were also some environmental constraints relative to impacting restricted areas within the flood plain that could be disturbed and encroachment restraints on previous environmentally sensitive areas. This required considerable excavation in the adjoining hillsides to move the extra track closer to the hillside and farther from the river. Asphalt was placed under all three tracks for a distance of 275m, (900ft), from MP 437.45 to 437.62 during the period April 2010. **Figure 11** contains a view of the construction process.

During the eight years since the re-aligned track and third main have been in service the section of track over which the asphalt underlayment was used has shown no instability due to subgrade problems. The only maintenance required is regular surfacing. No geometry defects have been noted. The use of the asphalt underlayment appears to have mitigated possible trackbed instability problems due to constructing the re-aligned track over the native shale material.

CONCLUDING COMMENTS

The United States railway industry continues to emphasise the importance of developing innovative trackbed design technologies for both heavy tonnage freight lines and commuter/transit passenger lines. The purposes are to achieve high levels of track geometric standards for safe and efficient train operations while minimising long-term track maintenance costs and extending track component service lives.

During the past several decades designs incorporating a layer of asphalt, (or bituminous), paving material as a portion of the railway track support structure have steadily increased until it is often considered as common or standard practice. Asphalt trackbeds have been primarily limited to heavy tonnage freight lines and commuter/rail transit lines in the United States, most often for maintenance/rehabilitation of special trackworks such as turnouts, rail crossings, highway crossings, WILDS, tunnel floors, bridge approaches, etc., or capacity improvements of existing lines. Based largely on its proven performance it is considered a standard engineering design practice for specified types of applications on a variety of freight railroads and commuter/transit rail lines in the United States. This technology also has demonstrated applications for the construction of numerous new high-speed passenger lines in Europe and Asia.

The asphalt layer is normally used in combination with traditional granular layers to achieve various component configurations. This practice augments or replaces a portion of the traditional granular support layers and is considered to be a premium trackbed design.

The primary documented benefits are to provide additional support to improve the load distributing capabilities of the trackbed layered components, decrease load-induced subgrade pressures, increase confinement for the ballast, improve and control drainage, maintain consistently low moisture contents in the subgrade, insure maintenance of specified track geometric properties for heavy tonnage freight lines and high-speed passenger lines and decrease subsequent expenditures for trackbed maintenance and component replacement costs.

The projects described herein were all designed and installed using highly technical standards of engineering practice relating to the developed technology for using a layer of asphalt, termed "underlayment", within the track structure to achieve specified high standards for trackbed performance. This factor is largely responsible for the perfect to near-perfect performances for the projects included and evaluated in this study. The coverage reported herein is not all-inclusive, but represents typical, pertinent and unique applications of asphalt trackbed technology.

ACKNOWLEDGEMENTS

This research effort was initially supported by the National Asphalt Pavement Association and the Asphalt Institute in cooperation with the Louisville & Nashville (L&N) Railroad, later Seaboard System and CSX Transportation. Also, the Santa Fe Railway, later BNSF Railway, participated during the early years. Additional cooperative participation was received from a local shortline railroad, TTI Transportation. Additional railroads, primarily the Norfolk Southern, have been substantially involved during more recent years as has the Kentucky Transportation Cabinet.

The recent phase of this study was primarily funded and supported by the National University Rail Center (NURail), a U.S. DOT OST Tier 1 University Transportation Center. Special accolades were presented to the numerous employees of the railroad companies and governmental agencies featured herein. The company and agency representatives were very cooperative in obtaining significant amounts of information and approving the information reported herein that was pertinent to their particular company or agency. The author was responsible for assembling the information and presenting it in summary form as accurately and factually as deemed possible.

REFERENCES

1. AREA (1980) American Railway Engineering Association. Stresses in Railroad Track, The Talbot Reports.
2. AREMA (2018) Manual for Railway Engineering, 2018.

3. Asphalt Institute (1998) Hot Mix Asphalt for Quality Railroad and Transit Trackbeds. Informational Series IS-137, 10 pages.
4. Asphalt Institute (2007) The Asphalt Handbook, MS-4, 7th Edition, Chapter 15.3 Railway Roadbeds, 832 pages.
5. Li, D., Rose, J., and LoPresti, J. (2001) Test of Hot-Mix Asphalt Trackbed over Soft Subgrade under Heavy Axle Loads. Technology Digest-01-009, Assoc. of American Railroads, April, 4 pages.
6. Rose, J. (2015) Asphalt Railway Trackbeds: Recent Designs, Applications and Performances. American Railway Engineering and Maintenance-of-Way Assoc. 2015 Annual Conference PROCEEDINGS, September, 18 pages.
7. Rose, J. (1983) 'More Progress on HMA Track Stabilization', Railway Track and Structures, Vol. 79, No. 6, pp. 32-36.
8. Rose, J. and Hensley, J. (1991) Performance of Hot-Mix Asphalt Railway Trackbeds, Transportation Research Record 1300, Transportation Research Board, pp. 35-44.
9. Rose, J. (2011) "Rehabilitation Techniques to Improve Long-Term Performances of Highway-Railway At-Grade Crossings," ASME/ASCE/IEEE Joint Rail Conference, Paper JRC 2011-56015, March, 13 pages.
10. Rose, J. and Lees, H. (2008) Long-Term Assessment of Asphalt Trackbed Component Materials' Properties and Performance. American Railway Engineering and Maintenance-of-Way Assoc. 2008 Annual Conference PROCEEDINGS, September, 50 pages.
11. Rose, J., Brown, E., and Osborne, M. (2000) Asphalt Trackbed Technology Development; The First 20 Years. Transportation Research Record 1713, Transportation Research Board, pp. 1-9.
12. Rose, J., Li, D., and Walker, L. (2002) Tests and Evaluations of In-Service Asphalt Trackbeds. Proceedings of the American Railway Engineering and Maintenance-of-Way Association, 2002 Annual Conference & Exposition, September, 30 pages.
13. Rose, J., Swiderski, M., and Anderson, J. (2009) "Long-Term Performances of Rail/Highway At-Grade Crossings Containing Enhanced Trackbed Support," TRB Annual Meeting Compendium of Papers Online, Washington, DC, January, 36 pages.

A new design method for geogrid-stabilised trackbed

AUTHOR:

Andrew Lees

**Senior Application Technology
Manager**

Tensar International

A new design method that accurately predicts subgrade deformation under train loading helps demonstrate the benefits of incorporating stabilisation geogrids in trackbed design, saving time and money over the lifetime of a railway.

With growth of passenger rail journeys predicted over the next decade or so, Network Rail is forecasting an additional 1bn journeys by 2030 and with the continued reliance on the network by industry for moving freight around the UK, there will be increased pressure on railway infrastructure in the coming years, especially in terms of track reliability and capacity.

Trackbed maintenance work and line speed restrictions significantly affect schedules and are expensive and disruptive to the public, industry, train operators and asset owners. A lot of maintenance is aimed at rectifying poor track geometry and a loss of vertical and horizontal alignment of the rails, caused by subgrade and ballast deformation, which often leads to speed restrictions.

Mechanical stabilisation of sub-ballast layers using geogrids is a tried and tested approach that can reduce maintenance, by reducing traffic-induced degradation, slowing the rate of track settlement, maintaining track geometry for longer and extending ballast life as much as ten-fold (**see figure 1**).

In fact, maintenance intervals can be up to three times longer, reducing whole-life costs, in terms of both cash and carbon. However, while geogrids have been used for decades in rail track construction, current performance-based design methods do not accurately predict long term behaviour of ballast, sub-ballast and the subgrade, which means their benefits cannot be truly modelled during design.

That is why Tensar International set out to resolve the issue, with the aim of developing a new design method that not only predicted track foundation performance more accurately but that would also allow the benefits of installing stabilising geogrids to be determined reliably.





Figure 1:

TriAx interlocks with aggregate particles to confine and restrain the granular material from lateral spread, which helps maintain horizontal and vertical rail alignment.



Figure 2: The new design method has been tested during full-scale field trials on live freight and passenger lines.

The Li-Selig method is the common approach used in performance-based track design. This is used to predict permanent subgrade deformation, based on empirical relationships and analysis models developed in the 1970s.

Initial investigations using finite element analysis, (FEA), with elasto-plastic constitutive models, instead of the linear elastic models of the older analysis methods, highlighted some of the drawbacks of using this approach.

In particular, the team found that, compared with other input parameters, permanent deformations were not particularly sensitive to the stiffness of subgrade and ballast layers ; which are key input parameters to the elastic layer analysis used in the Li-Selig method.

Furthermore, it was found that predictions were highly sensitive to the depth of the subgrade layer and the properties of the underlying soil layer, making an appropriate selection of the subgrade depth in the Li-Selig method almost impossible. As a result, the approach was found rarely to deliver an accurate prediction of trackbed behaviour.

In contrast, an approach developed by Tensor uses advanced, but readily available, hardening plasticity models to predict permanent subgrade deformations under train

wheel loading. These outputs are multiplied up by the more reliable element of the Li-Selig method that depends only on the subgrade soil type to obtain a prediction of the accumulation of subgrade deformation under successive train loading.

The method also includes a simple mobilised bearing capacity calculation for optioneering, rather than having to carry out a full 3D FEA, which can be time-consuming and expensive, if used on every design option.

Relationships have been derived between mobilised bearing capacity and permanent subgrade deformation that can also be multiplied up to obtain approximate predictions under successive train loading. Once the preferred option has been chosen, a full FEA model can be run.

The new approach was calibrated with TriAx geogrid, using laboratory testing carried out at the Czech Technical University, with 500,000 load cycles on rails and sleepers supported by stabilised and non-stabilised sub-ballast over a clay subgrade. Data gathered during full-scale field trials of geogrid placed in sub-ballast on live freight and passenger lines in Slovakia, the USA and South Africa was used to back analyse, and confirm, modelling predictions. Lower quality materials, (such as fouled

ballast), stabilised with TriAx were also tested and it was found that their stabilised mechanical properties exceeded those of non-stabilised, higher quality materials. This could have a major positive impact on costs and sustainability, as it enables re-use of fouled ballast materials as sub-ballast, in both new track construction and rehabilitation.

With an ever-increasing burden being placed on rail infrastructure, there is clearly a need to deliver safe permanent way efficiently, with designs that offer value for money, in terms of both construction and whole life costs, and have minimal environmental impact.

This essentially boils down to mitigating risk – a large proportion of which lies in the ground. Of course, it is incredibly difficult to predict every possible situation arising during construction and operation. However, more accurate modelling, which enables track engineers to design to actual ground conditions, can deliver more appropriate solutions, mitigate risks and ultimately add more value.

To that end, this new design approach enables designers to more accurately predict long term subgrade deformation and to model the benefits of incorporating stabilising geogrids into sub-ballast. This should save time and money during construction and over the operational lifetime of a railway, through longer maintenance intervals.

Geogrids have been used to stabilise track ballast, sub-ballast and the subgrade beneath railways since the early 1980s.

When granular fill material, such as ballast or sub-ballast, is compacted over a geogrid, it partially penetrates and projects through the geogrid's apertures to create a strong and positive interlock. This interlock enables the geogrid to confine and restrain the granular material from lateral spread, which helps maintain horizontal and vertical rail alignment.

Laboratory and field testing has shown that sub-ballast layers stabilised by geogrid are better able to distribute imposed traffic loads, by increasing the area of influence on the subgrade, so bearing pressures are lower.

By providing a stiffer foundation to the track, settlement has been reduced by almost 40%, for the same amount of rail traffic, compared with non-stabilised sub-ballast layers. These layers can also be up to two-thirds thinner, while maintaining bearing capacity, reducing excavation and replacement of weak subgrades, cutting construction time and costs.

Track profiles can also be smoothed at interfaces between structures, for example where embankments meet concrete trackbeds beneath overbridges and in tunnels, by reducing the effects of differential settlement.

Targeted asset management approach to mitigating railway earthwork instability

AUTHORS:

Ian Payne

Freddie Savill

Network Rail, Stratford, London

Simon Holt

Isaac Griffiths

Stuart Fielder

Atkins Limited

Chitts Hill Embankment, Colchester, Essex

ABSTRACT

Like many other ageing Victorian earthworks, the railway embankment at Chitts Hill, west of Colchester in Essex, has instability problems that are affecting the track and ultimately pose a risk to the public. The site is approximately 520m long between two overbridges on the 100mph busy London to Norwich railway line. The embankment is located within the River Colne valley and underlying deposits include local soft alluvium overlying the London Clay formation. Detailed interrogation of the site has taken place as part of the Control Period (CP) 5 and early CP6 asset management. The designer has undertaken a desk study, geomorphological mapping and a risk management and optioneering exercise to determine the mitigation extents and solutions.

The site has a history of repairs including toe weighting, cess retention and a sheet piled wall but problems persist. In addition to repeated twist faults, alignment issues and frequent maintenance of the track and trackbed, slope movement indicators are evident including a displaced cess walkway, toe bulges, poor drainage, vermin burrowing, tree related desiccation and run-on/run-off transition issues with structures. Understanding the geological complexities, slope movements through inclinometer data, establishing a sound ground model and understanding the robustness of existing interventions is key to selecting the appropriate mitigation. The oversteep clay slopes with ash crests typically show movements of 20-30 mm per year at 2-3 m depth with occasional more sudden movements triggering Temporary Speed Restrictions (TSRs).

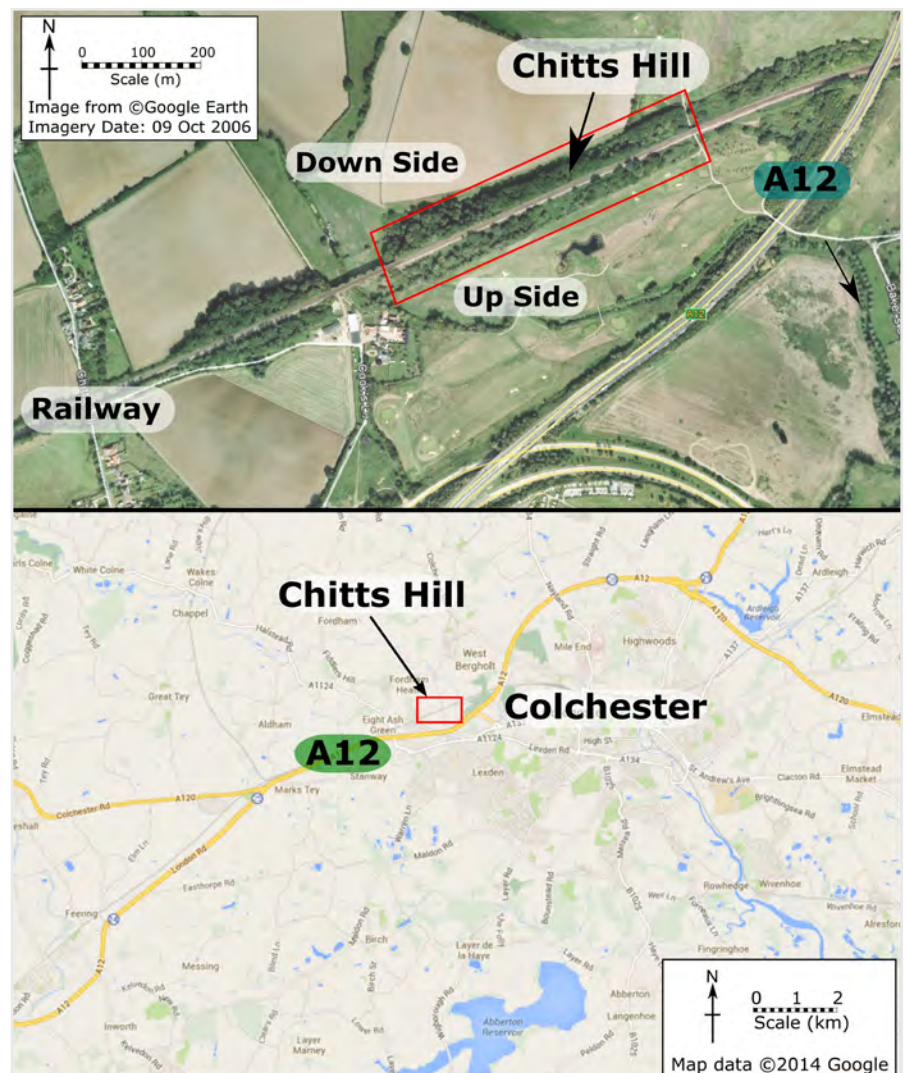


Figure 1: Site location plan

Category & Definition			Risk Rating	Risk Definition	
1 (Track and maintenance data)	A	Service Impacts (TSRs, Track Closures, delay minutes, service disruptions)	H	HIGH	TSR/track closure/delay minutes recorded within past 12 months.
			M	MEDIUM	TSR/track closure/delay minutes recorded within past 5 years
			L	LOW	No historic TSR/track closure/delay minutes recorded in section.
			?	NO DATA	No data available for section.
	B	Track Maintenance and Defects (NR track maintenance records and NR track geometry records/LADS data)	H	HIGH	Bespoke track maintenance implemented within past 12 months (hand jack & pack, temporary cess support etc.); more than 3 standard maintenance interventions (e.g. tamping/stoneblowing). Track dip / twist recorded within past 12 months.
			M	MEDIUM	Increased level of track maintenance in section within past 5 years. Bespoke track maintenance implemented within past 5 years; Maintenance intervention run off from adjacent section. Track dip / twist recorded within past 5 years; track dip/twist run off from adjacent section.
			L	LOW	No historic record of bespoke track maintenance in section. Standard maintenance works only. No historic track dip / twist recorded in section.
			?	NO DATA	No data available for section.
2 (existing GI data)	A	In place inclinometers / instrumentation observations	H	HIGH	Significant rate and/or total movement; deep seated movement in inclinometer; shallow movement in upper slope.
			M	MEDIUM	Minor rate and/or total movement; shallow movement in midslope or toe.
			L	LOW	No/negligible movement.
			?	NO DATA	No instrumentation available for section.
	B	Ground conditions	H	HIGH	Ground conditions deemed indicative of unstable earthwork conditions.
			M	MEDIUM	Ground conditions deemed suggestive of possible unstable earthwork conditions.
			L	LOW	Ground conditions do not indicate any signs of earthwork instability.
			?	NO DATA	No existing GI data available.
3 (visual site observations)	A	Track level & cess	H	HIGH	Visual evidence of significant movement to track, ballast shoulder, cess and / or lineside infrastructure.
			M	MEDIUM	Visual evidence of minor movement to track, ballast shoulder, cess and / or lineside infrastructure.
			L	LOW	No visual evidence of movement at track level.
			?	NO DATA	Not examined (provide reason).
	B	Slope face	H	HIGH	Visual evidence / indicator of significant slope movement on lower, mid or upper slope of embankment / cutting.
			M	MEDIUM	Visual evidence / indicator of minor slope movement on lower, mid or upper slope of embankment / cutting.
			L	LOW	No visual evidence of movement on slope face.
			?	NO DATA	Not examined (provide reason).
	C	Drainage	H	HIGH	Visual evidence of major drainage issues.
			M	MEDIUM	Visual evidence of minor drainage issues.
			L	LOW	No visual evidence of drainage issues.
			?	NO DATA	Not examined (provide reason).
	D	3rd Party mass movement feature; ponding; undercutting of embankment toe by 3rd party; loading of slope crest by 3rd part etc	H	HIGH	Visual evidence of major issues outside of railway boundary fence.
			M	MEDIUM	Visual evidence of minor issues outside of railway boundary fence.
			L	LOW	No visual evidence of issues outside of railway boundary fence.
			?	NO DATA	Not examined (provide reason).
E	Vermin	H	HIGH	Visual evidence of major vermin issues.	
		M	MEDIUM	Visual evidence of minor vermin issues.	
		L	LOW	No visual evidence of vermin issues.	
		?	NO DATA	Not examined (provide reason).	

Table 1 Definition of TAM failure criteria

Definition of TAM Risk Categories	
Risk Category	Definition
High (H)	Known evidence of regular high priority track issues and or above average slope movements with visual signs of instability with high potential to cause public disruption and a threat to the safe operation of the railway.
Medium (M)	Potential to cause continued track issues & affect maintenance regime. Slope movements are considered at or below average and steady. No imminent signs of failure from visual observations. Continue to monitor and have a future works strategy plan in place should it enter HIGH risk.
Low (L)	Minor track and maintenance issues with no cause for concern, below average slope movements (where data) and no visual indicators of failure.

Table 2: Definition of TAM risk category

The Anglia Targeted Asset Management (TAM) process includes value engineering principles to fix the areas posing the highest risk while continuing to monitor adjacent areas. The approach allows funding to stretch to other high priority sites across the region meeting the Network Rail earthworks asset policy objectives. Optioneering of the proposed engineering solutions, including cess retention and soil nails will be reviewed together with overcoming the constraints including access and managing ecological and environmental legislation.

INTRODUCTION

Past remediation works have often focussed on a particular section of earthwork exhibiting immediate concerns, rather than assessing failure in terms of the overall condition of the asset. However, by not assessing the entire asset, including both sides of the track and the surrounding natural setting, key failure indicators and an appreciation of scale may be missed. Furthermore, the presence of other failures and / or previously implemented remediation measures along an asset suggest that stability issues may not be limited to the area of current failure and that an ongoing or more widely spread problems could be present. Alternatively, the assessment of the entire asset can indicate that an issue is localised only, giving confidence in the chosen remediation measure. It is therefore essential that the asset as a whole is assessed to determine the extent of issues at a site and the nature of instability to ensure the correct mitigation type and extent is implemented to allow the continued serviceability of the earthwork and railway.

It is recognised however, that due to the large scale of many of the earthworks renewal projects and the constrained budgets available for remedial works, large-scale heavy engineering solutions across entire sites are not feasible. Therefore, a risk managed and targeted approach to renewal works is needed to ensure the correct remediation is implemented at the worst affected sections, whilst ensuring that a suitable monitoring system is in place to ensure other areas of concern do not deteriorate. This allows for efficiencies in remediation designs and helps to eliminate multiple period spot fixing that will cost proportionately more in the long term (see reference 9 for another case history).

TARGETED ASSET MANAGEMENT (TAM)

Targeted Asset Management (TAM) has been developed as a proactive way to meet the Earthworks Asset Policy objectives and optimise budgets. By implementing a risk management approach to undertaking works at the site, the approach moves away from implementing a full fix across an entire site to more sustainable solutions, allowing a larger area of earthwork to be remediated for the available budget by targeting works at

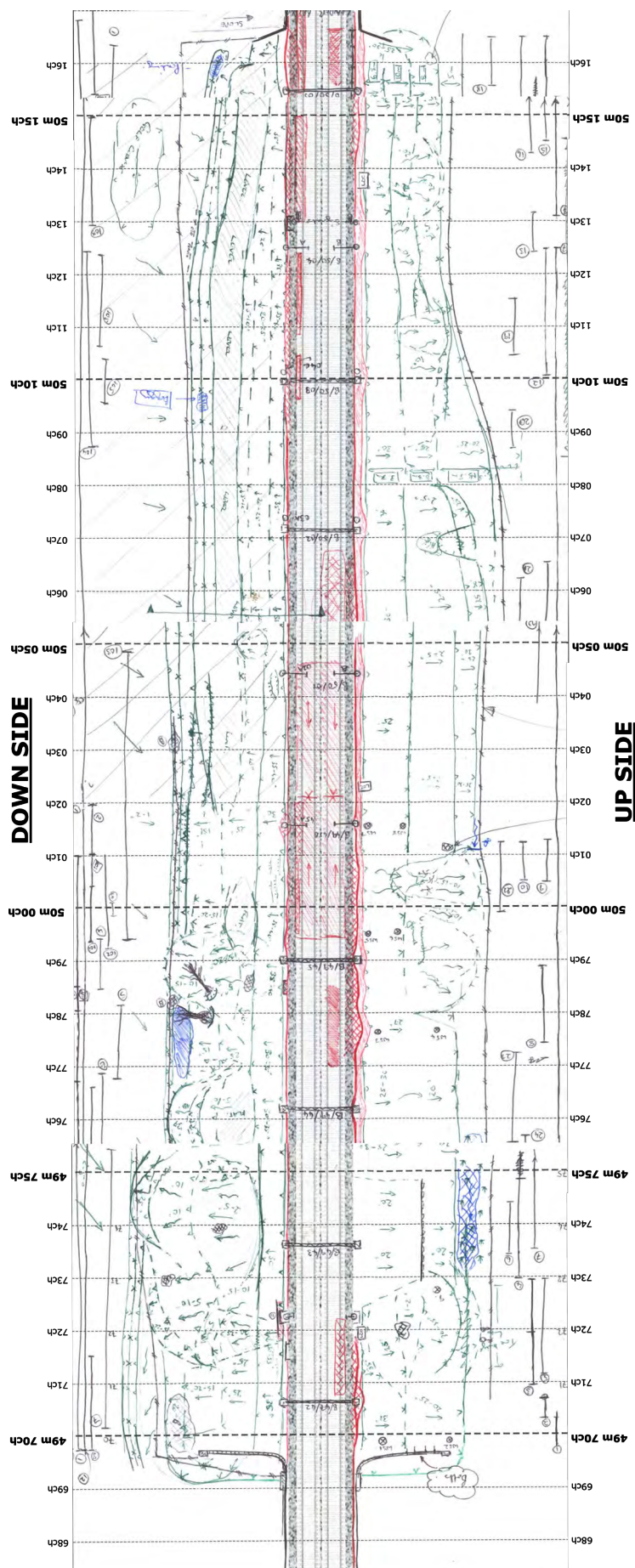


Figure 2: Detailed geomorphological mapping undertaken on 4th December 2018 and 22nd January 2019.

The detailed map was hand drawn on site based on field observations.

The red annotations indicate track issues, blue indicate drainage issues and green indicate slope issues.

Each of the numbered items records a detailed observation at the site which are not reproduced here.

the worst affected areas. The TAM risk management approach is being utilised to identify the scope of remedial works at key sites within the Anglia Earthworks CP6 workbank. The TAM process targets stabilisation at the highest risk sections of the earthworks to minimise operational disruption and is undertaken in four stages as outlined below.

TAM Stage 1 (GRIP 3-4) – Site mapping, data review, risk zonation, preliminary geotechnical analysis, optioneering and the Approval in Principle AIP (F001) output.

TAM Stage 2 – Cost estimation, scope ratification and confirmation of work scope.

TAM Stage 3 (GRIP 5-6) – Detailed design of agreed remedial works, construction support, further targeted GI and a future works strategy plan to ensure ongoing asset stewardship.

TAM Stage 4 – Continued monitoring and collation of associated data (Network Rail).

Constant dialog between the Client, Contractor and Designer is key to the TAM process and ensures that the final remediation option selected tackles the instability issues at a site, whilst remaining both affordable and constructible. TAM Stage 1 focusses solely on data collection and considers the asset as a whole, enabling the site to be divided into zones based on current condition. Outline analysis can then be completed for these sections allowing an optioneering process to be undertaken, both in terms of the type of remedial measures and extent of remedial works. The options determined during TAM Stage 1 are then scrutinised in terms of cost and constructability during TAM Stage 2 resulting in a finalised agreed scope of works. Detailed design and construction are undertaken during TAM Stage 3 as well as design installation of future monitoring and emergency works designs, enabling an immediate response in the event of an earthworks failure in one of the site zones not remediated as part of the main works.

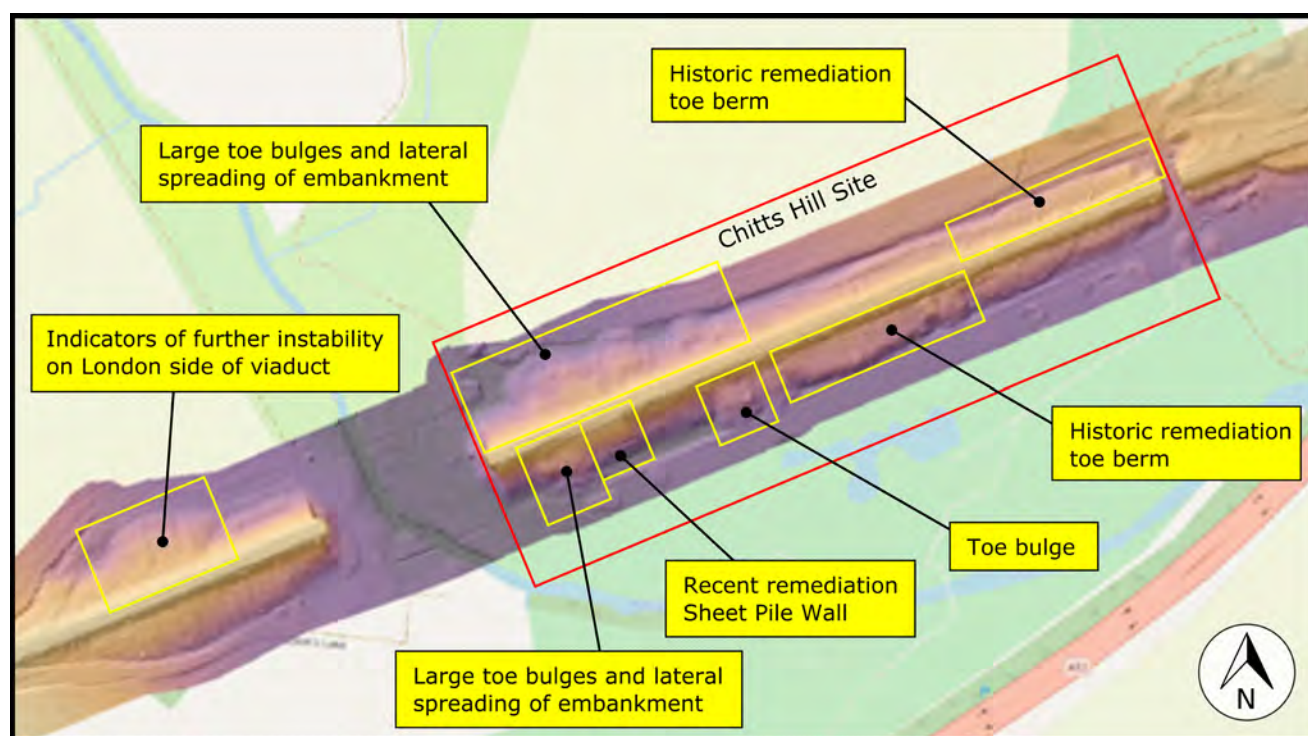


Figure 3: LiDAR imagery of the site

TAM STAGE 1

TAM Stage 1 aims to identify and prioritise the key geotechnical risks of the earthwork with potential to cause problems to the safe operation of the railway. A technical risk register is used to record the process and the output enables optimised renewal works at the higher risk areas. Measures such as continued slope movement monitoring are implemented at unremediated areas to control residual risks.

The TAM technical risk register has been agreed by the Anglia Route Collaboration (ARC) that uses 3 main failure categories:

1. Track and maintenance issues
2. Ground conditions and slope movement monitoring
3. Visual movement indicators

Each of the failure criteria is further subdivided as defined in Table 1 and a risk of low, medium or high defined based on the available data for a particular zone of the site. Where no data is available this is entered into the register, allowing areas of concern where limited data currently exists also to be identified. The zone is then given an overall TAM Risk Category based on the output of the initial failure criteria assessment.

These categories are used to determine the extent of remedial works recommended at the site and are largely based on engineering judgement of the initial failure criteria assessment output. The overall risk categories are defined in table 2.

TAM SITE CASE STUDY – CHITTS HILL EMBANKMENT

INTRODUCTION AND SITE LOCATION

The Chitts Hill railway embankment is located approximately 2km west of Colchester, Essex as shown in **figure 1**. The site runs southwest to northeast on the Liverpool Street to Trowse Lower Junction, (Engineers Line Reference LTN1), between 49 miles 69.5 chains (49m 69.5ch) and 50m 16.5ch and is bounded to the London end by a seven arch masonry viaduct over the River Colne and at the country end by an underbridge. The embankment is 10 m to 15 m high and lies on the edge of a flat flood plain at approximately 10 m AOD. The site is surrounded by agricultural fields to the north west and a golf course to the south east.

The Up side of the embankment has a history of instability with defects recorded on the earliest available modern inspections in 2005 and historical map evidence indicates past interventions and ongoing instability issues. More recently a section of the embankment between 49m 73ch and 49m 75ch was repaired during 2011.

This initially comprised a 4 m deep king post and Armco retaining wall at the crest of the embankment to retain the cess. Following continued deeper seated movement this was supplemented by a more substantial sheet pile retaining wall near the toe of the embankment with the regrading of the slope above the toe wall.

PUBLISHED GEOLOGY AND HYDROGEOLOGY

The British Geological Survey, (BGS), Map Sheet 223 of the 1:50,000 series, (British Geological Survey, 1982), indicates the geological succession at the site as superficial River Terrace Deposits overlying the bedrock geology of the London Clay Formation. Alluvium is mapped at the south western edge of the site associated with the River Colne and may extend beneath the London end of the embankment. Head deposits and glacial sand and gravel deposits are also mapped on the higher ground to the north of the site and may extend beneath the Country end of the embankment.

HISTORICAL DEVELOPMENT

The site is located on the Great Eastern mainline between London and Norwich which was opened in stages between 1839 and 1851, with the section through the site completed by 1844. The earliest available historic map is from 1877 on which the railway is already present. The embankment is shown to have an irregular profile toe from the end of the viaduct at 49m 69.5ch through to approximately 50m 00ch from which point the slopes and toe become more regular through to the end of the site at 50m 16.5ch, (see **figure 2** for reference to site mileages). The neighbouring land is shown as fields on both sides of the railway and along the Down side the embankment toe is indicated to be marshy or wet by the presence of hydrophyllic vegetation symbology, suggesting that drainage issues were already prevalent at this early stage.



A) 49m 73 to 75ch Up. Good condition slope above existing sheet pile wall earthwork renewal



B) 49m 74ch Up. Hydrophilic vegetation and ponding at toe beneath sheet pile wall earthwork renewal



C) 50m 01 to 05ch Up. Toe berm – ash and clinker construction – possible historic stabilisation



D) 49m 77 to 78ch Down. Ponding at slope toe – opposite worst defect on Up Side



E) 49m 76ch Down. Historic toe bulge blocking toe ditch causing ponding at slope toe



F) 50m 05 to 12ch Down. Toe berm on slope – possible historic stabilisation?

Figure 4: Site walkover observations of the earthwork slope



A) 49m 71ch Up. Exposed sleeper ends, ballast spilling down slope and failing cess



B) 49m 78ch Up. Large dip in cess walkway and associated track dip



C) 50m 05ch Up. Cess area in better condition compared to the rest of the site



D) 50m 15ch Up. Sleeper ends exposed, poor cess condition. A small king post retaining wall has been constructed to retain ballast at this location.

Figure 5: Site walkover observations at track level

A tree filled hollow at the toe of the Down side slope is also shown at approximately 49m 78ch between two toe bulges, which may represent the water concentration feature identified on site.

The 1897 and 1923 maps show no significant changes; however, the 1953-1964 map sheet shows considerable changes to the embankment slopes. Two linear benches are now shown on the Up and Down embankment slopes between 50m01ch to 07ch and 50m10ch to 15.5ch respectively, indicating implemented remedial works due to slope instability issues along the site. The toe of the embankment is also shown to extend to the boundary fence at the London end of the site on both the Up and Down sides, which may indicate further failure and lateral spreading of the slopes. The most recent detailed historic map of the site is from the 1960-1978 period and shows no considerable changes to the site.

GEOMORPHOLOGICAL SURVEY

A detailed geomorphological survey of both the Up and Down side of the embankment was undertaken during winter 2018/19, with key slope features and defects recorded on a geomorphological map of the site, shown in **figure 2**. Numerous indicators of stability issues were noted along the length of the embankment on both the Up and Down side including toe bulging and failure lobe features indicating deep seated failure of the embankment slope, (**figure 4E**). Indicators of groundwater issues were identified in the form of hydrophilic vegetation and ponding observed in areas where drainage pathways have been blocked by the presence of toe bulges, (**figures 4B, D & E**). Several historic repairs were recorded in the form of toe berms/weights on both the Up and Down side, (**figures 4C & F**), and a more recent sheet pile wall and slope regrade, (**figure 4A**), indicating an ongoing history of slope instability issues at the site.

Available LiDAR data was used both before and during the detailed geomorphological survey to help identify the location and scale of features at the site. The toe bulging and lateral spreading indicated by the historic map data at the London end of the site is visible on the LiDAR imagery as shown in **figure 3**. Historic and recent remediation measures are also discernible and aided the identification of these features on site during the detailed geomorphological surveys.

The embankment slopes at the site are heavily vegetated, with large mature deciduous trees present on both the Up and Down sides. These large trees are most densely concentrated at the London end of the site where the historic failures have led to less steeply graded midslopes.

Drainage issues are also key to embankment stability and often are the driving factor behind failures. Historic slipping on both the Up



A) 50m 73 to 75ch Up. Distorted cess walkway and temporary speed restriction (TSR) speed board, in early 2011 prior to remediation



B) 50m 73 to 75ch Up. Two rows of cess retention constructed during May 2011, the slope continued to deteriorate shortly after construction due to deep seated failure (Ref 11)



C) 50m 73 to 75ch Up. Sheet pile wall constructed in summer 2011 to replace the failing cess retention and address deep seated failure mechanism (Ref 12)



D) 50m 73 to 75ch Up. Recent photo along sheet pile wall showing good horizontal alignment.

Figure 6: Recent earthwork remediations

and Down sides of the embankment, visible on the LiDAR, aerial imagery and historic maps, was confirmed during the detailed geomorphological mapping of the site. This has led to a number of large toe bulges which have cut off drainage pathways and on the Down side has resulted in the formation of a significant pond approximately 10 m wide and 2-3 m deep when full. This pond aligns directly with the current worst failure location on the Up side.

The Country end of the site is founded on sidelong ground where the embankment runs parallel with the River Colne and at this point natural drainage from the high ground to the north into the valley is blocked by the railway embankment. There are no culverts recorded between the viaduct at the London end of the site and the underbridge at the

country end of the site, meaning that all water draining from the higher ground to the north of the site must either drain along the length of the embankment to the London end, where drainage pathways are blocked by historic failures, or make its way beneath the embankment as groundwater flow.

TRACKSIDE ISSUES

During the walkover survey the track and cess area was observed to be in very poor condition at multiple locations along the embankment. The worst observed area was at 49m 78ch on the Up side where a large dip in the track and cess walkway was recorded along with ballast shoulder thickening up to 1.5m and a lack of ballast shoulder above sleeper level (**figure 5B**).

At both ends of the site, where the embankment interfaces with adjacent structures, the track and cess conditions were observed to be in generally poor condition with ballast spalling down the embankment slopes leading to a low shoulder and exposed sleeper ends (**figure 5A & D**). A small king post wall has been constructed at the country end of the site to restrain the ballast shoulder, but this was observed to be in poor condition and out of alignment (**figure 5D**). Track issues such as these are commonly observed across the network at the embankment/structure interfaces.

Access to the full length of the Down side embankment at track level was not possible due to no walking route being present; nevertheless, it was possible to view the track area periodically along the length of the asset.



A) LLAMAR Rig set up at embankment crest at Country end of site for window sampling



B) Rotary rig set up at embankment toe at London end of site for continuous sampling

Figure 7: Ground investigation utilising a LLAMAR drilling rig and a rotary drilling rig

Some issues were observed on the Down side such as small track dips, loss of the ballast shoulder and exposed sleeper ends, however, the condition of the Down side appeared significantly better than the Up side.

TRACK MONITORING

NR periodically monitor track condition through train mounted equipment which records track geometry and associated ground penetrating radar (GPR) from which the condition of the trackbed can be inferred. The frequency of monitoring across the network is dependent on the frequency of use of the line, with the results of the monitoring presented as Linear Asset Decision Support (LADS) data². LADS data has been consulted for the site and indicates a history of twist faults around 50m 00ch on the Up side between 2016 and 2018, correlating to

the large track and cess dip observed during the walkover survey, (see **figure 5B**). The poor earthwork condition at this location is causing the twist faults observed at track level. Further twist faults are also recorded approximately 50m 16ch adjacent to the underbridge at the country end of the site, which correlate to the defects observed during the walkover survey, (see **figure 5D**), indicative of the embankment/structure interface issues previously discussed.

RECENT EARTHWORK REMEDIATION

An Armco type king post retaining wall, designed by URS, was constructed by CML at 49m 73ch to 75ch on the Up side of the embankment in May 2011¹¹, (see **figure 6B**). This structure was designed to remediate a large dip in the track, (**figure 6A**), which had

led to the implementation of a temporary speed restriction, (TSR), and was causing maintenance issues at the site. The two king post walls were constructed with 4 m long king piles and with two separate rows of piles to allow the wall to be constructed around an OLE stanchion on site. During construction it was identified that the slope failure was also deeper seated than originally thought and therefore the small cess retaining wall was not sufficient to arrest the deeper slope movement. Subsequently a larger lower slope sheet pile retaining wall was designed by URS and installed by CML in summer 2011¹¹, (see **figure 6C**). The wall comprised a 10 m long L605 sheet pile with a 2 m retained height. The slope behind the retaining wall was regraded with general granular fill to form a uniform slope. Following installation of the sheet pile retaining wall maintenance issues have abated at this

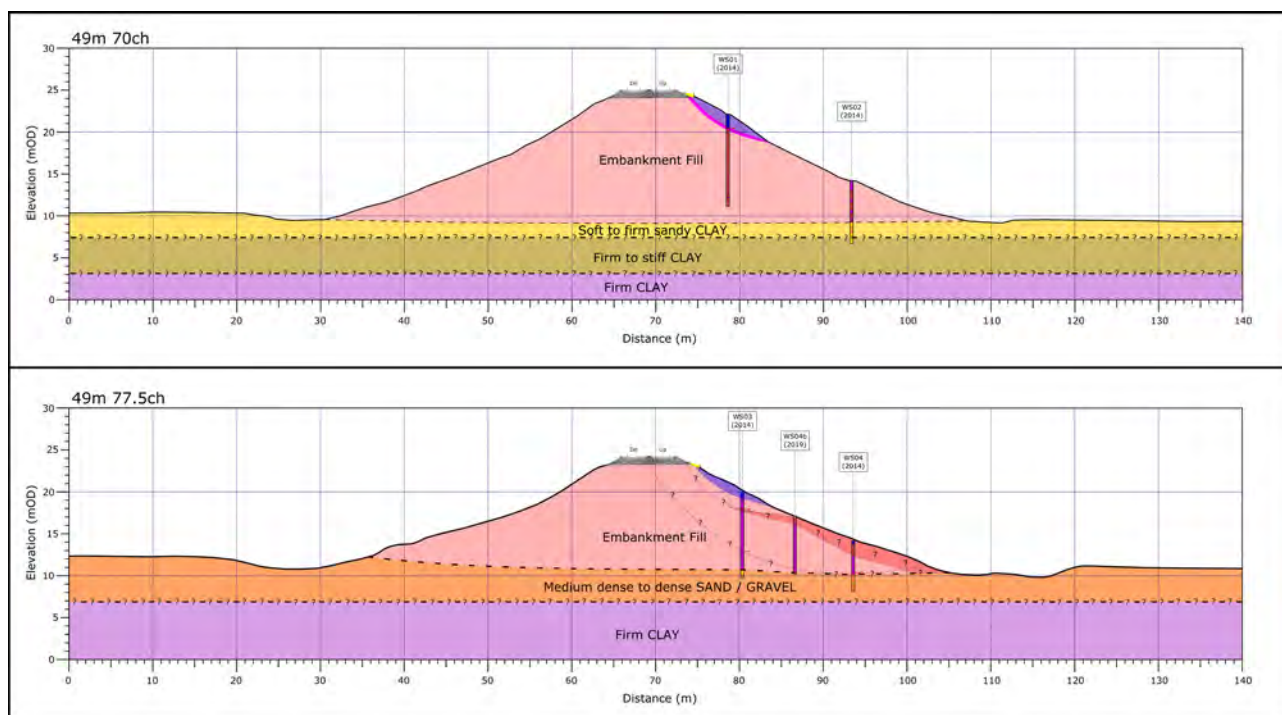


Figure 8: Ground models at 49m 70ch and 49m 77.5ch



Figure 9: Embankment fill material encountered during 2015 GI works

section of the site. The sheet pile retaining wall was also observed during a walkover survey in December 2018 and appeared to be effective, (figure 6D), however a small amount of vermin burrowing was observed in the granular fill above the sheet pile wall.

ECOLOGY SURVEYS

Ecology constraints are ever present at all sites across the network. Chitts Hill was initially subject to a Phase 1 habitat survey by Ecus in September 2018. This identified the potential for several protected species and recommended further surveys for great crested newts (GCN), bats, dormice and badgers, as well as a precautionary method of working in respect to common reptile species and nesting birds.

A robust approach to ecology is required to ensure that unexpected issues do not arise that delay a construction project. The majority of potential ecological issues have been managed through detailed surveys, with results for dormice and bats the only two outstanding surveys.

GROUND MODEL

GROUND INVESTIGATION (GI)

Several phases of recent GI have been undertaken at the site; an initial phase of GI was specified by Atkins' and undertaken on the Up side embankment slopes in 2015 by Topdrill¹⁰ to inform design work undertaken in CP5. The GI work comprised of 8 windowless sample exploratory holes to a maximum depth of 12mbgl undertaken at varying heights up the embankment slope. The exploratory

holes were undertaken using Topdrill Limited, (Topdrill), Lightweight Limited Access Modular Rig, (LLAMR), (see figure 7A). This rig enabled good samples of the embankment fill to be obtained; however, samples of the underlying natural ground were limited to 1-3 m due to the presence of sand and gravel deposits which caused early refusal in some of the positions. Upon completion inclinometers were installed in all 8 exploratory holes.

Further supplementary GI works were specified by Atkins and undertaken at the site by Topdrill during 2019 comprising 9 windowless sample exploratory holes and 3 dynamic/rotary core boreholes. The exploratory holes were undertaken to a maximum depth of 12mbgl and inclinometers were installed in all exploratory holes upon completion. The supplementary GI allowed the underlying natural ground profile to be confirmed with the use of a rotary drilling

rig, (see **figure 7B**), at the toe to penetrate the underlying sand and gravel layers.

GROUND CONDITIONS

The GI works undertaken to date have enabled the development of a detailed ground model for the site, which will be subject to further refinement during the detailed design process following the most recently installed slope monitoring data becoming available. Two sections were produced to allow stability analysis to be undertaken at 49m 70ch and 49m 77.5ch are shown in **figure 8**.

Typically, the embankment slopes at the site feature an over steepened upper slope comprised of loose ash and clinker deposits, overlying the embankment core, (see **figure 9**). Due to the nature of construction used on the early railway construction across the UK, and subsequent historic stability problems at the site, the composition of embankment fill does show variations across the site, but typically was found to comprise slightly gravelly sandy clays. At some sections along the site, horizons of softer clay were logged within the embankment fill which from the initial analysis appear to align with areas of movement identified in the inclinometers installed upon completion.

The underlying natural ground conditions, as anticipated based on interpretation of slope failure mechanisms and slope morphology, were found to vary along the site. At the London end of the site up to 3 m of soft alluvial soils associated with the River Colne were encountered, whereas the middle and country end of the site was underlain by more competent sand gravel and stiff sandy clay representative of river terrace and head deposits. These changes are directly linked to the embankment traversing a number of different geological settings, from the base of the river valley at the London end of the site onto the lower flanks of the valley side slopes at the country end.

The top of the London Clay formation was also confirmed along the length of the site, ranging from approximately 3 m OD at the London end of the site to approximately 8 m OD at the country end of the site, tying in with the nearby historic borehole data along the A12 corridor.

SLOPE MONITORING

Eight inclinometers were installed at the site during the 2015 GI and these installations have been monitored since installation. The installations are targeted at the worst affected areas of the site, (see **figure 2**), and movement trends observed in the inclinometers varied across the site.

At the worst affected area of the site at 49m 77.5ch, total movement of up to 91 mm was observed over the 4-year monitoring period, (**figure 10**). This movement was observed to be deep seated with a failure plane identified at approximately 7mbgl at the slope crest. This

deep-seated movement was also observed in a number of the other inclinometer installations at the site.

A different failure mechanism was observed adjacent to the viaduct at 49m 70ch. At this location a high magnitude of movement was observed, (57 mm max), but this progressive movement was observed at shallow depth at up to 2mbgl at the crest of the embankment, (**figure 11A**). It is thought that this shallow failure is caused by a loose ash layer which is confined to the upper shoulder of the embankment slope with some desiccation related movement evident in **figure 11B**.

Twelve additional inclinometers were installed at the site at the start of 2019 to allow more detailed examination of the slope movement at the site. The monitoring results from these installations are not yet available.

CHITTS HILL TAM STAGE 1 OUTPUT

The Chitts Hill site has been subjected to the TAM Stage 1 process and following the detailed site mapping the site was subdivided into zones. The zones were then assessed in line with the TAM failure criteria and assigned an overall TAM Risk Category as can be seen in **figure 12**.

The Up side has been subdivided into eight zones, the division of these zones being determined both by physical changes in the shape of the earthwork, (indicative of different failure mechanisms), and the condition at track level, which has the most immediate impact on the operational safety of the railway. Each of these zones has been scrutinised in detail and all available data analysed to determine the resultant TAM Risk Category. The quantity of available GI and slope monitoring data on the Up side has enabled the zoning to be targeted, enabling resultant remediation works to target the worst affected areas.

In contrast, the Down side has less individual zones as the information available for this side of the earthwork is limited, as this did not form part of the original site scope. Therefore, the subdivision is based entirely on site observations and available track data. However, as a result of undertaking this assessment, various issues have been identified on the Down slopes which were not previously known, including various historic failures, historic intervention works and drainage issues that may be directly affecting the Up side condition at the site. Due to the investigation undertaken there are now plans to undertake drainage improvement works on the Down side to address the identified issues.

The TAM zoning process has allowed the proposed remedial works to be tailored to the specific requirements of each zone, which ultimately will allow a greater percentage of the site to be fixed within the available budget. The data also allows a detailed analysis of the mode of failure in these areas, giving NR

the option to consider smaller localised fixes in some areas, (such as run on / run off of structures), to maintain the serviceability of the railway without implementing a full scale embankment remediation throughout. The zoning and remedial works options for the site will be further refined during the final phases of TAM Stage 1 once the ongoing GI works are completed and during the TAM Stage 2 scope ratification process, ensuring that the chosen remedial works are robust and fulfil Network Rail's requirements.

DESIGN OPTIONEERING

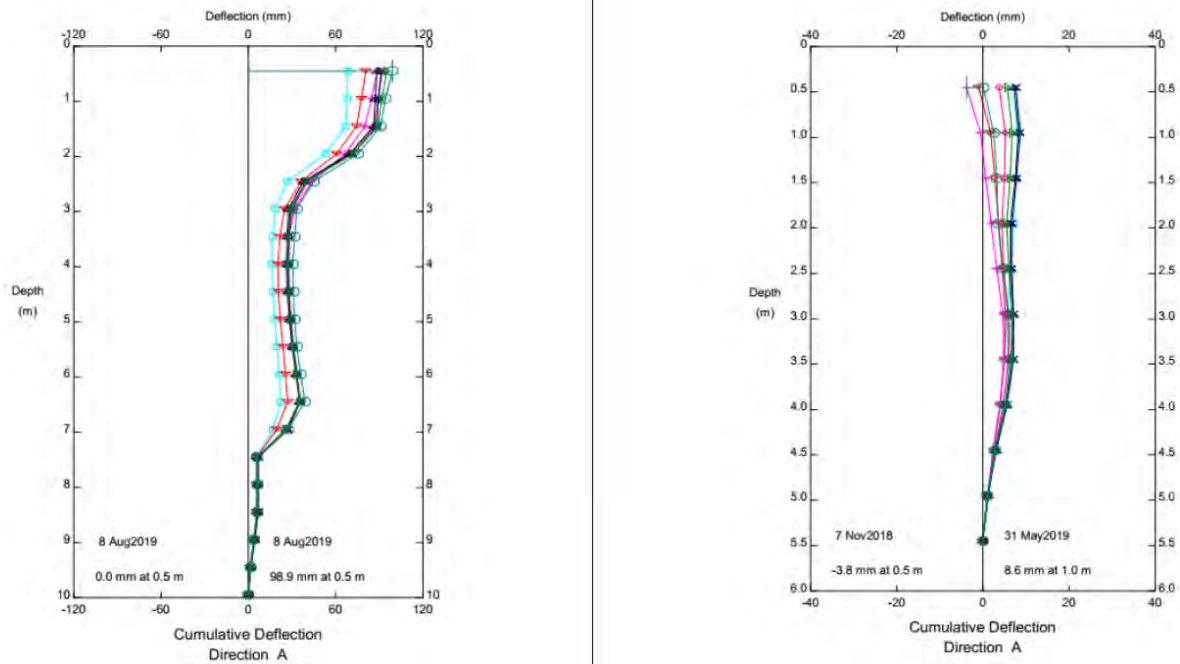
Following completion of the TAM Stage 1 Risk zonation, initial analysis and design optioneering was undertaken for the earthworks renewal at the site. Initial design options were considered for all high (red) and medium (orange) areas of the site, (**figure 12**). Three options were considered in the optioneering exercise; toe berm with slope regrade, soil nails with cess retention and a sheet pile retaining wall with slope regrade. The design solutions need to manage both the deeper seated failure in the embankment and the near surface failure in the upper layer of ash fill.

Outline geotechnical analysis for each option was undertaken in accordance with BS EN 1997-1:2004: Geotechnical design (including National Annex)^{7,4}, NR's design guidance document NR/L3/CIV/071⁸ and BS 8006-1:2010 Code of practice for strengthened/reinforced soils and other fills⁵. The design life of the stabilisation measures was 60 years for the soil nail option and 120 years for the slope regrade and sheet pile wall option. Rail traffic loading was taken from BS EN 1991-2⁶ and maintenance loading was considered over the cess area. Geotechnical design parameters were derived from the GI works based on in-situ and laboratory test results and were checked against back analyses of the embankment slopes. Groundwater level was taken at the toe of the embankment due to ponding observed at various locations along the asset and a pore pressure coefficient $r_u = 0.2$ was considered in the embankment fill material.

The outline design output indicated that all three options were feasible for renewal of the earthwork. The three options were taken forward to TAM Stage 2 in which construction pricing was estimated, the soil nail option was selected as the preferred option following this assessment.

ASSET MANAGERS PERSPECTIVE

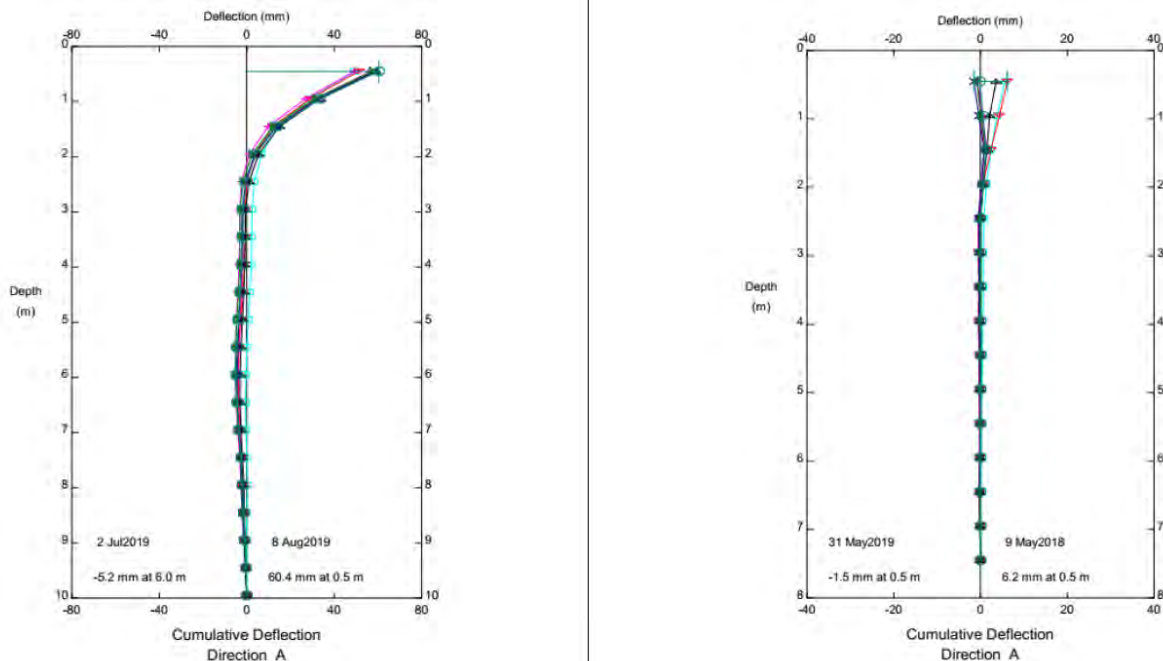
During Victorian railway construction most of the fill was end tipped using horse-drawn earth wagons with little or no compaction. Settlements were large but accepted as an inevitable consequence of the construction method, initially mitigated by topping up with readily available materials such as locomotive ash and more recently mitigated by speed restrictions and ballast packing. Monitoring



A: (left) 49m 77.5ch WS03 (slope crest) 99 mm max movement between 2014 and 2019. Two potential zones of movement are visible – one at 2.5mbgl and one at 7mbgl.

B: (right) 49m 77.5ch WS04 (mid-slope) 8 mm max movement between 2014 and 2019. Inclinometer is founded at shallow depth (5.5mbgl) therefore deeper-seated movement could be occurring below the base of the inclinometer.

Figure 10: Inclinometer monitoring results indicating deep seated movements at 49m 77.5ch



A: (left) 49m 70ch WS01 (slope crest) 60mm max movement between 2014 and 2019.

B: (right) B 49m 70ch WS02 (mid-slope) 6mm max movement between 2014 and 2019.

Figure 11: Inclinometer monitoring results indicating shallow depth failure adjacent to viaduct

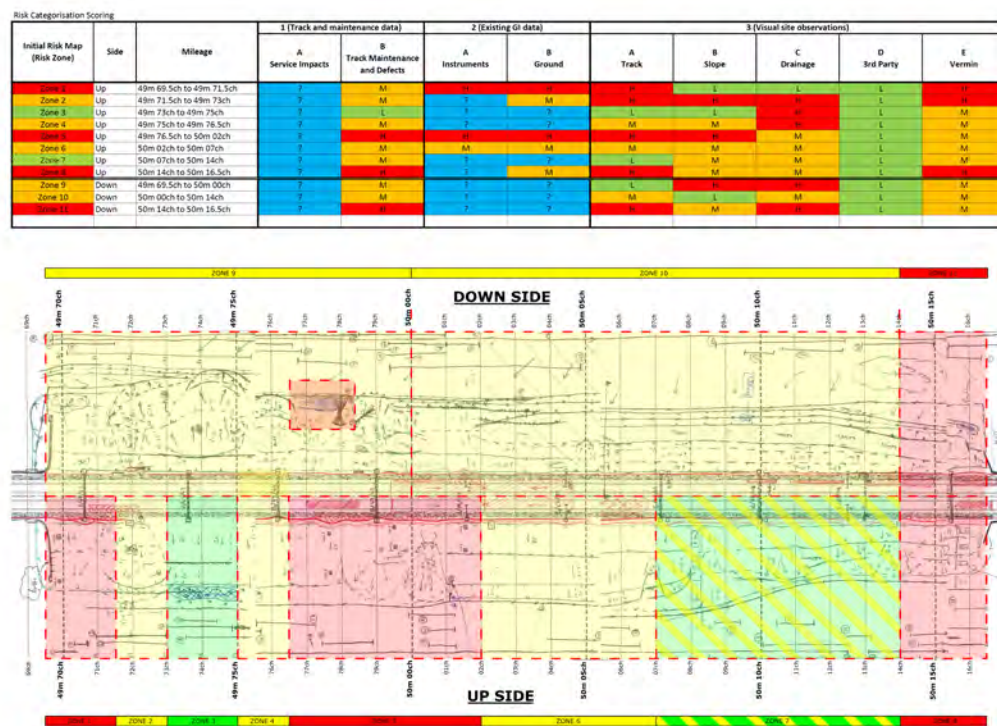


Figure 12: Chitts Hill site TAM risk zonation

slope movements at various depths allows the identification of clear failure modes with deep seated failures in the over-steep unengineered London Clay embankment and shallower near surface movements associated with degradation of the upper embankment layer of ash fill evident at Chitts Hill in common with many other embankments in the Anglia region.

The Targeted Asset Management, (TAM), process has proved useful in managing the challenges faced by infrastructure managers holding limited budgets and high performance expectations of rail customers. Detailed interrogation of slope movement trends, track problems and the development of a ground model enabled optimised mitigation for higher risk zones of the embankment slope, demonstrating sound asset management.

The Chitts Hill site was subdivided into areas of low, medium and high risk against a set of failure criteria with the view that initially only the higher risk and some of the medium-risk areas would be mitigated earlier. The earthworks renewal portfolio is subject to budget constraints and the use of a more innovative risk-based and focused mitigations releases funding to maximise the number of site that can be treated across the wider regional earthworks portfolio.

Risks associated with other adjacent untreated areas are controlled through ongoing observational and instrumentation monitoring. With increased rail traffic and continued unpredictable weather in the future, it is important for Network Rail to have such a proactive strategy of Planned interventions

to avoid needing shorter term Reactive or Emergency management of slope instability which would result in much less cost-effective asset management.

CONCLUSION

The Chitts Hill embankment site demonstrates the challenges of working on large linear earthworks that have been in constant use for over 150 years. Old earthworks such as this experience a variety of issues with fundamentally different underlying causes. A holistic approach is required for the investigation of the assets in order to fully understand the driving causes behind the issues to ensure that an appropriate remediation strategy is implemented. Access difficulties and limited availability of historical records add to the difficulty of investigating the assets. A pragmatic approach is required to ensure that necessary works are undertaken to maintain the safe operation of the railway within limited available budgets. This has been achieved at the Chitts Hill site through the use of the Targeted Asset Management, (TAM), approach which has allowed renewal works to be targeted at the worst affected areas of the asset whilst risk control measures are implemented at other high priority sections.

REFERENCES

1. Atkins, 2014. CP5 Anglia Critical Earthworks Risk Management Package 1 Particular Specification to the Master Specification for Chitts Hill. Doc Ref: 137959-ATK-SPE-EGE-000023 Rev01.

2. Bentley, 2019. LADS Data to Analyze Rail and Track Condition. Available from: <https://www.bentley.com/en/capabilities/apm/analyze-rail-track>
3. British Geological Survey, 1982. 1:50,000 Series England and Wales Sheet 223 Braintree Solid and Drift Geology.
4. BSI, 2007. NA to BS EN 1997-1:2004: National Annex to Eurocode 7: Geotechnical design - part 1: General rules. BSI, London, UK.
5. BSI, 2010. BS 8006-1:2010: Code of practice for strengthened/reinforced soils and other fills. BSI. London, UK.
6. BSI, 2010. BS EN 1991-2:2003: Eurocode 1: Actions on structures - Part 2: Traffic loads on bridges. BSI, London, UK.
7. BSI, 2010. BS EN 1997-1:2004: Eurocode 7: Geotechnical design - part 1: General rules. BSI, London, UK.
8. Network Rail, 2011. NR/L3/CIV/074: Geotechnical Design Issue 4. NR, London, UK.
9. Payne, I. Holt, S. and Griffiths, I., 2018. Railway embankment stabilisation: economical asset management. Proceedings of the Institution of Civil Engineers - Geotechnical Engineering 171(4): 332-344.
10. Topdrill, 2015. CP5 Anglia Critical Earthworks Report for Ground Investigation at: Site 12 - Chitts Hill. Doc ID: TOP1829 - 137959 Chitts Hill FR01.
11. URS, 2011. Chitts Hill Embankment LTN1: 49m 1620 yards Form B Cess Retention General Arrangement Drg. Doc Ref: 46382007/ FORM B/001.
12. URS, 2011. Chitts Hill Embankment Repair Works - Sheet Pile Wall. Site Layout Plan And General Arrangement. Drg No: 46382007/ FORM B/101.

Collecting asset data and generating intelligence

AUTHOR:

Kevin Hope
Network Rail

The resurgence of the railways has meant that the importance of understanding the condition and performance of infrastructure assets has never been greater. As usage increases, so to does the rate at which deterioration occurs, meaning that in general terms maintenance intervals can be expected to reduce.

However, running more trains also means that there is less time available for maintenance. In addition, as the network becomes more congested the impact of any failures that do occur is much greater for the passenger.

This conundrum is the subject of this article which considers the evolution of infrastructure measurement into its current state and describes how, over the course of the current 5 year Control Period, (2019-2024), it is expected to change further to meet these new demands.

A DRIVER FOR INVESTMENT

The first dedicated Infrastructure Measurement (IM) vehicles in the UK were developed by British Rail Research in the late 1960s and early 1970s to measure track geometry, using analogue systems.

A bespoke vehicle was built to measure structure gauge and a coach was converted to create the Mentor overhead line measurement vehicle, (**figure 1**). The first ultrasonic test unit was also developed.

Unfortunately, it was the Hatfield disaster in October 2000 that prompted the transformation of those early vehicles into the measurement fleet that Network Rail operates today.

During the early 2000s the focus was on increasing the frequency at which the network could be covered by introducing new vehicles. There was also a significant expansion of the capability of the fleet through the introduction of new technology.

The aim was twofold; firstly, to try and reduce the number of people working on the operational railway measuring and inspecting the infrastructure and secondly, to move from a reactive regime where failures occurred and were fixed to one where maintenance engineers had early warning of issues and could plan preventative work before failures occurred.

This period saw the introduction of the New Measurement Train, (NMT), (**figure 2**), in 2003, as well as the creation of additional ultrasonic test units. New technologies were introduced to measure rail profile, the position and wear of overhead wires, track intervals and trackbed condition using Ground Penetrating Radar, (GPR). In addition, the first steps were taken towards trialling the use of in-service TOC trains to collect asset data, with Unattended, (track), Geometry Measurement Systems, (UGMS), being fitted to passenger carrying vehicles on the East Coast, West Coast, Great Western and Chiltern mainlines.

More recently, the major development has been the introduction of the Plain Line Pattern Recognition, (PLPR), system, which enables track inspections to be carried out from an office environment using high definition video footage instead of people manually patrolling the track and exposing themselves to the risks associated with trackside working, (**figure 3**).

The introduction of PLPR required the creation of two additional trains, a signification re-configuration of the fleet and a major re-write of the train plan to deliver the four weekly recordings required. It also led to the creation of analysis suites where the different data sources are amalgamated and where the examination inspectors review the potential faults, (candidates), identified by the machine vision algorithms.

Other developments have included the trial and introduction of eddy current testing to understand the extent of cracking in the surface of the rail. Again, this will replace manual inspections but will also provide a greater understanding of asset condition due to the ability of the system to measure the depth of cracks rather than just the length of a crack on the rail surface.

This development is particularly relevant as it is aiming to detect the failure mode that caused the Hatfield disaster.



Figure 1: Structure Gauging Optical car (left) and Mentor Overhead Line measurement vehicle (right)



Figure 2: New Measurement Train

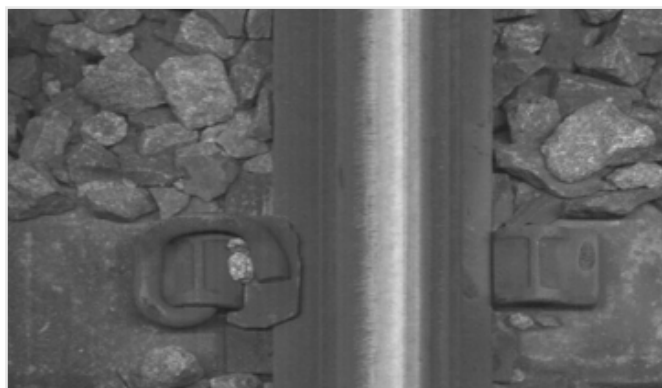
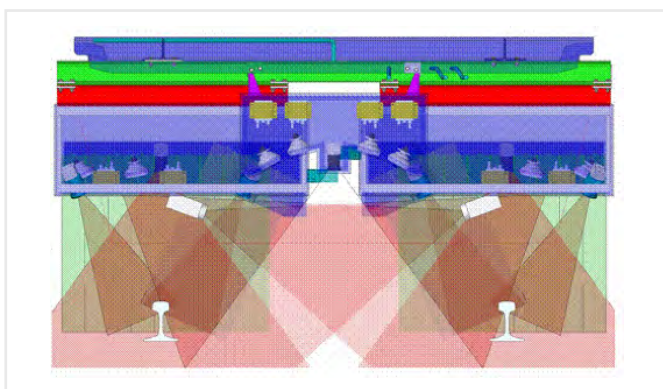


Figure 3: Schematic showing the PLPR camera views and an example image, captured at speeds up to 125mph

SUCCESS STORY

The IM fleet now consists of 11 measurement trains, measuring 16 different datastreams. It is a 24/7 operation with more than 2000 shifts every year and more than 750,000 miles of data being collected. **Table 1** summarises the datastreams currently collected by the fleet, the technology used to collect this data, and which trains have these different capabilities.

It is fair to say that the IM fleet has been a huge success in mitigating some of the key safety risks – derailment, dewirement and rail breaks. An example is shown in **figure 4**, which shows how the number of rail breaks per year has reduced from almost 1000 per year pre-Hatfield to a consistent level of around 100 per year over the last five years.

Datastream	Technology	Trains with this capability
Track geometry	Inertial & laser/camera	NMT, PLPR1, PLPR2, PLPR3, PLPR4, TRU, MPV
Video inspection (PLPR)	Linescan cameras	NMT, PLPR1, PLPR2, PLPR3, PLPR4
Rail profile	Laser/camera	UTU1, UTU2, UTU3, UTU4, TRU
Rail flaw	Ultrasonics	UTU1, UTU2, UTU3, UTU4, UTU-S
Rail surface crack	Eddy current	UTU1, UTU2, UTU3, UTU4
Ballast profile & track interval	Laser scanner	NMT, PLPR1, PLPR2, PLPR3, PLPR4
Structure gauge	Laser/camera	UTU1 (SGT2), UTU3 (SGT1)
Trackbed condition	Ground penetrating radar	UTU1, UTU2, UTU3, UTU4
OLE wire wear	Video	NMT, PLPR2 (EMV)
OLE geometry	Laser scanner	NMT, PLPR2 (EMV)
OLE video	Video	NMT, PLPR2 (EMV), PLPR1 (Mentor)
OLE contact forces	Inertial & load cells	PLPR1 (Mentor)
Conductor rail geometry/profile	Laser/camera	PLPR3
Radio survey	GSM-R test kit	NMT, PLPR1, PLPR2, PLPR3, PLPR4, TRU
Forward facing video	HD video	NMT, TRU, MPV
Video survey	Video	TRU

Table 1: Summary of Network Rail's measurement fleet capability

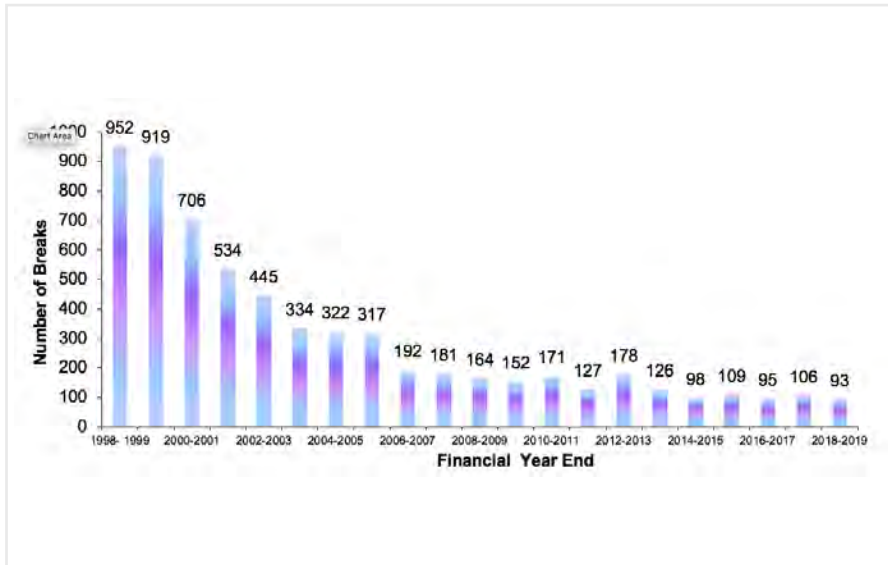


Figure 4: 20 year view on rail breaks, showing a significant reduction



Figure 5: Reduction in Service Affecting Failures



Figure 6: Summary infrastructure assets fitted with embedded monitoring systems

It is important to recognise that safety is not the only measure of success. For passengers, safety is a given, they automatically assume that they will arrive at their destination safely. This means that they are concerned with arriving on time, having had a comfortable journey and having paid a reasonable price for their ticket; so this is about performance, capacity and efficiency.

From a performance perspective, over the last 6 - 7 years the number of trains arriving on time, (Public Performance Measure - PPM), has been consistently below target, even though that target has been revised downwards on a number of occasions. During the same period however, the total number of infrastructure failures that have caused a delay, (Service Affecting Failures), has reduced by around 20%, (figure 5). Although on the face of it this may seem contradictory, the reason for this is that the impact of each asset failure is increasing, with more and more trains being delayed by each failure on our increasingly congested network.

One of the reasons for the reduction in the number of Service Affecting Failures is the fitment of embedded monitoring devices to more than 60,000 assets, (figure 6). As well as allowing control centre technicians to understand how assets are performing in near real time, the over-arching system monitors how asset performance is changing over time so that the early signs of a potential failure can be detected and the right intervention can be planned and executed before a failure does occur and service is affected.

As the demand to run more trains continues to increase, there is clearly a need to further reduce the number, (and if possible the impact), of Service Affecting Failures. This logically leads to looking at how other assets, particularly linear assets such as track and overhead lines, can be monitored more continuously.

There is certainly no scope to do this by running the IM fleet more frequently, for two reasons; firstly there aren't enough IM trains but even if there were running them would use up the much sought after capacity on the network that is being demanded by passenger and freight operators. Any approach to monitor linear assets more frequently is therefore reliant on using vehicles already operating on the network ie in-service TOC and / or FOC trains.

THE FUTURE OF TRAINBORNE ASSET DATA COLLECTION

In 2015/16, Network Rail carried out a study to consider if any feasible alternatives to a dedicated fleet of measurement trains existed. The requirement was analysed at a detailed level and a modelling tool was built to understand how all the infrastructure that needed to be measured could be recorded at



Figure 9: PLPR imagery showing multiple rail surface defects

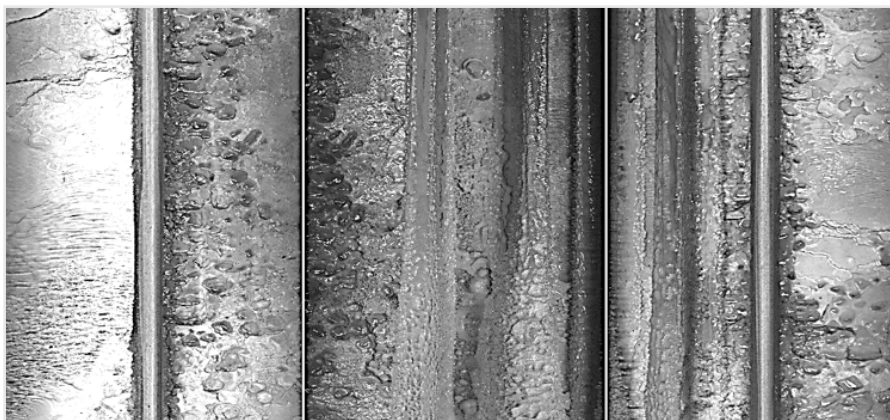


Figure 10: PLPR imagery showing slurried trackbed

However, a large proportion of reports result in no fault being found with the track. The trials are therefore trying to provide a more objective measure of vehicle response that can be monitored for changes over time to provide an early warning of a potential issue even if it is developing rapidly.

From an OLE perspective, Network Rail are actively progressing with the introduction of overhead line measurement systems onto passenger carrying vehicles on the West Coast, East Coast and Great Western Mainlines to provide the linespeed measurements that are required, but that cannot be delivered by Mentor, (which is limited to 100mph operation). These OLE measurement systems are focussed on complying with the requirements of Network Rail engineering standards and the Energy TSI.

There are also initiatives that are pursuing simpler solutions for OLE monitoring that are more widely applicable. There has been some success with simple accelerometer systems that identify locations with high longitudinal accelerations to try and prevent chipping of the pantograph carbons. Recent developments in sensor technology are likely to make it possible in the future to have embedded accelerometers in all pantograph heads which has the potential to turn all trains into measurement trains!

There has also been a significant focus on the exploitation of pantograph camera footage,

both to identify potential issues in a similar way that the PLPR system does for track, but also to derive wire position and estimate forces from the imagery. This is another exciting development that again has the potential to vastly increase the frequency with which OLE can be monitored without running additional dedicated trains.

EXPLOITING THE DATA

So far this article has focussed on the collection of data, and the message is clear; it is becoming easier and cheaper to collect more and more data. However, for our already overstretched maintenance organisation, simply providing this data directly to them is not helpful. The challenge is therefore to use all this data to help our maintenance engineers prioritise their workbank and reduce the number of things they need to respond to urgently.

This is the focus of the Intelligent Infrastructure programme, which was launched in April 2019 to deliver enhanced 'predict and prevent' capability using advanced data analytics and new Decision Support Tools, (DSTs).

An example is the Track DST, which allows multiple, similar datasets to be overlaid and deterioration rates to be established. This enables predictions to be made on the time remaining before a fault is 'expected' and for maintenance engineers to have a means of knowing where to focus their immediate

attention to prevent Service Affecting Failures and in addition, where to plan work in the future. Having this forewarning should allow the right work to be planned and therefore reduce the number of repeat visits to a particular location. **Figure 8** shows the overlay of multiple datasets in the prototype track DST.

The DST, which has been migrated from a desktop application to a web-based tool also enables teams to drill down and extract different data sources to identify the root cause of a failure. A key data source for this root cause analysis is the PLPR imagery. The aim is to use this approach to develop greater desktop scoping capability, which has the potential to determine the right treatment without needing to go out to site. **Figure 9** and **figure 10** are clear examples of how imagery can help provide understanding that may not always be apparent when considering the primary sources of data individually; ultrasonics and track geometry in these cases.

Another opportunity that cross-correlation of different sources of data offers, is the potential to reduce false positives. In much the same way as machine vision algorithms are used in the PLPR software to differentiate which candidates may be potential faults and which aren't of interest, a similar approach can be used across different datastreams. The most obvious example is the use of imagery to supplement the analysis of rail flaw and rail surface crack data. There are a number of, (benign), track features e.g. bond pins that show up in the ultrasonics that are difficult to identify by just looking at that data. However, when the ultrasonic data is combined with imagery this uncertainty is removed. On this basis, it is felt that there is a large opportunity to reduce the number of ultrasonic suspects that are reported, thus reducing the amount of manual, on-track verification required.

CONCLUSION

As the demand for train travel continues to grow, and with plans to run even more trains in the future due to the digital railway, the need to collect, analyse and exploit asset data has never been greater. As sensors continue to develop and become smaller and cheaper there is undoubtedly an opportunity to collect asset data in a less intrusive manner using in-service platforms. However, unless there is a major technological breakthrough there will continue to be a need to measure rail flaws and rail surface cracks at speeds slower than in-service vehicles typically operate. The challenge therefore is to determine the optimum mix of dedicated recording platforms and in-service monitoring installations to ensure that the infrastructure is both safe and available. To realise the full potential that this hybrid approach offers will require considerable investment in data management to ensure that the data can be distilled down so the frontline only receive the information they need to carry out the right work, at the right location, at the right time.

Speed restrictions, maximum safe speed and automatic train protection (ATP) speed supervision

AUTHORS:

Dr Daniel Woodland
MEng (Hons), CEng, FIRSE

Ricardo Rail

Joss Apps
BEng (Hons), CEng, FIMechE,
Ricardo Rail

This paper was produced for, and peer reviewed by, the IRSE ASPECT international technical conference, being held in Delft from 22 to 25 October 2019. By kind agreement of the IRSE it is also being published here, slightly in advance of that conference.

SUMMARY

In this article the authors consider the main reasons why speeds may need to be limited during operation and the methods used to determine permissible speeds and maximum train speeds on UK railways. They then consider the implications that introduction of comprehensive ATP systems should have on definition of maximum safe, (emergency), speeds, (EVmax), to facilitate optimum usage of the rail infrastructure under ATP supervision.

INTRODUCTION

In normal operation, a train's speed must not exceed either the safe limit, (before, say, derailment may occur), or the

comfort limit, (where passengers may be bounced about or otherwise experience unacceptable discomfort). These characteristics can be defined as Vmax for the particular train type at any given location.

Since ATP systems are provided as safety systems, they must ensure that unsafe levels of overspeeding do not occur. At the same time, in order to support efficient operation of the railway, they must not be overly restrictive in constraining a driver's normal, (safe), driving behaviour.

If an ATP system is to prevent the train speed from reaching unsafe levels, it must:

- Allow for delays in brake application once an intervention has been made;
- Allow for the system's own processing delays;
- Allow for worst case acceleration of the train during these delay periods.

It must, therefore, initiate an intervention at a speed well below the actual safe limit. In addition to the constraints imposed by safety, many operators also require ATP systems to:

- Provide a warning to the driver if he/she is detected as overspeeding;
- Allow the driver some reaction time following a warning before intervention occurs.

If such facilities are provided, the speed at which warnings must be initiated will be even further below the actual safe limit. However, in order to ensure efficient operation, such warnings are generally required to commence only once overspeeding has occurred, (i.e. the train is travelling at a speed which exceeds the maximum 'authorised' or 'permissible' speed).

At this point, the implementation of ATP supervision starts to look like it will have a significant, (detrimental), impact on operating speeds if drivers want to avoid intervention. Fortunately, however, the permissible speeds applied to the railway are not set at the maximum safe and comfortable speed for travel, (Vmax). In general, whilst a line speed or Permanent Speed Restriction, (PSR), will be based on an assessment of the track topography, (and condition), and perceived acceptability, (safety / comfort of ride), of movement at a given speed, that assessment is made qualitatively, based on, (conservative), 'Engineering Judgement' and it will be formally defined as a nice rounded, (down), number that can be easily displayed, read and understood from trackside signage and route descriptions.

Thus, the PSR is in fact significantly below the Vmax. In degraded conditions, these may be superseded by a lower Temporary Speed Restriction, (TSR), or Emergency Speed Restriction, (ESR), in order to protect against

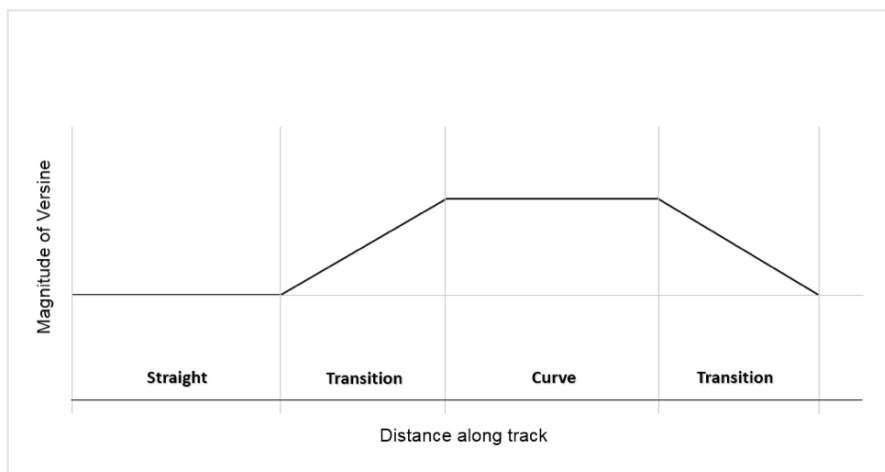


Figure 2 1: – Track curvature described by versine measurement

concerns that operation at the PSR is no longer safe, pending remedial works - but the basis of calculation for a TSR / ESR is similarly qualitative.

On the mainline railway maintained by Network Rail there are several differential PSRs; probably the most significant is that for Sprinter trains, ('track friendly' trains, allowed to operate at higher PSR compared to non-Sprinters passenger rolling stock and freight). Differential PSRs recognise that there are differences between train types.

Many PSRs exist on the basis of 'grandfather rights' and modern engineers would be hard set to justify quite why they are at the speed defined, however, clearly, absence of incidents over time shows that they haven't been set too high. Similarly, TSRs / ESRs are often set based on 'broad brush' assessments of the type of problem being experienced.

Indeed, during a lecture to the eighth IEE vacation school on Railway Signalling and Control Systems, it was noted that "generally speed restrictions are imposed either for comfort or to reduce wear and tear. There is usually a substantial margin for error. In the case of track-based speed restrictions the overturning speed is typically 50% above the speed limit"⁸. Any such 'margin' between the permissible and safe speeds of travel for a train may provide 'room for manoeuvre' in the development of ATP speed supervision criteria.

On which thought we arrive at a new idea... when it comes to ATP implementation, it is not only the case that the permissible speed (PSR / ESR / TSR) is below the speed that needs to be 'protected', but even the V_{max} , (which allows for comfort as well as safety), could be exceeded in a worst-case scenario without compromise to safety. Thus, for ATP supervision the real speed of interest is that which a vehicle could be permitted to achieve in emergency conditions, (ie worst-case speed that could be permitted before ATP intervention brings speed under control) – or an Emergency V_{max} , (EV_{max}). On this realisation, the feasibility of implementing an ATP system without detriment to current operating speeds suddenly becomes apparent.

In this article, the authors consider the main reasons why speeds may need to be limited during operation and the methods used to determine permissible speeds and maximum train speeds on UK railways. They then consider the implications that the introduction of comprehensive ATP systems should have on the definition of maximum safe, (emergency), speeds, (EV_{max}), in order to facilitate optimum usage of the rail infrastructure under ATP supervision.

TRACK ALIGNMENT

A number of the reasons for setting speed restrictions relate to the alignment of the track. In order to assist the reader's understanding,

the authors will begin by briefly considering the subject of track alignment in order to define the terms that will be used in the subsequent discussion.

In plan view, track consists of straight, curved and transitional sections designed to ensure safety against derailment and maintaining comfort for passengers. For low speed train operation, transitions are not necessary. However, as speed increases, transitions between straight and curves are required. A common method for setting out track alignment is by versine as this can be measured using simple chord and offset process, (figure 2-1).

As a train travels around such a curve, it is necessary to rotate the vehicles which naturally tend to continue in a straight line. This rotation is achieved as the result of a centripetal force acting inwards towards the centre of the curve, exerted on the train's wheelset by interaction with the track, (figure 2-2).

In accordance with Newton's third law of motion, the track experiences a reaction that is equal and opposite to the centripetal forces that it is exerting on the wheelsets.

This reaction, known as the centrifugal force, therefore acts horizontally outwards from the curve, with a magnitude equal, (but opposite), to the centripetal force and given by:

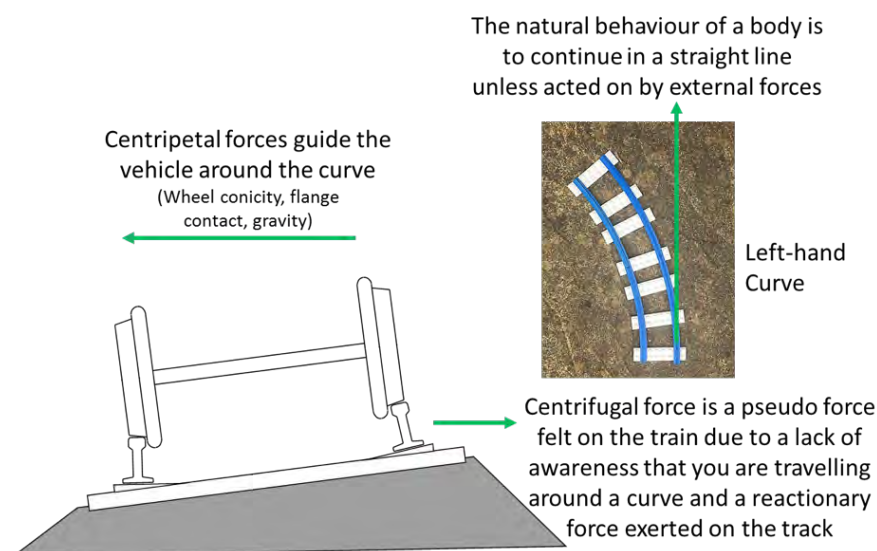


Figure 2-2: Forces experienced on a curve

$$\text{Centrifugal Force} = \frac{MV^2}{R} \text{ [N]}$$

Where M is the vehicle mass (kg), V the speed (m/s) and R the radius of the curve (m). (Equation 2-1).

If both rails of the track are horizontally aligned, objects within the vehicle will also experience deflection from the straight-line motion and the consequent centrifugal reaction to the curving forces. This reaction will cause the objects within the vehicle to tend to slide outwards. If one of the objects is a passenger, this will cause an uncomfortable sensation as if he/she were being pushed over. Cant is therefore applied to the track in order to reduce the effects of centrifugal forces. Cant is the difference in vertical level across the track gauge. It is measured in mm at the railhead centres or contact rolling point of each rail, or as an angle between the plane of the track and the horizontal, (see figure 2-2). If the track is canted inwards, the centrifugal force becomes resolved into two components, one perpendicular to the vehicle floor and the other parallel to it. Similarly, the forces produced by the mass of the train also become resolved into two components, one perpendicular to the vehicle floor and the other parallel to it in the opposite direction to the centrifugal forces, (see figure 2-2). The two forces parallel to the vehicle floor therefore act against each other, reducing the effects of lateral acceleration on passenger comfort.

As the forces due to the vehicle mass are constant but the centrifugal forces are dependent on the speed and curve radius, it is possible to design a curve with a level of cant that causes the perpendicular force components to cancel each other out at a given speed. This cant is referred to as the 'equilibrium cant' which, when achieved, produces no sensation of lateral force for passengers on the train.

Unfortunately, since the equilibrium cant can only exist at one speed on a particular curve, most trains will travel around the curve at a higher or lower speed. This causes a deficiency or excess of cant, in both cases leading passengers to experience the sensation of lateral forces. If the cant excess or deficiency becomes too high, the train may become liable to wheel flange climb and subsequent derailment or overturning. Interestingly, flange climb derailments tend to occur at low speed not high speed; and long before the limit of reasonable comfort for passengers and the driver will be reached. A balance must therefore be found in selecting suitable levels of cant and determining line speeds.

Cant deficiency and excess are measured either in terms of the angle, (in degrees), or the distance, (in mm), by which they differ from the equilibrium cant, rather than the speed differential that they represent, (figure 2-3).

If the track on a simple curve is canted and the straight track to which it is joined is not, a cant gradient is introduced across the join.

This can cause a sudden jerk in the train's movement, affecting both passenger comfort and safety. In order to avoid this occurrence, a transitional section is included in between the circular arc or the curve and the straight track to change both the horizontal curvature and track cant gradually and uniformly. "The nature of the transition curve is probably the most important design feature of a railway alignment for high speed passenger vehicles as it has the greatest influence on passenger comfort"^{3 p14}.

Horizontal curves are not the only element of track alignment to consider. Railways also require gradients. As with horizontal transitions, vertical curves are used to minimise the transient effects of changes in acceleration where sections of track with different gradients join.

They must limit the rate of change and value of vertical acceleration experienced by passengers to a comfortable value, limit wheel unloading during the transition, prevent excessive compression of the springs of the inner axles of any vehicles with three or more fixed axles and maintain track clearance, (to avoid 'grounding').

However, "in the context of rail speed increases, vertical radii could be considered less important than horizontal curves"^{3 p15}. They will not, therefore, be expanded upon here.

THE NEED FOR LIMITING SPEEDS

The speed of a rail vehicle can affect both the comfort and safety of passengers through a number of mechanisms. Each of these mechanisms raises the need for limiting speeds in certain circumstances, for certain vehicles or at certain locations. In order to consider the relevant mechanisms and their effects, the authors have identified five reasons why speed may need to be limited, each of which will be considered in turn.

PASSENGER COMFORT

The basis for most track geometry and line speed limits is passenger comfort.

The effect of speed in increasing centrifugal forces has already been considered earlier under TRACK ALIGNMENT. In terms of static and quasi-static lateral forces, it is the lack or excess of cant that is most felt by passengers. A 110mm cant deficiency at the wheelset corresponds to 0.72m/s² lateral acceleration. Allowing for vehicle body roll in the suspension, this is generally increased to 1m/s² as felt by the passenger. For a tilting train running at 300mm cant deficiency with a tilt compensation of 75%, (50% after allowing for body roll), the passenger still feels no more than 1m/s²^{6 pE11/3}. Hence, some of the adverse effects of lateral accelerations on passenger comfort can be overcome by operating tilting trains - enabling them to run comfortably around curves at higher speeds.

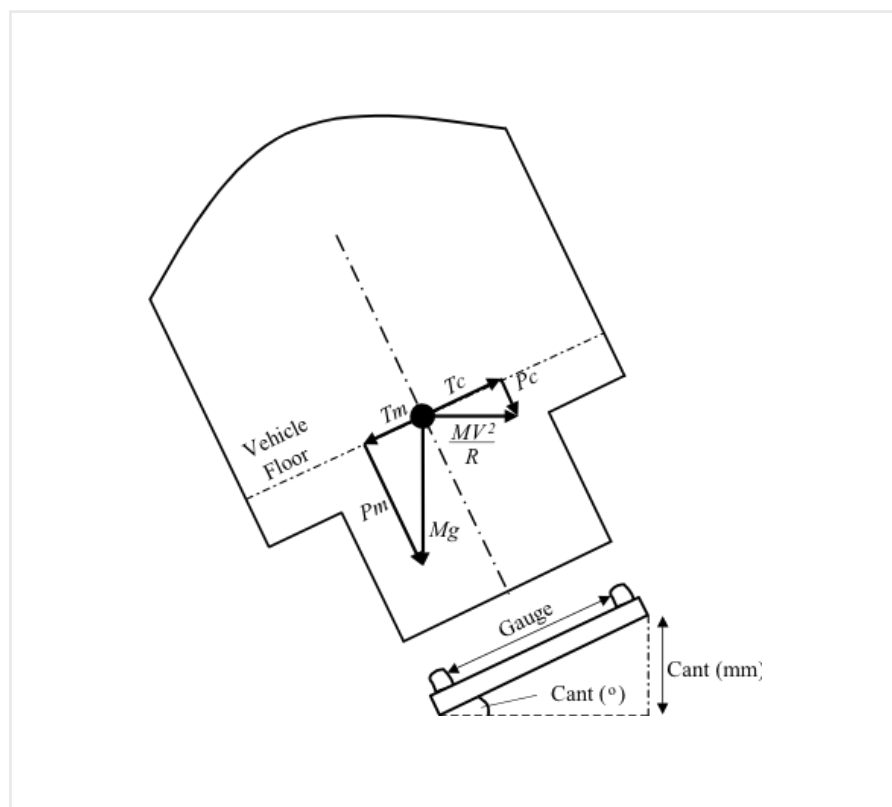


Figure 2-3: Weight and centrifugal forces on canted track^{5 p97}

Another significant factor, contributing to the lateral jerk experienced by passengers is the rate of change of cant, (a measure of the rotation of the car body and the passengers within it). A European pre-norm suggests that a roll rate of 80/s makes less than 1 in 10 people feel uncomfortable. The current UK limiting value for conventional trains is 3.40/s and for tilting trains is $4.20/s^6$ pE11/4.

In 1984 a high-speed train was run on a curved route at speeds of up to 30% above the normal curve speeds. The study found that at normal operating speeds 12% of standing and 3% of seated passengers were dissatisfied with the ride comfort and that this dissatisfaction doubled when the line speed was increased by 10 mph³ p22.

Passengers are also subjected to random dynamic accelerations caused by track irregularities, which can cause physical weariness. Sensitivity to such irregularities has been found to be greater on curved than on straight track and to reach a maximum at vibration frequencies in the order of 5 Hz³ p23;9 pp35-6.

DERAILMENT

The derailment of a train can result from a number of causes. Those that can be speed related include:

- Flange climb: the flangeway clearance on a wheelset typically allows 7 to 10mm of lateral displacement to occur before the flange contacts with the rail. However, on tight curves this allowance may be insufficient to prevent the flange making contact with the rail. If the flange becomes unable to slide past the rail for a finite distance when this occurs, (typically for a couple of metres), the wheel will climb up the rail, ultimately derailing the train. It is more likely that this will occur if there is a high lateral force between the wheel and rail, often on curves less than 200m radius where speed is low
- Dynamic reaction to track geometry: if cyclic features in the track, (such as dips in the rail at joints and welds), excite the suspension of freight wagons into resonance, they can start to bounce violently; possibly right off the rail. Where cyclic conditions occur, the speed of vehicles needs to be restricted to ensure they cannot reach their natural

frequencies, which will be dependent on both vehicle type and loading; occurring at lower speeds for fully loaded vehicles, but more violently for unloaded vehicles

- Gauge spreading: on curved track with relatively high lateral curving forces the gauge can become excessively widened. If this occurs, the wheels drop off the rail into the four foot. Gauge spread develops over time and the speed of an individual train is not generally a significant factor, but the lateral forces exerted by all trains increase in proportion to the square of the speed, making gauge spreading more likely on lines with higher permissible speeds;
- Track shifting: If the transverse forces generated by a passing vehicle exceed the track transverse resistance, the track will shift, which can cause derailment. The transverse track resistance depends on the type of sleepers and track maintenance used. (It is worth noting that application of ballast shoulders on high speed curves improves the resistance.) It is highest on concrete sleepers with mechanical means of maintenance and lowest on track with timber sleepers and manual maintenance. In all cases, it is lowest just after track maintenance, which

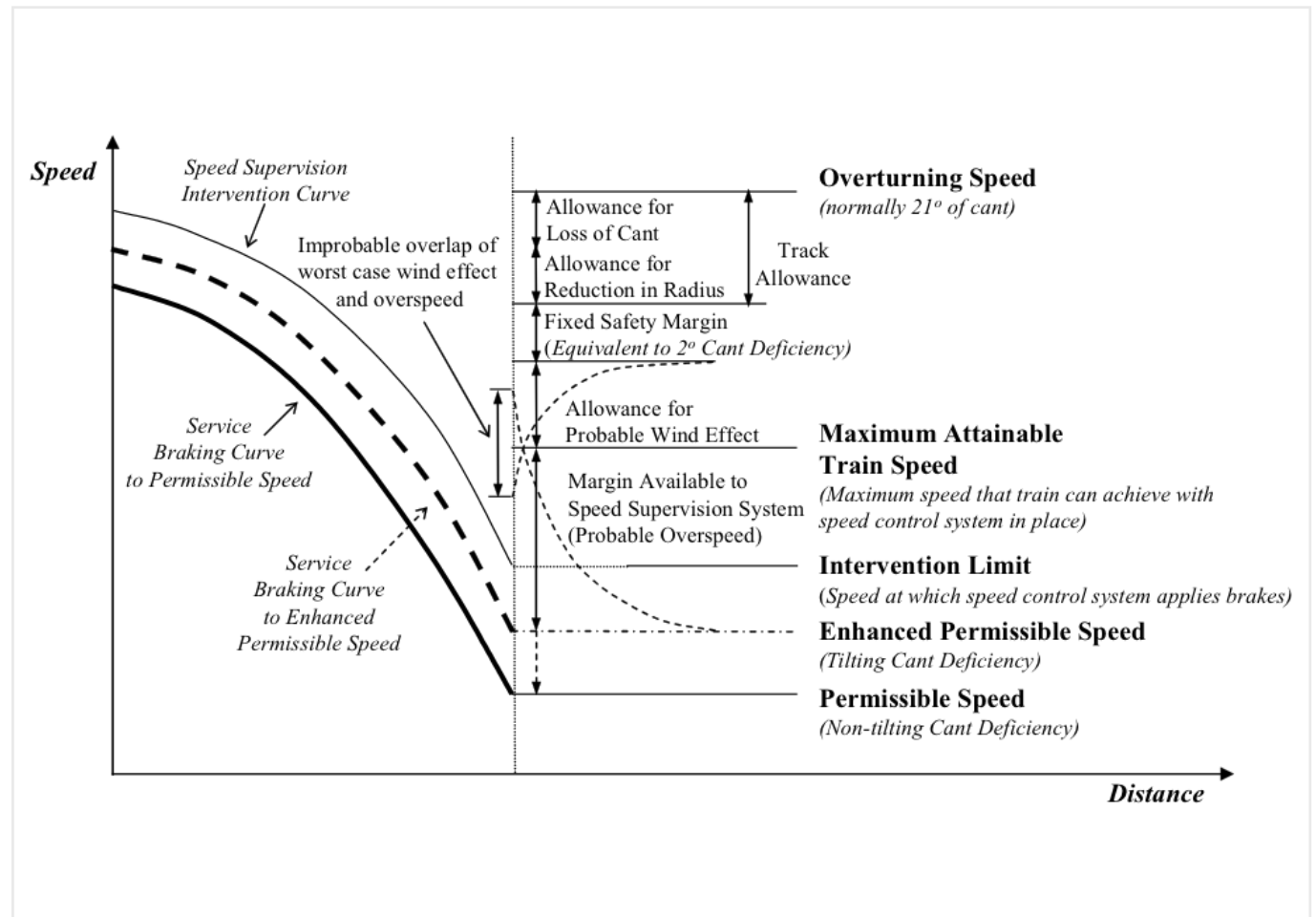


Figure 3-1: Determining the safe limit of permissible and enhanced permissible speeds¹² pp24-25; 4 p14

destabilises the track. Transverse forces are produced by unbalanced centrifugal acceleration on curves as well as the dynamic effects of track and rolling stock defects. This form of derailment is, therefore, more likely at high speeds.

It is worth noting that application of Ballast Shoulders on high speed curves improves the resistance.

Where there is significant risk of any of these derailment modes occurring, speeds may need to be limited; either on a permanent or temporary basis.

OVERTURNING

When a train is subjected to high lateral forces, it is at risk of overturning. This can occur under three conditions:

- At high speeds on curved track a combination of overspeed, curve misalignment, cant loss and cross wind can result in excessive cant deficiency and unloading of the inner rail
- Lightweight empty wagons standing still or with a displaced freight load can experience unloading of the outer rail on track with high cant and an unfavourable cross wind
- Unloading of the outer rail can also occur when a train failure results in the brakes at the rear of a train failing to release^{3 p33}.

In general, the main track related factors influencing the overturning of a train are the design cant and curve radius.

Rail group standards in the UK require vehicles to be designed with mass distribution and suspension characteristics that allow them to travel around smooth curves at constant speed without rolling over at not less than 16.5° cant deficiency for freight vehicles designed to operate at up to 75mph and not less than 21° cant deficiency for all other vehicles^{1 p8}.

When it is considered that the maximum cant deficiency permitted for a conventional train on UK main line infrastructure is 150mm, (5.74°), it can be seen that there is, at worst, a margin of 15° cant deficiency between the train's permissible speed and its roll-over resistance. This margin is reduced to 9° cant deficiency for tilting trains, which are permitted to operate at cant deficiencies of up to 12°^{11 p23}. The INF TSI allows for higher cant at 180mm for all services and 190mm for passenger only lines. Whilst a trial at 200mm track cant is applied at Cullompton, this required special permission and restriction of the types of freight vehicles using the site^{10 p28}.

A train travelling at a nominal design cant deficiency may experience significantly higher cant deficiency in practice, due to the effects of imperfect wheel condition, track irregularities, (especially in cant and curve radius), wind and

possible over speeding of the train. Factors such as these reduce the effective margin to overturning and must, therefore, be accounted for in the design of appropriate track, trains and speed limits.

The track irregularities experienced on UK main line railways have been measured by track recording coaches. From the measurements taken, it has been concluded that for a design curve radius of less than 3000m, the minimum curve radius expected is 80% of the design radius. For curves with radii of 3000m or greater, the minimum expected is 70% of design radius. In most cases, deviation in cant is less than 10mm, (0.38° cant deficiency)^{4 p3}. Fixed allowances can, therefore, be made for these factors in determining speed restrictions.

However, if all of the effects that could lead to a train overturning were considered to act simultaneously, the permissible speed that could be considered acceptable would be very restrictive. Therefore, probabilities of wind speed and overspeed, which represent the most significant factors in overturning risk, are considered, rather than absolute values. To this end, the calculation of permissible speeds on UK main lines includes:

- Fixed allowances for reduction in curve radius and loss of cant
- Probabilistic allowances for overspeed and the effects of wind
- A fixed safety margin of 2° cant, (an allowance for inaccuracies in the calculation of other allowances)

An example of how this is done is given in EVMAX DEFINITION.

PERMISSIBLE FORCES

As a train travels along the railway it exerts vertical, lateral and longitudinal forces on the track and its support structures, causing fatigue in their materials and deterioration of the track geometry.

The longitudinal forces on the rail result from acceleration and deceleration during train operation. They are dependent on both train design and operating speeds and must be considered in the setting of speed limits and restrictions so as not to generate forces which could damage the structural integrity of the rails, track and infrastructure. Longitudinal forces are particularly taken into account in the design of bridges on railway lines.

When subjected to vertical forces, the behaviour of the rails and sleepers is elastic, while that of the ballast and the subgrade is elastoplastic.

The vertical forces produced by the passage of a train consist of four components:

- The normal static load of the wheel
- The quasi-static load resulting from cant deficiency in curves
- The random, (dynamic), overload caused by rail to wheel interaction of un-sprung mass when the train runs over variations in the vertical alignment of the rail, (high frequency 20-150Hz)
- The random (dynamic) overload caused by rail to wheel interaction of sprung mass, (low frequency 0-20Hz)^{9 p36}.

All four components are influenced by the train's design, whether directly by its mass or as a result of its suspension arrangements. The quasi-static and dynamic forces are also influenced by track design / quality and train speed.

Rail Group standards in the UK require vehicles to be capable of negotiating a vertical ramp equivalent to a dipped rail joint on straight track at their maximum design operating speed without exceeding a total vertical force, (static and dynamic), of 322kN per wheel^{2 p7}. Vertical forces must also be considered in the setting of speed limits and restrictions so that trains will not generate forces that could damage the structural integrity of the rails, track and infrastructure, (including bridges and viaducts), over the normal range of vertical track irregularities at normal operating speeds. Just as with longitudinal forces, the lateral forces on the rail also result from several causes:

- Inclination of the wheel / rail contact patch, (occurring particularly where wheel conicity is high – whether by design or following wear)
- Creep forces across the contact patch
- Dynamic instability, (hunting)
- Lateral curving, (centrifugal) forces
- Inertial forces generated at track irregularities.

Railway Group standards require vehicles to be designed so as not to generate lateral forces that could jeopardise the structural integrity of the rails and track. The maximum permitted lateral force is given by:

$$((M / 3) + 10) \text{ kN ,}$$

Where M is the static load^{2 p8}.
(Equation 3-1)

In the UK, conventional trains are not permitted to operate at more than 150mm cant deficiency and the static and quasi static forces that occur when operating under these conditions account for only 25% of the lateral force limits. For tilting trains, which can operate at up to 300mm cant deficiency, the static and quasi-static forces are far more significant, accounting for 50% of the lateral force limits^{6 pE11/2}. The dynamic component of the lateral forces can be controlled by maintaining track to sufficient quality, designing trains with sufficient suspension and by limiting train speeds.

TRAIN SEPARATION / BRAKING DISTANCES

The final need for limiting train speeds that will be considered in this paper is the requirement to keep trains separated by safe braking distances.

Some sections of line, (particularly straight plain line sections), are physically capable of safely supporting operating speeds far higher than the speeds that are actually permitted over them. Where this is the case, it would be physically possible to set a higher permitted speed. However, for a section of line with an existing signalling layout, the line speed can only be increased for trains capable of sufficient braking performance to stop the train from the higher speed within the distances required by the signal spacing, otherwise safe train separations cannot be guaranteed. It is likely, therefore, that any increase in permitted speeds would need to be accompanied by an improvement in braking performance. For a new section of line, (or one undergoing resignalling), it would be possible to design the new signalling to support any desired speed of operation, whilst maintaining adequate separation between trains. However, the need for longer braking distances from the higher speeds would result in a reduction in the headway that could be achieved on that section as the permitted speeds were increased. The train headway required to deliver the desired capacity on the line, the train's braking performance and the design of any signalling layout are all factors that must, therefore, also be considered in setting permissible speeds for a section of line.

SPEED SUPERVISION

Returning to the starting point of this article: If we are considering the introduction of a comprehensive ATP system that will guarantee safety of operation, (avoidance of over speeding risk), then we need to think not just about why speed needs to be restricted, but also how that relates to the ATP system supervision criteria. Whilst this was considered at high level in the article's introduction, more detailed consideration is warranted.

PROBABILITY OF OVERSPEEDING

The permitted speeds in use on British main line railways have generally been set on the basis of assumed manual driving without speed supervision. Therefore, some level of over speeding has been assumed in setting them.

According to a now withdrawn Rail Group standard from the 'Railtrack' days, (GO/ RT 3253), train-operating companies were required to carry out checks on the speeds of their trains. In so doing, any incidence of the permissible speed being exceeded by more than 3mph had to be reported to Railtrack as quickly as possible.

The action to be taken beyond this depended on the level of overspeed:

- If the permissible speed was exceeded by 4mph (6km/h), the driver was to be informed and the facts recorded
- If exceeded by 6 to 10mph, (10 to 16km/h), the driver was to be informed and interviewed at the first scheduled stopping point where a competent person could establish both the facts and the driver's fitness to continue duty
- If exceeded by 11mph, (18km/h), or more, Railtrack were to arrange for the train to be stopped at the first available point where the driver could be informed of the infringement and interviewed by a competent person to establish both the facts and the driver's fitness to continue duty^{7 p5}.

Whilst that particular standard has now been withdrawn, (as its content was deemed outside the scope of rail group standards, and more fitting for each operator to decide their own response), some explanation of the criteria used within it can be found in the still current GE/RC 8517¹⁰, where it is noted that:

- A mechanical speedometer typically requires a tolerance for driver control of 4km/h
- Below 160km/h, speed measurement precision is typically 6km/h^{11 p33}.

A driver's real speed could, therefore, be 10km/h above the permissible speed before it is reasonable to assume that he/she is over speeding. On top of that, it is also entirely possible that in a 'human' controlled process, drivers will, on-occasion, 'over speed' - either due to misjudgement, inattention or deliberate intent.

Existing operations require driving at the signed PSR / TSR / ESR. In consequence, the signed speed must be set sufficiently below the actual maximum safe speed, (EVmax), so as to ensure that at least the occurrences of misjudgement and inattention will not result in an unsafe condition. Then, of course, there is also the need for meaningful signage, (already discussed), so the EVmax must be converted into a '(probably) safe maximum driving speed' and then rounded down to the nearest PSR/ TSR speed that can be signed. In the process, there is usually a fair margin for error...or would be if that was actually how the PSR / TSR was calculated. As noted in the introduction, however, there is not so much science applied to the process. Engineering Judgement and 'gut feel' are applied in liberal quantities; backed up extensively by experience and 'grandfather rights'. Better safe than sorry. Therefore, as long as the PSR / TSR is set low enough, there should never be any issues.

Speed restrictions on UK main line railways are always quoted in 5mph (8km/h) intervals^{6 pE11/4}. This is done to assist drivers in remembering the permitted speed for the section of track they are travelling over. Whilst trains are

driven on the basis of route knowledge, or on the basis of limited aspect speed signalling through lineside signals, this is a necessary simplification.

THE EFFECT OF ATP ON SPEED RESTRICTIONS

With the introduction of ATP, the considerations change somewhat. We still have the objective of driving at the PSR / TSR and we still want to avoid any possibility of exceeding the EVmax value. However, in ensuring that we no longer need to make 'assumptions' about the maximum over speed that could be inadvertently achieved by a human driver, instead, it becomes necessary to consider the speed supervision criteria that will be used in determining warning and intervention limits on-board the train and the 'margin' that these impose between the EVmax and maximum target driving speed. So long as the target driving speed is at least this 'margin' below the EVmax, that target can be safely applied. In theory, there is no need to sign the speed limit; and thus no need to 'round' the signed speed. Hence introduction of ATP systems should enable an Enhanced Permissible Speed of operation, (EPS).

If this sounds too good to be true...it almost is. There are a couple of catches. Firstly, the simplistic approach to defining an EPS for ATP protected operation assumes that we actually know how to determine the EVmax in a rigorous / scientific manner. Secondly, it requires us to define ATP supervision 'margins' that will avoid intervention, including scaring the driver into operating at a slower speed by issuing warnings, when the driver is correctly controlling the train's speed, whilst also 'guaranteeing' that the ATP will be able to intervene before the EVmax is exceeded.

ATP SUPERVISION 'MARGINS'

The second of these issues is actually the easier to address. In doing so, tolerances including the accuracy of speed measurement, (such as wheel diameter calibration, slip and slide, sensor accuracy, and the dynamics of controlling the train's speed, (such as delays in traction cut off and brake application), must be accounted for.

As an example of this, if the driver of a class 390 realised that his/her train was exceeding the permitted speed the train's speed could continue to rise by 9.3km/h before he/she would be able to bring the train's speed under control under worst case conditions. This figure is based on:

- 2s allowance for driver reaction
- 1s delay in traction cut off
- Maximum 3% down gradient
- 4s brake build up delay, consisting of 2s delay to start of application, followed by assumed linear build up
- Maximum acceleration 0.44m/s² below 70km/h, then decreasing linearly to 0.07m/s² at 230km/h

- Brake Rate 9%g
- 1.6km/h allowance for speed measurement error, (based on a specified maximum speed measurement error of $\pm 0.5\text{km/h} \pm 0.5\%$ of speed, with maximum speed of 225km/h).

If automatic speed supervision is configured to provide a warning prior to brake intervention, the margin between the warning and brake intervention must, therefore, be at least 9.3km/h if the driver is to be allowed to act on the warning without invoking an intervention under all circumstances. This is typical of other train classes, the margin between warning and intervention generally needing to be between 5 and 10km/h^{11 p38}. At higher speeds, when trains tend to have poorer acceleration performance, the required margin is smaller. Returning to the example of a class 390, the maximum achievable acceleration at 200km/h is only 0.07m/s². This reduces the required margin between warning and brake intervention to around 4km/h.

If the warning is to be given only once the train is definitely travelling above the permitted speed, a further margin of 5.5km/h would be required for a class 390, (allowing 4km/h tolerance for driver control and 1.5km/h for possible speed measurement error). The train could, therefore, achieve a speed nearly 15km/h above the permitted speed if the driver applied the brakes on receipt of an overspeed warning under the 'worst case' conditions.

Every ATP system / train type has their own set of margins, but all can be similarly calculated, based on their physical and programmed characteristics.

EVMAX DEFINITION

Earlier in THE NEED FOR LIMITING SPEEDS, the authors discussed the main reasons that speeds may need to be limited on a railway. Of the factors discussed, the two most significant are passenger comfort and overturning risk.

For a conventional, non-tilting train, the constraints of passenger comfort mean that large margins are available between permissible and overturning speeds during normal operation. Since ATP can do nothing to improve passenger comfort, it appears that the introduction of ATP can have no effect on the setting of permissible speeds. It can only ensure that the speeds determined as acceptable for passenger comfort are not exceeded by too large a margin. However, this is not quite true.

As already noted, permissible speed must always be selected as a safe and comfortable speed and on a 'conventional' railway, (manually driven with no speed supervision), it must always be rounded down to the nearest 5mph, (8km/h), interval. This small reduction will have a minimal effect on journey times at high speed, (up to 3.5% at 200km/h), but could be significant at lower speeds, (for example, up to 14% at 50km/h).

If a railway were to be operated on the basis of in-cab signalling that includes an indication of the permitted speed, it could be possible to refine the permitted speeds to the nearest 1mph, (or 1km/h if the railway were to switch to the standard European units). However, in the opinion of the authors, the methods used for determining speed restrictions are not currently precise enough to make full use of this potential refinement. It is, therefore, unlikely that any significant benefits could be gained by attempts to implement it.

Tilting trains can travel at enhanced permissible speeds, (EPSs), much closer to their overturning speed than conventional trains can reach without causing undue discomfort to passengers. This may mean that the main constraint on tilting train speed is the risk of overturning, rather than passenger comfort. In a similar way, temporary speed restrictions, (TSRs) are sometimes set to mitigate the risks of derailment or overturning in areas of poor infrastructure. Here ATP can have a significant effect on determining safe EPS and TSR values. By reducing the probability of any overspeed, the ATP system reduces the risk of the train attaining overspeed levels that could result in overturning or derailment. The enhanced permissible speeds that can be considered safe for a tilting train and some TSRs for all trains will, therefore, become directly related to the implementation of the ATP's supervision criteria. If the probable overspeed can be reduced, the EPS / TSR can be increased by an equivalent amount without increasing the overturning or derailment risk. An example of this can be seen in **figure 3-1**.

CONCLUSION

For conventional trains, the predominant factor in determining permanent speed restrictions is passenger comfort. This means that large margins are available between the defined permitted speed and speeds at which overturning and / or derailment become serious concerns. In order to make efficient / effective use of modern ATP systems, we must move away from the current 'PSR / TSR' definitions and identify the true 'EVmax' that must not be exceeded if derailment and overturning are to be avoided. If we succeed in doing this, we will not artificially constrain ATP system performance, and thus driving under its supervision and may even be able to enhance permitted speeds in some areas.

ABBREVIATIONS

ATP	Automatic Train Protection
EPS	Enhanced Permissible Speed
ESR	Emergency Speed Restriction
g	Acceleration due to gravity (9.81m/s ²)
M	Vehicle mass (kg)
PSR	Permanent Speed Restriction
R	Curve radius (m)
TSR	Temporary Speed Restriction
V	Vehicle speed (m/s)
Vmax	Maximum speed a vehicle should achieve in normal operation
EVmax	Maximum speed a vehicle can be permitted to achieve in emergency conditions (i.e. worst case speed that could be permitted before ATP intervention brings speed under control)

REFERENCES

1. Blakeney A, 'Resistance of Railway Vehicles to Derailment and Roll-Over: GM/RT 2141 issue three', Railway Group Standard, 2009
2. Boocock D, 'Permissible Track Forces for Railway Vehicles: GM/TT 0088 issue one', British Railways Board, 1993
3. Carney R S, 'Track Alignment for Tilting Trains: A Case Study on the Constraints to Line Speed Enhancement', MSc (Eng) dissertation, Sheffield University, 2001
4. Cheeswright P R, 'Overturning of Tilting Trains in Curves – Investigation and Recommendations for Control: RR/ SAM/99/038 Issue 1.1', AEA Technology Rail, 1999
5. Cope G H (editor), 'British Railway Track: Design, Construction and Maintenance, 6th Edition', The Permanent Way Institution, 1993
6. Dyson A M, 'The Development of Standards for Tilting Trains', Third RIA Railway Infrastructure Engineering and Management Course, 2000
7. Evans R M, 'Checking the Speed of Trains: GO/RT3253 Issue One', Railway Group Standard, 1995 – Standard Withdrawn in 2007
8. Fenner D, 'Application of Train Protection to British Mainlines', IEE Power Division Eighth Vacation School On Railway Signalling & Control Systems, IEE, 2000
9. Montagne S, 'Permanent Way for High Speed', Rail Engineering – The Way Ahead Vol. 1, IMechE, 1975
10. RSSB, 'Guidance on the Infrastructure Technical Specification for Interoperability Issue Two', GIGN7608, 2016
11. RSSB, 'Controlling the Speed of Tilting Trains through Curves Issue One', Rail Industry Standard, RIS-8012-CCS, 2017
12. RSSB, 'Calculation of Enhanced Permissible Speeds for Tilting Trains: RIS-7704-INS issue One', Rail Industry Standard, RIS-7704-INS, 2018

NETWORK RAIL SUMMER TRACK ENGINEERING CONFERENCE

THE INSTITUTION OF ENGINEERING & TECHNOLOGY, LONDON

JULY 2019

AUTHOR: CHRIS PARKER, PWI CONFERENCE REPORTER

Conference delegates were welcomed by the Conference Chair, Pablo Forteza, Engineering & Innovation Director, IP Track, Network Rail (NR).

PRESENTATION 1

TRACK DELIVERY UPDATE

STEVE FEATHERSTONE
PROGRAMME DIRECTOR
IP TRACK, NETWORK RAIL

Steve ran through an enormous amount of detail very rapidly, and those who wish to get the full benefit of his presentation should refer to the electronic copy of it that will be distributed by the PWI and will be available on the PWI website.

He concentrated on three main areas, beginning with "Our Journey so Far". In this part he described how IP Track had come from being the worst performing function in the company to being the best today and for the last 2 years. Major reductions in lost time incidents and over-runs, together with improvements in many areas have contributed to this success. Examples of improvement include safety, plant reliability, compliance, delivery of cost and volume and many more. High speed handback has been a terrific achievement, built upon sound engineering principles and practices.

After celebrating past success, Steve moved on to look to the future. He said that CP5 had been about specialist teams getting the detail right, but in future alliances and a system engineering approach will be essential. The contract form in future will be rail system alliances. The "Putting the Passenger First" programme means a matrix organisation and will require a three-stage process; transaction, transition, transformation. Steve looked in

some detail at the new organisation envisaged, with three alliances covering the network; North, Central and South. He described how these would fit with the new Region and Route structure of the company to provide services to them. Each alliance will be run by a Capital Delivery Director, and he described how responsibility will transition to them from the current organisation.

Finally, Steve emphasised that some things will not change. The focus on safety, sustainability and putting passengers first will remain foremost. In support of these, high speed hand-backs will continue, installation quality will be a priority, and handing back on time will remain essential. Steve listed many other matters that are currently priorities and will continue to be so. Customers, TOCs and FOCs were obviously included.

Steve finished with a personal thank you for the contributions everyone has made during the journey so far.

PRESENTATION 2

S&C REFURBISHMENT; STANDARDS & CONTROLS

LIAM JACKSON
SENIOR PROJECT ENGINEER
NETWORK RAIL

BETHANY QUAYLE
PROJECT ENGINEER
NETWORK RAIL

Liam began by setting out the background to the subject, talking through the problem statement and looking at a case study.

First, he defined what he meant by S&C refurbishment; "Targeted replacement of one or more component types in the S&C system, with the aim of extending the service life of the whole S&C asset." Heavy refurbishment is intended to provide a 50% life extension, medium 20%. In CP5, the planned volumes were not achieved, particularly those for heavy refurbishments.

One problem is that there is no standard or control mechanism for S&C refurbishment. Many issues arise from this; failure to treat root causes consistently, variable quality and a failure to track the outputs and quality achieved. Finally, it was not possible to show compliance with NR Track Asset Policy.

The case study was a refurbishment which had been undertaken at Welwyn Garden City. The RT60 S&C, laid in 2004, showed very poor geometry due to formation issues and was being maintained by stoneblowing.

The project was handed to IP Track at GRIP 4, so they had no involvement in the development of the specification, which called for a 300mm reballast with a geotextile. Success was defined as handback at 80 mph and no worsening of SD values.

It was decided to carry out the excavation using RailVac and to use the DTS as part of the handback preparations. The latter required sign-off from Safety, Technical and Engineering (STE).

When the excavation began on the first weekend, (24/25th February 2018), it was found that the undersides of the concrete

bearers were significantly damaged, possibly by Kango packing, and that the rail clips were badly strained. Installing the geotextile was very difficult and slow, losing time such that the DTS was applied only to the Up Fast. Four point ends were treated, the remaining four being planned for the following weekend, but having to be deferred due to the severe weather of “the Beast from the East”.

Upon completion the track geometry results for the February 2018 work looked good. It seemed that the specified outcome had been achieved. However, both Up and Down Fast lines deteriorated rapidly, the Down being significantly worse. The customer was unhappy. Voiding occurred in critical areas of the layout and a cast crossing cracked by October 2018.

Liam said that this exemplified the requirement for proper standards and controls, to prevent the wastage of funds and resources on such unsatisfactory projects.

Bethany took over the presentation at this stage, to talk about the development of these standards and controls. First, she explained why it was that IP Track is involved, saying that the department is being engaged more frequently to undertake refurbishment works. As refurbishment is not for them “the day job”, they feel in particular need of a proper process and guidance. IP Track therefore approached STE.

The process used to develop the required documents was the common safety method (CSM), recognised by RSSB & ORR, a hazards based approach widely accepted in many industries. The Track Standards & Controls Group approved the remit for the development of a Level 3 standard. The process was begun in May 2018 with the aim of publishing the standard in December 2019. The hazard identification process involved over 30 people from a wide range of backgrounds.

TEF3255 is to have three parts, covering respectively: scoping, specification and the review of outputs against specification. It has been recognised that good scoping is difficult, requiring competent people and a PWI course has been developed which takes account of the new standard.

A review by stakeholders is under way now, with the intent to publish at the planned date later this year.

DISCUSSION

As is normal at these conferences, a Q&A session followed every so often, and at this point it featured the speakers from presentations 1 and 2.

PRESENTATION 3

TRANSITION DESIGN DEVELOPMENT

BRIAN WHITNEY
ENGINEERING EXPERT
NETWORK RAIL

BARNABY TEMPLE
HEAD OF ENGINEERING
RHOMBERG SERSA

Brian began the presentation by speaking about the need for track stiffness transitions at points where the track stiffness would otherwise change sharply. This may happen for many reasons, typical cases being at the change from slab track to ballasted, where track crosses and under-line structure or at the ends of a direct-fastened bridge.

He spoke about the importance of stiffness and settlement, and how consistency is vital to maintaining good track geometry and avoiding problems like rail failures. He mentioned some of the past efforts at providing transitions, such as those used at the ends of some BR PACT track slabs.

Brian also talked about the issue of broken rails, the past success that has reduced annual numbers from almost 1000pa a few years ago

to around a tenth of that currently, and the challenges we now face, as the numbers have stopped falling while the demand for further reductions continues. With ever increasing rail traffic and decreasing opportunity for engineering access, reducing the failure rate to 50pa or lower is going to be a challenge. In that context, he considered the consequences that follow from the absence of proper stiffness transitions, and showed examples of rail failures which have resulted. Other problems also arise from this, such as strained clips, voiding and the need for packing of the track and more. Clearly this is an issue that needs attention if we are to meet our aspiration for fewer rail breaks and better reliability/performance.

Barnaby took over at this point, describing in more detail some of the traditional solutions that Brian had mentioned. He also pointed out that the problem is more severe at the edge of a fixed structure than at a weld or a joint, since the affected length is roughly doubled in the case of weld/joint, halving the rate of change. Modern means of ameliorating the situation include sleeper soffit pads, geowebs/grids, piling, ballast gluing and confinement of the ballast by means of walls or gabions at the sides of the trackbed. Deutsche Bundesbahn (DB), for example, uses a combination of these and other methods such as strap rails on special sleepers at the transitions between ballasted and slab trackforms.

None of these solutions have been a total success, he said, and Rhomberg Sersa offer a solution called the V-TRAS, which the

company believes gives superior results. It is a prefabricated steel ladder structure, two longitudinal beams running under and parallel with the rails, carrying support platforms over which the sleepers sit. The beams are tapered with their full depth ends supported on a bearing shelf built onto the end of the slab or underbridge deck and the shallow ends supported in the ballast remote from the structure. Ballast extends right up to the stiff structure, around and under the V-TRAS and sleepers, and the whole thing can be tamped, stoneblown or manually packed.

Benefits claimed are reduced differential settlement, reduced frequency of maintenance intervention, and a reduction in risks like rail breaks, whilst there is no interference with normal maintenance methods.

One example where V-TRAS has been used in the UK, is in Queen Street in Glasgow, where the transitions have been installed in the cutting at the slab/ballast transitions. Another possible site might be at Kings Cross where slab track is being reintroduced to Gas Works Tunnel. The transition zone at the north end will need to be managed appropriately.

Barnaby suggested that a system solution for transition zones needs to deal with the settlement risk by a combination of bridging the transition, confining the ballast laterally, and giving additional support to the less stiff track. Formation and drainage need special attention in these areas and precautions against twist and buckles need to be taken seriously.

PRESENTATION 4

RUNNING RAILWAYS FOR PASSENGERS

ANDREW COOPER
NON-EXECUTIVE DIRECTOR
PWI

Andrew began by explaining his background, starting as a BR graduate trainee, and finishing as Chief Executive of Cross-Country Trains and serving the PWI as a non-executive director. This gave him an unusual perspective of rail infrastructure and qualified him to make some valuable comments about the industry. He began by saying that we are working in particularly interesting times for the industry, with the move away from lineside signals to in-cab signalling and automated train control. With signalling moving away from the track, a significant shift is going to occur in the relationships between the different parts of the rail infrastructure system.

Nevertheless, the first priority of the rail system will remain safety. He spoke of some of the concerns that he has about this, mentioning recent train incidents at Waterloo and Cardiff which could have had far more serious outcomes and must stand as wake-up calls

for the industry. He talked about the risks of the train/platform interface, emphasising how vital it is that engineers consult train operators when proposing works affecting platforms and platform interfaces. He also referred to some recent incidents where plant or materials had been left at the lineside and not adequately secured against unauthorised interference. In one of these a wood chipper had ended up under a train after an attempted theft had left it abandoned on the running lines. A train had been out of service for a significant time after this incident, and it was fortunate that that was the worst consequence of the occurrence. A continuing theme of Andrew's presentation was the essential requirement for co-operation and collaboration between infrastructure people and train operating people. Together we can avoid service disruption. If we do things unilaterally, all too often problems result. An example was when the "Gotcha" wheel force measurement system was introduced without sufficient involvement of train operators, causing disruption when it was implemented. Operators expect infrastructure owners to know their assets and support their customers. So delays in gauge clearance of trains are not acceptable, for example.

Andrew was pleased that there have been improvements in the use of major possessions. It has been good to see the re-introduction of line-speed handbacks on plain line jobs, and, he said, the achievement of line-speed handbacks on S&C jobs has been a real achievement.

The loss of many diversionary routes in the past has made life harder today, but substitution is disliked by customers and so infrastructure working is more challenging than it might have been. On the other hand, he praised the customer friendly possessions being tried in some places, such as the mid-week ones taken to install a flood protection culvert at Cowley Bridge Junction not long ago. He challenged the industry to be more innovative over such issues, holding discussions to explore possibilities such as doubling the length of possession time available to high-output teams in order to get the work done faster overall and reduce unit costs. He accepted that managing freight traffic would be challenging but suggested that it would be worth exploring possibilities.

Andrew praised the way in which exceptional engineers avoid route closures in emergencies, as at the Unstone slip site in 2014, where good engineering kept the line open despite severe challenges. But, he also accepted that sometimes this just isn't possible, as was the case with the Harbury slip the following year. He ended by saying that he sees the engineering focus now is better on passengers, customers and costs. There is, he said, a good story to tell if we do it right. We should celebrate the benefits from the money and effort invested in our industry, and he gave the example of the celebratory train from New Street to York that ran on 31st March 2019.

PWI PRESIDENT'S UPDATE

JOAN HEERY
PRESIDENT
PWI

Joan began by showing the Presidential Chain of Office, that she is currently proud to wear. She showed how the pendant on it contains engraved details of every President of the PWI right back into the early days of the Institution in the 19th century.

She also mentioned her unusually rapid ascent to the post of President that followed from organisational changes at the Institution. Instead of serving a year as Vice-President Elect, she had gone almost immediately into the post after Stephen Barber moved from the Presidency to become Chief Executive.

Joan then moved to her aspirations for her time in office. She acknowledged that there is too much to do for her to do it all and thanked her

great team at the Institution for the hard work that they put in on the Institution's behalf.

She will be concentrating particularly on two key areas; the first of these being the establishment of stronger relations with the corporate members. Steve Featherstone did great work in recruiting over 40 of these organisations, and Joan intends to build upon this by visiting each one personally, to find out how the PWI can best support them.

Secondly, she intends to help the Sections of the Institution to be the best they can be. The Chairs and Secretaries of the Sections do a great job with limited resources, but need help to do even more. A key priority is the recruitment of more, younger Institution members.

Following this she discussed the results of a survey of PWI members which was carried out in 2017. Details will be in the full presentation, but suffice it to say that one strong message to emerge from the survey was the imperative to get more young, active people into membership.

Finally, Joan finished by saying a few words about Steve Featherstone, as he approaches the end of his post-presidential year as a Deputy President and retires from the PWI Board. She praised him, in particular for being a fantastic advocate for the PWI, for having been instrumental in the drive to become a professional registration body recognised by the Engineering Council, and for having increased significantly the corporate membership of the Institution. In addition, he has been responsible for developing this series of very successful technical conferences. He has visited most Sections of the Institution personally, and has made very active contributions to the PWI Board, all whilst continuing to carry out an intensive, 7 day/week job.

DISCUSSION

At this point the second Q&A session took place with the presenters of papers 3, 4 and 5.

RECOGNITION & AWARDS

STEVE FEATHERSTONE
PROGRAMME DIRECTOR
IP TRACK, NETWORK RAIL

The first session after lunch, as usual, involved a lot of people getting up and moving around as the meeting celebrated success.

Steve Featherstone had the pleasure of presenting awards and books to numerous people who, in the six months since the last NR TEC, have attained the PWI diploma in Track Engineering or other engineering qualifications

including CEng ICE, CEng PWI, FPWI, and EngTech PWI. He also presented some PWI Journal Awards.

As always, it was great to celebrate with colleagues who have achieved such meaningful and worthwhile targets.

CONGRATULATIONS!

To everyone who received their Diploma and other qualifications at the Network Rail Track Engineers' Conference



Andy Hibbert



Benjamin Zuliani



Chrisopher Ford



Erik Kodjie



Ewan Morrison



Harry Williams



Imtiaz Dada



James Featherstone



Joe Frank



John Mansfield



Luke Taylor



Matthew Davies



Nick Matthews



Nick Round



Pablo Forteza



Patrick White



Steve Goddard



Thomas Aldous



Tyrone Williams



Vivek Vilay



William Stephenson

If you spot a mistake in any of the names, please do let us know! journaleditor@thepwi.org

PRESENTATION 5

SNAKES UNDER A TRAIN

(MAP PROJECTIONS & TRANSFORMATIONS)

COLIN MCATEER
PROGRAMME MANAGER
BIM, NETWORK RAIL

DR JIM TURNER
BIM SPECIALIST, HS2 LTD

Colin began this talk by illustrating why the subject matters. Showing Greenland and Africa as they are commonly represented on maps, he pointed out that whilst it appears from the maps that the former is comparable in area with the latter, in fact Africa is roughly 14 times larger than Greenland. This distorted

understanding is caused by the distortions inherent in the commonly used methods of projecting the Earth's curved surface into a plane surface. An idea of what that looks like was given by asking volunteers from the audience to attempt to wrap spheres in paper! Similar distortions affect surveys of large features like railway lines that exist on the curved surface of the Earth.

Jim took forward the presentation from here, and he explained the size of the problem. The Ordnance Survey (OS) National Grid, the UK's standard co-ordinate system, has an inherent distortion of 20cm per kilometre in London. Elsewhere it can be worse, being 40cm in Birmingham for example.

For track engineering and similar purposes, we require a co-ordinate system that is continuous over hundreds of kilometres but with low distortion of engineering grids. The OS Grid is not good enough.

HS2 has developed the HS2 Survey Grid Snake Projection, a route specific snake grid that achieves the required low distortion. In fact, it has a distortion of very much less than 20 ppm at ground level along the grid. Using

this to measure the distance from London to Birmingham produces a dimension about 60cm greater than if the OS Grid was used, and the Snake Grid result is the correct one.

Jim went on to explain more about how this is used in practice. There is an HS2 system in Bentley Microstation, for example, which converts OS data into a format compatible with the HS2 Survey Grid, making it possible to use such data in the HS2 system accurately.

He also explained how it is necessary for the OS to regularly update their network of survey stations to reflect geodetic changes. Without this, changes in the surface of the Earth, (continental drift and so on), would cause errors between earthbound surveys and satellite navigation system data. HS2 has to account for these changes in its work. HS2 has developed a distortion free co-ordinate grid for high speed rail design and construction, HS2 Survey Grid NTv2, which complies with all the requirements described. The company plans to submit this to the EPSG Geodetic Parameter Registry, making it widely available.

PRESENTATION 6

CHIEF ENGINEER TRACK, SWITCHES & CROSSINGS UPDATE

JOHN EDGLEY
CHIEF TRACK
S&C ENGINEER
NETWORK RAIL

John asked how we meet the performance challenge; are we doing enough? Performance is generally falling against a trend of traffic increase. There is an industry wide challenge to be met; we have missed our targets.

Looking at seasonal variations in PPM, there is regularly a big performance drop in autumn, with smaller ones in summer and winter.

Do we prepare for these as well as we could? Perhaps, but we still need to do more and differently to do better. That asset reliability is improving is good news, but assets only affect 25% of train delays. Train delays per incident are increasing, negating any reductions in incident numbers. The average age of track assets is also increasing.

How do we meet this challenge? John looked at five areas where we are trying to improve:

- Infrastructure projects: renewals delivery innovation, induction welding, trackbed modelling, BIM, use of geocells, high-speed handback, progressive assurance, DTS on S&C, high speed temporary joints, intelligent compaction.
- Workload & Competence: competence framework, analysis of how actual TME workload compares with what was expected.
- Technology & Assets: improvement of the gauging process, improved tools & materials.
- Process: identification & sharing of best practice, standards updates.
- R&D: additive manufacturing, intelligent infrastructure.

More is still required: examples include whole system safety & performance, collaborative engagement to do the right thing for the industry, and targeted improvements, such as seasonal performance focus. John also mentioned several individual items such as the managed lineside, the use of under sleeper pads, wheel-slip protection & sanding and on-train flange lubrication.

Finally, he spoke about the need for changes in culture and values, discussing some of the key points he perceives.

DISCUSSION

Once again time was taken at this point for a Q&A session with the presenters of the most recent talks.



Presentations from this seminar can be viewed in the PWI Technical Hub.

www.thepwi.org/technical_hub/presentations

PRESENTATION 7

ELECLINK PROJECT
OVERVIEW

CHRIS HARLER
DELIVERY ENGINEER
BALFOUR BEATTY

OLIVER SCHOLEY
DESIGN/DELIVERY ENGINEER
BALFOUR BEATTY

This presentation was introduced by Mike Barlow of the PWI London Section. Mike explained that the paper and its two presenters had won the 2019 Tech Factor contest, the Tech Factor being an annual opportunity for young rail engineers to make presentations in a competition for the Peter Coysten Award.

Mike and Oliver had been involved in the Eleclink Project, which was initiated in order to install a major new link between the British and French national power networks. The 1000MW link, which would increase the capacity of the links between the two countries by roughly 50%, was to be installed through the Channel Tunnel.

They described the design and installation challenges involved in preparing for the installation of this link. The cables of the link are to be installed on brackets attached to one of the side walls of one of the running tunnels. One major challenge was the limited maximum length of cable that could be delivered to the tunnel portals. The size of the cable drums that can be used is restricted, such that each can only carry 2.5 km of the cable. Jointing such large cables is complex and time consuming, and a key innovation made by the Balfour Beatty team was to propose that this work be carried out outside the tunnel. That made a crucial difference to the project because it significantly reduced the time needed for works inside the tunnel.

To facilitate this innovative approach the project team needed to devise a means of storing lengths of cable near the tunnel portals and drawing the cable into the tunnel, length by length, as the lengths were jointed together. Chris and Oliver described the design and installation of the cable brackets and of a monorail system attached to these that will permit the cables to be drawn into place. Each bracket needs to withstand at least a 25 kg force in any direction, and to avoid fatigue failure, they are fabricated without welds. In association with the monorail system, it was necessary to have a cable storage system at each tunnel portal, each of these needing to store a kilometre of cable whilst fitting into

the very tight space available. They devised a helical cable rack system for this purpose. The brackets each require four bolts to secure them to the tunnel wall, and the holes for these bolts need to be drilled very precisely at every bracket location. Once again, time in the tunnel was at a premium, and so the adopted solution to this challenge was a 12 wagon train carrying 36 drilling units, one for each bracket position and each carrying four drills correctly spaced for a bracket. This system allowed simultaneous drilling of all of the bolt holes for 36 brackets, covering a 240m length of the tunnel.

A bespoke lifting system on the train was used to lift the hexagonal rails of the monorail up to the brackets after they had been installed. Electronic records were used to confirm the correct installation of each component of the system, so that any problems were reported immediately and could be readily followed up and rectified.

At the time of the conference presentation, the monorail was fully in place, and the cable storage systems at either end of the tunnel were loaded with cable, with cable extended from them to the tunnel portals, ready for the cable haulage to commence when access to the tunnel for this becomes available. Four bespoke cable haulage trains are ready to carry out the installation of the cables.

PRESENTATION 8

MIND THE
GAP, GAUGING
IMPROVEMENTS

ROBERT LACEY
PRINCIPAL ENGINEER
TRACK & LINESIDE
NETWORK RAIL

Gauging has three principles, Robert said; ensuring that trains do not hit the infrastructure, ensuring that trains do not hit each other, and ensuring that passengers can enter and leave trains safely at station platforms.

Critical to all this is knowing what “capacity” the infrastructure on a route has, and maintaining that capacity through renewals works, maintenance works and the introduction of trains new to the route. He said that currently this is being managed totally through renewals and train introductions. Maintenance is not managing gauging effectively through its works. He went on to discuss what it may be that is preventing maintainers from doing their bit on gauging. Perhaps there isn’t the money, or perhaps the system does not exist

for it. Possibly Group Standards are to blame because maintainers feel unable to achieve compliance. Currently each Route has a Route Gauging Engineer, but how the new organisation will affect this is not known. In any case, TMEs need training and systems to enable them to manage.

A new module of Track 001 is to be introduced, requiring a baseline gauging and survey of the whole network every 5 years. All sub-normal and non-compliant clearances will require risk assessment and the production of an appropriate action plan to manage each of them. However, datum plate surveys will no longer be mandatory.

Robert continued by discussing the high-level programme of gauging development. There is research and development going on, with external funding, to look at alternative means of gauging. He talked about the perceived over-conservatism in gauging, which seems to be based upon the idea that “a foul” may have existed for some time, but has never resulted in a collision. He looked at some of the reasons why such a situation may arise:

- The original vehicle gauging model may have been over-conservative
- Over-conservative assumptions about infrastructure movement
- Poor data quality e.g. affected by vegetation

- Conditions required for the “foul”, such as crush loading or suspension deflation, have never occurred
- Inaccuracies in the gauging measurement system itself

A tactical response to all this is “probabilistic gauging” or the “Avoidance of infrastructure change project.” This has been described already by others, particularly Dr David Johnson, and is to be trialled on the Scotland Route. In-depth analysis of pinch points is required, and it is likely to necessitate an enhanced maintenance regime. Industry benefits are likely to be high, but direct benefits for Network Rail will probably be low, while its risk and costs are likely to increase somewhat. The strategic, longer term response is an alternative gauging methodology. This will mean new vehicle dynamics, improving the vehicle models for all vehicles on the network. It will require a much better understanding of track fixity, likely to be derived using “big data” from track monitoring systems, so as to reduce the uncertainty about infrastructure movement. Finally, new gauging survey techniques will be needed, to increase accuracy and reduce the tolerances in calculations. Robert gave a brief outline of where things are currently in respect of each of these requirements.

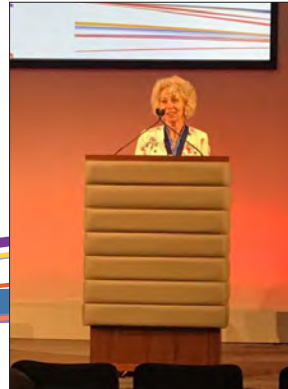
DISCUSSION A final Q&A session took place, covering the last two presentations.

CLOSING REMARKS

STEVE FEATHERSTONE

Steve said that he considered this to have been one of the very best in this conference series, and thanked the presenters for making it so. He also gave his thanks to the organising team, the PWI and the IET.

After mentioning that he hoped that the conferences would be continued after the reorganisation of Network Rail and mentioning some forthcoming PWI events, he closed the conference.



“

Feedback from our delegates

One of the strongest agendas that I can remember. All presentations were relevant to current issues and topics in the industry and I didn't feel like people were trying to sell me anything.

The networking opportunity the PWI conferences provide is invaluable. Those of us operating in the rail engineering community will often converse via email or conference call, so the chance to talk face to face in a non-working environment is a positive one.

S&C Refurbishment Standard and control presentation. Also the venue and lunch was exceptional.

Quality of the speakers was superb and the topics were focused on problem solving.

”

2020

PWI SEMINAR

UTILISING NEW TECHNOLOGY ON RAILWAYS

PWI TECHNICAL SEMINAR

The 2020 North West technical seminar will review the application of latest developments in railway technology across rail networks, providing real life examples of the benefits technology applications are delivering for today's infrastructure.

Delegates will hear from technical leads, rail infrastructure owners, technology developers and research organisations as they share their insight and aspirations for new technology from design right through to implementation.



4 MARCH 2020

09:00 - 16:30
REGISTRATION FROM 08:00

MANCHESTER CONFERENCE
CENTRE
SACKVILLE STREET
MANCHESTER M1 3BB

£70 MEMBER
£120 NON-MEMBER
£10 STUDENT

BOOKING NOW OPEN:
www.thepwi.org/calendar

W thepwi.org

f [PermanentWayInstitution](https://www.facebook.com/PermanentWayInstitution)

t [@PermWayInstit](https://twitter.com/PermWayInstit)

in [Permanent Way Institution](https://www.linkedin.com/company/permanent-way-institution/)

@the_pwi

SPONSORSHIP AND EXHIBITOR
SPACE AVAILABLE

Please contact 01277 230 031
secretary@thepwi.org

International Conferences



AUTHOR:

INARA WATSON

London South Bank University

PhD Researcher

PWI Member

International fire and security exhibition and conference

IFSEC (International Fire and Security Exhibition and Conference) which was held at ExCel in London from 18th to 20th June 2019 is the largest annual security industry event in Europe. The history of IFSEC goes back to 1972. This year 528 exhibitors of IFSEC presented the biggest developments in security and fire safety industries to more than 27,000 visitors from 113 countries. The threat to security is one of the biggest challenges to modern society. IFSEC brought world leading security professionals and companies manufacturing security equipment under one roof to show the latest technologies, products and best practices.

There were many presentations and keynote speeches from recognised security experts.

The chair of the panel sessions on security topics was Frank Gardener OBE, broadcaster and security journalist. Seminar sessions covered a large range of topics including:

- Cost vs safety and security for the transport industry - Which is the most important? What is the right balance?
- Using drones to secure the future
- Is the security world ready for 5G?
- Crime reduction - Overcoming the disruptive effects of criminality
- Social media and internet Security - A new opportunity
- Physical and cyber risks posed to transport systems.

One of the topics of day one was "Cost vs safety and security for the transport industry- Which is the most important? What is the right balance?"

The panel participants were Andy Billings, Head of Security and Contingency Planning for Southampton Port, Nick Orwin, Emergency Planning Manager, London Luton Airport and Chris Stevens, Technical Security Director of an independent security consultancy. For the past seven years Chris Stevens has been security advisor on the Crossrail London project.

The representatives from the three transport industries discussed how organisations should find the balance between costs and the most appropriate safety and security level. Andy Billings shared his experience in using security contractors to reduce the cost of providing security in Southampton port. The number of cruise ships are not stable during the year. In winter it can be 3-4 per week but in summer it can be 4-5 per day and to keep a large number of staff throughout the year is not economically viable.



Chris Stevens admitted that the goal of airports is to deliver a product to meet the expectation of customers whilst tolerating some amount of risk to achieve this. Chris Stevens stated that safety and security are linked, and it is cheaper to invest in safety and security at the design stage.

Another session that attracted lots of attention from the participants of IFSEC was "Using drones to secure the future." Participants of this panel session agreed it is important to understand the purpose of drones. In many cases the use of drones is a very good tool for reducing risks to personnel. The flying time of drones is increasing to three and a half hours and in the near future drones will fly autonomously. The most important thing is to improve the reliability of drones so they will be used widely. The next movement in the drone industry will be development of very small drones with a wider area of flying.

The last panel session of day one was "Crime reduction - overcoming the disruptive effects of criminality." Participants of the panel were Dr Gary Buck, Andy Palmer and Warren Stein who emphasised the huge impact that crime causes in everyday life and the necessity to develop new technological solutions to prevent crime. One of the new developments is face recognition software. This software can identify 4800 faces in one second. Advanced software can recognise if people carry knives or other weapons, but at this moment it is still not accurate enough and gives too many false alerts. On the Converged Security Panel advanced software was demonstrated that will help to understand and analyse the complex physical and cyber risk posed to transport systems. This software can help to improve network flow and passenger experiences.

The three days of IFSEC were intensive with debates, networking and collaboration. The IFSEC is a good platform for sharing knowledge, latest technologies and tools that will secure and protect citizens and businesses. The next IFSEC will take place at ExCel, London, 19-21 of May 2020.

UK rail station development and regeneration conference

Travelling by railway is becoming an increasingly important mode of transportation, because it offers many advantages compared to other modes and it is set to increase. With the growth in population of UK to 70 million by 2030, the number of railway journeys, will grow to around 3.5 billion annually. The growing number of passengers, increases the pressures on the railway network and stations. There are around 2500 railway stations in UK welcoming over 4 million people daily. Some of the stations were built more than a hundred years ago. There is a need to redevelop and modernise these stations. They must reflect the modern requirements of transport and meet local needs whilst also contributing to economic and social benefits.

The 5th Annual UK Rail Station Development and Regeneration Conference was held on 4th July 2019 in London to discuss the plans and lessons for improving the stations. This conference brought together around 80 professionals in the rail, property, business industries as well as representatives from local authorities. The conference programme was split into three parts:

- Plans and updates on station development
- Practical insight on how to deliver station improvements
- Lessons learned for delivering station improvements.

The Conference was opened by the Chair, Mr Norrie Courts, Director of Stations, Network Rail. In his speech Mr Norrie Courts talked about the importance of collaboration in delivering railway projects. The first presentation of the day was given by Mr Stuart Kirkwood, Development Director, Network



Rail. Mr Kirkwood gave an overview of achievements of Network Rail Property. In the past five years land sales generated around £285m from the sale of non-operational land that will be reinvested in the railways.

The second presentation was delivered by Mr Tim Wood, Northern Powerhouse Rail Director, Transport for the North. Mr Wood in a passionate speech talked about the positive changes that the North of UK will have with the development of HS2. It will increase the capacity of the railway, reduce journey times, improve the connectivity between regions, create new jobs and will create opportunities for new businesses.



SLIDING FRICTION BUFFER STOPS

Rawie Friction Buffer Stops provide protection for track ends worldwide. They can be designed to suit all types of rolling stock, accommodating varied train weights and speeds.

RAWIE®
SINCE 1882

SKELTON

Manufactured by A.RAWIE GmbH & Co. KG.
Tel: 0049 541 91 2070
bufferstops@rawie.de
www.rawie.de

Supplied in UK & Eire by H.J. Skelton & Co. Ltd.
Tel: 0044 1635 866877
sales@hjskelton.com
www.hjskelton.co.uk

In the second part of the conference Mrs Kate Cohen, Project Director, Euston, Department for Transport talked about the regeneration of Euston station. The Euston Station redevelopment will transform the station, becoming a transportation and economic hub which will connect rail, buses and taxi services, improve the walking and cycling facilities and create thousands of new jobs in the area.

The railway station will be in the centre of a regeneration project for the whole area and will connect communities, new business, commercial, leisure and residential areas. This will make the London Borough of Camden economically stronger. The area surrounding the station and the station itself will be a new destination offering new services and new experiences. To make the project successful it is important to have collaboration between railway industry and community stakeholders.

In the third part of the conference one of the presentations was delivered by Mr Mark Lahiff, Director and Partner of IJM Land. Mr Lahiff shared his experience in the delivery of the regeneration project of a 2.7-acre site in Royal Mint Street. This unique project was characterised by the fact that it was just a few inches from an operational railway track. The additional challenge for this project was safety. There were some concerns about risks to the track geometry, to falling objects onto the railway track, to railway operations and delays to passengers. To mitigate these risks there was very close collaboration between the developers and Network Rail to impose railway industry safety standards on the contractors.

In 2030, 75% of the population will be living in urban areas. Lack of vacant land in cities for housing development and business will only increase. Mr Fred Beltrandi showed some examples from other countries of how they are solving this problem. For example, in Chongqing, (China), the new light rail line is routed directly through a residential tower. In the Netherlands they will expand an underground bicycle park at Utrecht Central railway station from 7500 to 12500 spaces. Developers around the world are looking for solutions how to use space more effectively around railway stations; both above and below. The Chair in his closing remarks summarised the main points of the presentations and panel discussions. He said that the station is not only a transportation and economic hub but also a gateway to the city and stations should be a desirable place for residents and visitors. The conference was an excellent opportunity to interact, discuss and exchange visions on the future sustainable solutions in development and regeneration of railway stations.

Future of Infrastructure Conference 2019

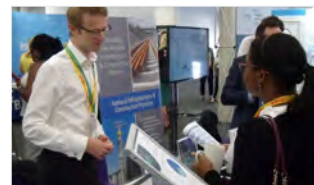
On 18 July 2019 the "Future of Infrastructure Conference 2019" was held at Queen Elizabeth II Conference Centre in London. 300 delegates attended from transport industries, local authorities and policymakers. The speakers covered a wide range of topics from cybersecurity to the future growth of the transport industry.

There were six key themes: workforces of the future, investment in infrastructure, supply chain collaboration, infra tech, low carbon infrastructure and investment in 'green' initiatives.

The conference was opened by the Chair, Emer Murnaghan, Vice President of ICE and head of Responsible Sustainable Business GRAHAM. Ms Murnaghan admitted there are challenges facing the transport infrastructure to adapt to an increasing population, weather change and future skills shortages. A focus on improvements through the use of technology, better use of data and artificial intelligence is required to tackle these challenges. The UK government is focussing on innovation and transport. This will support economic growth, creating new workplaces and helping the UK to prosper.

The first presentation was delivered by Professor Lord Robert Mair, Head of Cambridge Centre for Smart Infrastructure and Construction. In an outstanding presentation the Professor spoke about benefits that fibre optic sensors bring to the construction industry and transport. These sensors can be used on structures such as tunnels, bridges, roads and other constructions and help to monitor their stability. The sensors collect and transmit data and they are safe and cheap to use. They can be embedded in tunnel walls or in road surfaces and will monitor the vibrations and displacements.

The topic of Ms Susannah Clements, Group Director of People, Anglian Water was "How Anglian Water is developing workforces for the future". Anglian Water Services employ



around 4000 staff and provide drinking water and recycled wastewater to millions of households in UK. Anglian Water is introducing new ways to maintain their assets; instead of being reactive they are moving to proactive maintenance. This is possible through the introduction of real time sensors that monitor the condition of water supply systems. The company is investing in engineering and automation of hazardous jobs that were previously undertaken by human labour.

This assists in the retention of older staff and attracts more young people and women to join the company. The growing diversity of labour leads to the increase in productivity of the company. Another challenge that is facing the industry is an aging of labour force; currently 50 percent of staff are age 40+.

Anglian Water has an individual approach to staff offering split shifts, flexible working hours and working days of the week.

Mr Phil Graham, Chief Executive, National Infrastructure Commission in his presentation "Meeting the infrastructure needs of the 21st Century-Where are we?" talked about the aim of the UK Government to generate 50% of electricity from renewable sources by 2030 and by 2050 to reach net zero emissions. Reducing costs and improving technology, increasing the amount of renewable and localised energy sources will in turn support an increase in the number of electric vehicles. To reach zero emissions by 2050, the UK government is investing in electric vehicles and the infrastructure to support them. A £43bn funding between now and 2040 has been allocated to this initiative. The net zero

emission target will create new businesses and job opportunities; there will be a reduction in pollution and an improvement in air quality. Another important change that faces society is the introduction of 5G coverage across all of UK by 2033. This will create new commercial opportunities, boost productivity and transform communications and support more effective operation of complex systems.

There were several more presentations that covered topics such as weather and climate change, unlocking the private investments in developing infrastructure, workforces of the future and current policies and regulations. The conference was a splendid place for networking, debate with outstanding presentations from business and government leaders.

CALL FOR PAPERS

PWI TECHNICAL SEMINAR



2020 ELECTRIFICATION PROJECT CHALLENGES

The third PWI electrification seminar will be held in Glasgow on 28 April 2020.

The Scottish Government has recognised the benefits of a rolling programme of electrification and Network Rail Scotland is developing those plans. Electrifying an existing railway requires the electrification system to be integrated into the broader railway system: the configuration of the traction system and its constituent parts has implications for the operation, maintenance, and performance of the railway.

The challenge facing engineers of all disciplines is to simplify the systems integration task so that it supports a rolling programme of electrification rather than impedes it. This seminar will help engineers across the railway disciplines understand the implications of converting a route to electric traction, and explore ways in which system specification, design, and implementation can support a rolling plan.

Proposals for papers are requested covering the following areas.

- 25kV traction feeding system architecture
- Earthing and bonding of 25kV electric traction infrastructure
- Isolation and earthing for the issue of permits to work
- Designing and testing new traction electrical systems, and overhead lines
- Development and operation of railway plant for use on the electric railway
- Practical challenges presented by a rolling programme including the application of lessons learnt in Projects in UK and Abroad
- Performance criteria, robustness and temperature resilience
- Structural clearance innovations
- Power Management and Rolling Stock
- High Output Construction
- Track Design for Electrification (Plain Line and S&C)

ABSTRACT SUBMISSION DEADLINE
6 January 2020

SEMINAR DATE
28 April 2020

ROYAL CONCERT HALL
GLASGOW

Papers should focus on the technical aspects of the topics mentioned here; solutions, lessons and best practice learned.

Abstracts to be submitted by 6 January 2020 to Brian Counter:
technicaldirector@thepwi.org

To submit a paper please email a short introduction for the proposed paper with the focus of the paper and a minimum of 8 bullet points listing the areas to be covered. Any questions should be directed to Brian Counter.

What in the world...?

AUTHOR:

Phil Kirkland

PWI Vice President for England (North)

An occasional look at some significant rail infrastructure developments overseas with the intention of 'inspiring and exciting' both today's and tomorrow's railway infrastructure engineers.

Hudson Bay Railway

INTRODUCTION

The remote areas of Northern Manitoba reaching up to Hudson Bay in Canada have seen some significant and rather amazing railway activity in recent years:

- The disposal of nationalised assets to a private company
- The wrath of mother nature in destroying the main rail link to some particularly remote locations
- The unwillingness of the private sector to recognise and accept any social responsibility
- The struggle to obtain national government support
- The impounding of rolling stock by local government
- Success through coordinated lobbying
- Well executed rail engineering recovery works
- The establishment of a community railway operation.

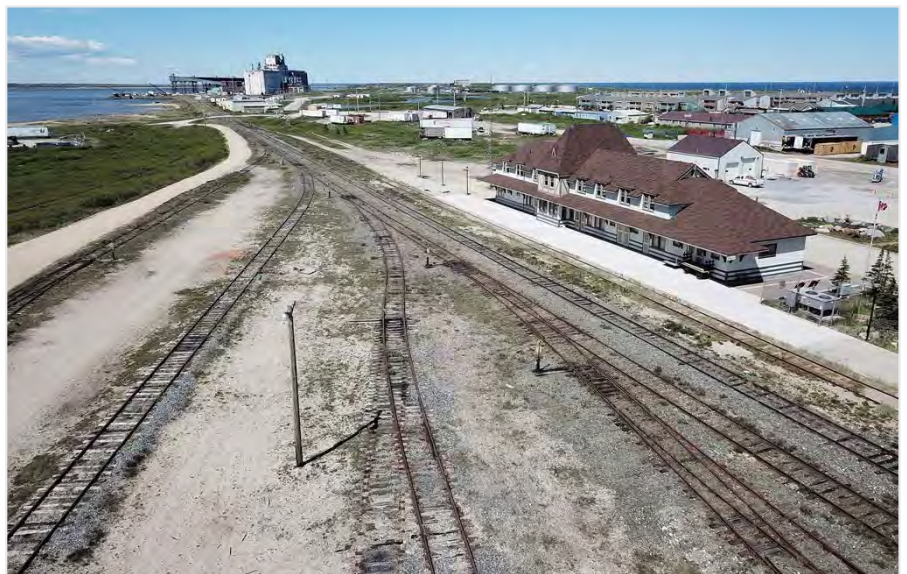
BACKGROUND

On Tuesday 2nd August 1932, the steamship 'Pennyworth' of Newcastle upon Tyne, England, (Yes, we Geordies are both adventurous and well-travelled!), set sail from the port of Antwerp in Belgium and began a voyage that was to open up a new seaport in the barren, northern lands of Canada. A journey which was hitherto unknown, and which would have a major impact upon the development of the fledgling Canadian economy at that time.

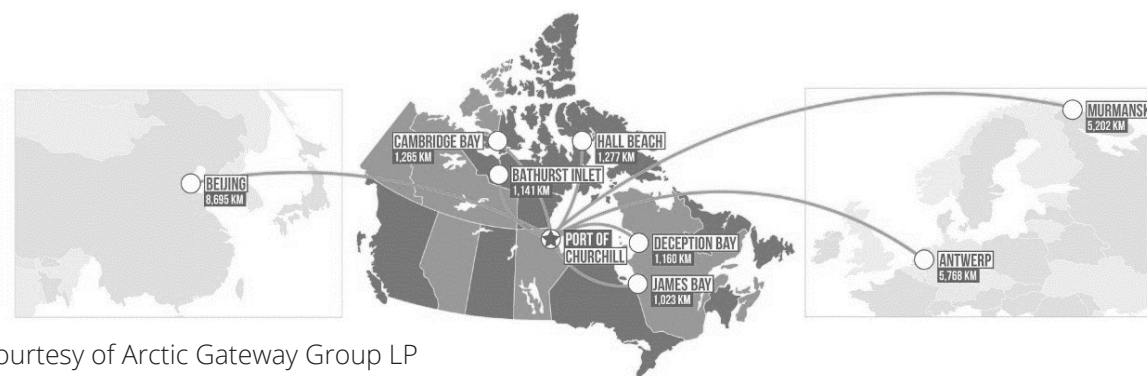
Hudson Bay has a polar climate being one of the few places in the world where this type of climate is found south of 60° N. From Arviat, Nunavut to the west, to the south and southeast prevails the subarctic climate. The average annual temperature in almost the entire bay is around 0° C or below. Water temperature peaks at 8–9° C, (46–48° F), on the western side of the bay in late summer. It is largely frozen over from mid-December to mid-June when it usually clears from its eastern end, westwards and southwards. A steady increase in regional temperatures over the last 100 years has been reflected in a lengthening of the ice-free period which had been as short as four months in the late 17th century. Churchill is along the Hudson Bay at the mouth of the Churchill River on the 58th parallel north far above most Canadian populated areas. Churchill is far from any other

towns or cities, with Thompson, approximately 400 km, (250 mi), to the south, being the closest larger settlement. Manitoba's provincial capital, Winnipeg, is approximately 1,000 km, (620 mi), south of Churchill. Much of the land surrounding Churchill and towards Thompson and Winnipeg comprises Tundra and Muskeg swamp.

Originally, the Hudson Bay port where the rail line was to terminate was to have been Port Nelson, at the mouth of the Nelson River, which drains Lake Winnipeg. During World War One the construction of the rail line was suspended to divert resources to the war effort. When construction was recommenced, the decision was made that maintaining a port on the Nelson River would have too many ongoing expenses, and that the port should be relocated to the mouth of the Churchill



Churchill station, Manitoba with the port facilities and Hudson Bay in the background. Image: The Canadian Press



River. The Nelson River has a greater volume of flow, and contains more silt, a channel several miles long would have to be regularly dredged. In addition, the river's mouth was wide, and shallow. The Churchill River's mouth was deeper, clearer, and required less on-going dredging. This change of port is the reason the rail line turns almost directly north, just beyond the settlement of Gillam, Manitoba. The Hudson Bay Railway was built starting in the early 1900s under Canadian Northern Railway before being taken over by the Government of Canada and completed in 1929. The lines were under the jurisdiction of the nationalised operator Canadian National Railway, (CN), from 1929-1997 before being sold to OmniTRAX, a private rail company based in Denver, Colorado, USA.

OmniTRAX Inc. is a transportation and transportation infrastructure holding company based in Denver, Colorado, in the United States. It primarily owns and operates railroads, with a network of 21 regional and short line railroads in 12 US states and 3 Canadian provinces. It is one of the largest privately owned railroad companies in the United States. The firm also invests in, develops and operates ports, multimodal transportation terminals, and industrial parks. Hudson Bay Railway, (HBRY), is the Canadian short line railway operating over 1,300 kilometres, (810 mi), of track in north eastern Saskatchewan and northern Manitoba. HBRY was formed by private railroad holding

company OmniTRAX of Denver, Colorado, USA in July 1997. This was to facilitate the purchase of the former Canadian National Railway, (CN), rail lines running north from The Pas on two branches; one to Flin Flon and on to Lynn Lake, the other to Thompson and on to the Port of Churchill on Hudson Bay. Operations began on August 20, 1997, with responsibility for all assets, infrastructure inspection, maintenance and renewals and train operations.

At the same time, OmniTRAX also took over the operation and marketing of the Port of Churchill from Transport Canada. Previous owner CN had limited the allowable tonnage and axle weights to operate on the lines, claiming a combination of lighter rail weight, (100lb FB), and poor track formation / subgrade. However, the HBRY took an alternative view and has been able to successfully operate heavier rail cars and longer trains in recent years without difficulty, resulting in increased business to the Port of Churchill and from various mines and pulp mills.

HBRY is a vital transportation link in northern Manitoba, hauling ores and concentrates, copper, zinc, logs, craft paper, lumber, and petroleum products. Major freight customers for HBRY include HudBay Minerals, Tolko, Vale, Gardwain North, Stittco Energy, Farmers of North America, and the Canadian Wheat Board. Via Rail Canada, The state-owned

passenger rail operator, also uses HBRY tracks to operate its passenger train service between The Pas and Churchill.

THE KEEWATIN RAILWAY COMPANY

On April 1, 2006, the Hudson Bay Railway sold the former CN Sherridon Subdivision, between Sheritt Junction and Lynn Lake, to the three First Nation native tribes in the area, who now own and operate the railway, running twice-weekly mixed, (passenger plus freight), trains. The Keewatin Railway diverges from the Hudson Bay railway at The Pas, Manitoba, (see map).

The Keewatin Railway Company is the First Nations-owned short line railroad that operates in Northern Manitoba, between The Pas, and Pukatawagan. This is Canada's second First Nations railway, the first being Labrador and Northern Quebec's Tshiuetin Rail Transportation.

The railway company currently operates and maintains the line formerly owned by Hudson Bay Railway, and used by Via Rail passenger trains. This passenger service continues under a new operating agreement between Keewatin Railway Company and Via Rail Canada, which still operates twice-weekly passenger trains, (Numbers 290/291). Uniquely, these are mixed trains.



Keewatin Railway Company – mixed train (left) Kershaw ballast regulator (right) (Images: Keewatin Railway Company)



Aerial view of 200 year flooding, Manitoba (left). Typical trackbed washout (right). Images: OmniTRAX Inc.



Typical culvert works and Geocell earthworks stabilisation. Images: Paradox Access Inc.

But let's get back to the Hudson Bay Railway. In August 2018 after lengthy disagreements and litigations played out both in court rooms and in public, the line and port was eventually sold by OmniTRAX to the Arctic Gateway Group. Arctic Gateway Group LP is a public-private partnership formed to own and operate the Port of Churchill and the Hudson Bay Railway, which connects The Pas to Churchill, Manitoba. The 50% public share of the partnership is Mississippi Rail LP, a consortium of northern Manitoba First Nations and local governments, with the private share split between Toronto-based Fairfax Financial

Holdings and Regina-based grains company AGT Food and Ingredients. The map below depicts the ready world import/export markets available to Canada via the Port of Churchill.

2005 WASHOUT

On July 27, 2005, heavy rains washed out part of the railway between The Pas and Pukatawagan; all HBRY services over the line, including Via Rail trains 690 and 691, were immediately suspended while emergency repairs took place. Service was restored on August 2, 2005.

2017 WASHOUTS

On May 23rd, 2017, communities across Northern Manitoba, including the northern community of Churchill, received the news that would shape their lives for the next 18 months. Sections of the Hudson Bay Railway, the only dryland link to the rest of Canada, had been washed out by the spring flood, and nobody was coming to fix them. The communities in the North, totalling about 30,000 people, faced a severe uphill battle. The loss of the railway link meant the loss of a lot of things: passenger rail service on Via Rail; freight shipping for vital



Extensive flooding and washout HBRY, Manitoba (left). VIA Rail train stranded at Churchill station (right)
Images: OmniTRAX Inc.

commodities, including consumer supplies, lumber, tools and other essential goods; even access to groceries that shipped in on the rails. In short, they were stranded, and until the battle to get the railroad fixed was finished, they would stay that way. OmniTRAX announced that the line was closed indefinitely between Amery, 47Km northeast of Gillam, and Churchill, due to unprecedented and catastrophic flood damage.

On 9 June 2017, OmniTRAX announced that the HBRY was not expected to reopen before the winter season, pending evaluation of the damages and repairs. An independent, preliminary engineering assessment determined that the track bed had been washed away in 19 locations, with five bridges visibly damaged and 30 bridges and 600 culverts requiring further assessment. National passenger operator VIA Rail said its services would continue to operate between Winnipeg and Gillam, but no alternative transport would be provided for the 300 km from Gillam to Churchill. OmniTRAX also stated 'The Hudson Bay Railway requires significant seasonal maintenance, the extent of the damage created by flooding this year is by far the worst we have ever seen, and it will be several weeks before we have a final report of the damage to the line, and are concerned that the future of the track is in jeopardy.'

The loss of rail services, both passenger and freight, impacted the tourism industry and imposed other costs on Churchill's already fragile economy. Churchill, and other northern communities where cargo had to be alternatively delivered by air, faced skyrocketing prices for staples such as groceries and fuel being located 1,000

kilometres north of Winnipeg. The railway owners were severely criticised for taking a singularly commercial view of the issue, and allegedly displaying little or no social concerns for the communities they served.

Due to the subsequent disagreement over which entity was responsible for repair costs, it was uncertain whether the line would ever be repaired. The Canadian government filed an \$18 million lawsuit against OmniTRAX for breach of contract. The position of Canada's Natural Resources Minister, was that OmniTRAX Inc. had legal obligations to repair the rail line and its tracks, citing a contract that required OmniTRAX to "operate, maintain and repair the entire Hudson Bay Railway Line in a diligent and timely manner until March 31, 2029." The position of OmniTRAX was that the extensive flooding constitutes a force majeure that excused it from fulfilling the contract. (Who's been there too then?)

OmniTRAX, for its part, argued it could not afford the repairs, estimated to cost between \$40 million and \$60 million, after the 2017 flood that washed out the rail line in many, many locations. The line remained unusable since May 2017 and there followed many squabbles over who was responsible for repairs with owner Denver-based owner OmniTRAX continuing to reject demands from the federal government to fix it. Instead, OmniTRAX attempted to sell the line. A vociferous protest campaign was mounted with intense lobbying of both OmniTRAX, the province of Manitoba and the national government. The flooding had left the entire VIA Rail passenger train stranded at the northern extremity of the line, where the locomotives and rolling stock were held 'hostage' by the local authority.

After months of wrangling the train was recovered by ship via the port of Churchill. The Canadian Transportation Agency ruled OmniTRAX should have taken reasonable steps to repair the line by November 2017. The federal regulator ordered OmniTRAX to begin repairs by July 3 and file monthly progress reports beginning in August until the work was completed. OmniTRAX signalled its intention to appeal the federal order. That appeal was heard by a federal court, which had the authority to order the company to fix the line and pay financial damages to Churchill. However, all of this became academic.

A deal was struck to sell the line and the port to two groups representing northern communities and First Nations, One North and Mississippi Rail LP, operating together as Mississippi Rail Partners - along with Fairfax Financial Holdings and AGT Food and Ingredients, - leaving the new owners with the responsibility for repairs.

On 31 August, 2018, the Federal Government announced that they would be helping to fund the purchase of the railway, and port facilities, back from OmniTRAX. \$43 million of the \$117 million the Federal Government committed was a grant to help cover operating costs, for the first three years of Arctic Gateway Group's operations.

On 4 September, 2018, the group bought the rail line and Port of Churchill. Within a week, crews were dispatched to the washed out tracks and got to work. Working day and night, the crews inched forward towards Churchill, repairing washouts and getting things prepared for rail operations. Work to repair all washouts along the Hudson Bay Railway line was

completed less than six weeks after Arctic Gateway Group LP took possession of the rail line connecting The Pas to the Port of Churchill in Manitoba. A significant achievement for the permanent way engineers. On the evening of October 31st, the first train arrived at the station in Churchill, the second would arrive the next day, as Via Rail's passenger train pulled in with its first cohort of visitors in 18 months. Churchill was reunited with Canada once again. So how did they do it?

The original railway had been built across nearly 1000 km of muskeg and swamp, capable of swallowing large sections of ballast and track, as well as areas of shifting permafrost. There were also the significant outcrops of Canadian Shield that needed to be blasted away during the harsh, early construction period. A typical railway must withstand the most challenging demands; weather combined with the weight, speed and frequency of loads travelling its rails. Add in a curved ball like permafrost and muskeg and you really have a seasonal nightmare on your hands. Today's permanent way engineers faced up to these challenges.

Much of the works in 2017/18 required significant repairs to the track bed that had been washed away in 19 locations, with five bridges visibly damaged and 30 bridges and 600 culverts requiring further assessment, and the strengthening of several miles of embankment. Once floodwaters had begun to recede, detailed assessments and repair methodologies could be determined. With damaged track panels removed, embankments and washouts were excavated down to base formation levels, then rebuilt bottom-up making particular use of Geocell technology. Primarily using Paradox's 'Tough Cell', a cellular confinement and soil stabilisation product made of a novel polymeric alloy geocell.

This product is of a specification which is uniquely suited to constructing railway in permafrost and muskeg areas, where an unstable substrate can lead to lateral spreading of ballast and differential settlement of the railbed. Tough Cell's honeycomb structure provides lateral restraint of ballast and leads to the entire track settling together. This extends the life of the ballasted formation and lowers the cost of maintenance. (Those of us who worked on the infamous Newham Bog on the East Coast Main Line north of Newcastle will remember our exploits with the Geocell and the good guidance from colleagues in the then York earthworks section - pioneering at its best!!!).

Proper application of Tough Cell in permafrost conditions can also prevent melting, which further preserves ballast and formation integrity.

The advantages of products such as Tough Cell Geocell are:

- Reinforces track substructure, and stabilises ballast layers
- Provides lateral restraint, (versus the lateral spread of traditional railbed construction)
- Reduced settlement of ballast materials and fouling by subgrade attrition
- Increased strength and resilience
- Reduced maintenance
- Lowers the total cost of ownership.

But the work does not stop here. Ongoing maintenance is needed to keep the rail line working in an efficient and safe working order. While initial repairs were completed before the start of winter, with the subsequent spring thaw, crews will be hard at work replacing sleepers and doing additional maintenance work including tens of thousands of tonnes of ballast, tamping and regulating. This work ensures that washouts can be minimised.

The structured, forward programmes now include:

2019-2020 OPERATING TRACK MAINTENANCE PROGRAM

- Culvert repair & replacement programme
- Beaver management program
- Line side vegetation control
- Sperry ultrasonic rail inspection / rail changing
- Track geometry testing / remediation plan.
- Surfacing programme on the Bay Line (tampers / regulators)
- Fire patrols as required.

2019-2020 CAPITAL TRACK PROGRAM

- Replacing 27,500 track feet, (55,000 Lineal), of 100lb FB rail, with new 115lb FB rail
- Replacing approximately 100,000 sleepers across the HBR network
- Distributing between 800 - 1000 cars of ballast on all subdivisions.

In addition, Arctic Gateway, supported by Canadian government grants, have made an impressive capital investment in maintenance equipment. (Hopefully they are all to be painted yellow!!)

NEW EQUIPMENT PURCHASED/LEASED

- (3) OTM Harsco Mark 4 tampers
- (3) OTM Knox Kershaw ballast regulators
- (2) OTM sleeper changing machines
- (1) OTM sleeper shear
- (1) OTM sleeper spike puller
- (1) OTM sleeper spiker
- (3) OTM sleeper cranes
- (1) OTM baseplate placer
- (1) OTM ballast scarifier (undercutter)
- (12) RRV Ford F350 hi rail trucks
- (2) RRV TFO trucks incl crane
- (2) RRV hytracker excavators
- (2) RRV mechanical service trucks
- Misc hydraulic equipment

The current train operating plan is as follows:

2019 TRAIN OPERATING PLAN

- Twice weekly service to Flin Flon 991/992, (freight)
- Twice per week service to Pukatawagan 291 / 290, (mixed passenger/freight)
- Once per week to Thomson from The Pas 995/996, (freight)
- Once per week Thompson to Churchill 295/294, (freight)
- Three times per week VIA service to Churchill 693 / 692 - 691 / 690, (passenger)
- 4 additional GP 38's leased locomotives added to the HBR Fleet making a total locomotive fleet of 16.

Sadly, Arctic Gateway Group reported a fatal derailment which occurred 15 September 2018 on the Hudson Bay Railway near Ponton, Manitoba. The derailment resulted in the death of an employee on the locomotive. A second employee sustained "serious injuries" and was airlifted to a nearby hospital. The train that derailed had three locomotives and several dozen rail cars, some of which were carrying liquefied petroleum. The Arctic Gateway Group monitored the situation very closely, and advised that there did not appear to be any significant environmental danger to nearby areas resulting from the derailment. A Transportation Safety Board investigator indicated beavers may have contributed to the derailment, which occurred at a washed-out trestle bridge in a swampy area south of Thompson, Manitoba.

Eventually however, after a tremendous engineering effort by all concerned, on 1 November 2018, Prime Minister Justin Trudeau helped welcome the first train to arrive in Churchill in 18 months. The first passenger train travelled the line a month later. The new railway business is now both thriving and expanding, and once again has provided essential services to the people and port of Churchill, Manitoba, Canada.

I sincerely hope you have found this 'non too technical' article of interest? You may even wish to now further explore the use of Geocells in formation and subgrade works.

In collating and writing this article, particular thanks should be extended to personal contacts at Arctic Gateway Inc., OmniTRAX Inc., Harsco Track Technologies and Paradox Access Solutions Inc.



Derailment Ponton, Manitoba. Image: Transportation Board Canada



Resleeper in progress. Image: Arctic Gateway Inc.



Newly delivered Harsco Mark 1V HD tamping machine. Image: Arctic Gateway Inc.



RRV Track recording vehicle arrives Churchill, Manitoba. Image: Arctic Gateway Inc.



VIA Rail passenger train departing for Winnipeg at Churchill, Manitoba. Image: Alan Graham

Are you new to the railway and confused about everything going on? Or a veteran of track and want to gain professional qualifications?

Then the PWI Track Engineering Diploma could be the course for you.

The PWI Track Engineering Diploma covers a great variety of content relevant to everyone involved in track engineering, however there is far too much to cover in this article. I shall provide a brief overview of what is covered over the four days it takes per module, based on my experience of it earlier this year.

Module 1 is the introduction to everything track, covering the very basics of what the components of track are, introducing how the track is maintained in plain line and S&C, from how track geometry is defined to finishing with an introduction to rail types and defect management. This module introduces cant and cant deficiency, which can be confusing when first encountered, but you are also shown the benefit of knowing how to use the cant equation as it is used to calculate what line speed you should have on the curve.

During the first module, Thermit Welding gave the opportunity for candidates to visit Thermit Welding's Derby office and view the production of a Head Repair weld, which is a technique used for the repair of discrete defects in the head of the rail. Candidates on the course were talked through all the steps of the welding process, as well as all the considerations required of the welding.

In addition, candidates were shown new equipment, such as the accelerated cooling device - the SMARTWELD ACE - which reduces the time taken per weld by facilitating an earlier grind. Thermit also showed candidates the equipment for some of the services they offer, such as Verse testing for calculating the stress free temperature of the rail, and ballast bonding which is currently used in a variety of ways on track - such as anti-vandalism on ballasted sections of track for some trams, increasing the lateral resistance of track, and bonding the ballast together to prevent it washing out in coastal areas of track.

Module 2 builds on the information covered in Module 1 concerning track geometry. It mainly covers how track is designed, focusing on horizontal and vertical curves, finishing with an introduction to complex S&C design. With a focus on curves, this module has the most mathematical content, but not to fear! The most complex the maths gets is using squares, and like in Module 1 when learning about cant, the lecturers are more than happy to teach you how to do the maths and apply it to the real world.

Finally, **Module 3** focuses more on track asset management and planning, covering how long maintenance tasks can take, to planning a plain line renewal in groups. We were taught the techniques and the various pros and cons of the different kinds of plant, and how they are used to achieve the various tasks associated with a renewal. Another area covered is the complex task of S&C refurbishment. We were taught the two types of refurbishment, medium and heavy, and the type of work that each refurbishment encompasses, and what plant is suitable for each job. With all these tasks, in addition to techniques and plant currently used, we were taught about techniques used abroad but not used in the UK, and experimental plant and techniques that may well one day be used here in the UK to show where the railway may go. The fourth day of the module had an expert from RAIB to talk through how rail accidents are investigated and reported, which provided a lot of interesting information as to how the industry responds to these events.

At the end of each module there is an exam, however, all the content is covered in the four days it takes to teach each module, and Brian and the team allow time



Steve Featherstone presenting William Stephenson with the PWI Diploma in Track Engineering at the Network Rail Track Engineers' Conference in July.



to revise the areas candidates may struggle with, and willingly make time at the end of each day to run through any issues candidates may have. And after a hard day of learning, the lecturers are more than happy to buy everyone a pint and have some social time. I found this to be great for networking as there were people who had worked on the railways for 20 plus years, to those who were just starting their career in the Permanent Way, and learnt a lot just from the socialising.

I fall into the category of being new to track, having spent a year on placement working more in the civils and project management side of the railway, and as such have found this course immeasurably helpful. Working for Thermit Welding as the Technical Services Engineer, my job is not purely welding so whilst the content regarding welding and management of rail defects etc was very useful, the rest of the content helped me with other aspects of my role - such as verse testing where, because of this course, I already knew about stress free temperature before being qualified to carry out the testing. I will also be using the course for my application to become a professionally registered Engineering Technician as an example of course based learning, and aim to go for Incorporated Engineer with the PWI in a year's time.

So, if you know nothing about track engineering, the PWI's Track Engineering Diploma will give you a great foundation of knowledge to build on, whether you're involved in designing, constructing or maintaining track. And for those with prior experience, it is a great opportunity to help further your professional development, as it can help with applications for professional status such as Engineering Technician, Incorporated Engineer and Chartered Engineer.

William Stephenson
Technical Services Engineer
Thermit Welding

Delegates on the PWI Track Engineering Diploma.

See page 12 for more details of the course and how to book.

What does a good PDP and CPD record look like?

Let the Chair of our Professional Development Committee, Paul Ebbutt, tell you...

What is CPD?

Continuing Professional Development (CPD) is what you do to maintain and expand your professional competence. The PWI Code of Professional Conduct requires members to be responsible for developing their professional knowledge and skills, as well as development of others, through CPD. Every PWI member should maintain a record of CPD, and for Professionally Registered members it is mandatory.

Established practice in virtually all areas of professional life (not just in engineering) is that CPD is documented in two ways:

- firstly, an individual should have a written plan setting out what development they intend to pursue - a personal "Professional Development Plan" or PDP for short, and;
- secondly, a written record of the professional development activity they have actually undertaken - a "CPD record" - showing how the PDP is being delivered and tracking the individual's progress.

What is a PDP?

A personal Professional Development Plan (PDP) will help you prioritise your development activities and plan your CPD. Your PDP should demonstrate how you intend to maintain and develop the knowledge and skills you need to succeed in your current job and future career and how you intend to maintain / improve your professional competency. It is an essential part of planning your professional registration journey ie from EngTech through to CEng.

To determine your development activity and priorities, you will need to do the following:

1. Identify career aspirations and determine career path - identify career trajectory options
2. Carry out a personal SWOT assessment (identify your strengths and weaknesses; identify potential opportunities and threats)
3. Identify the knowledge, skills and experience desirable to move your career forward
4. Consider short and long term goals. Consider 'hard' technical needs and 'soft' behavioural needs
5. Produce a plan; what is needed and by when. Try to forecast how much time is needed to achieve each objective
6. Identify your priorities.

What does a good PDP look like?

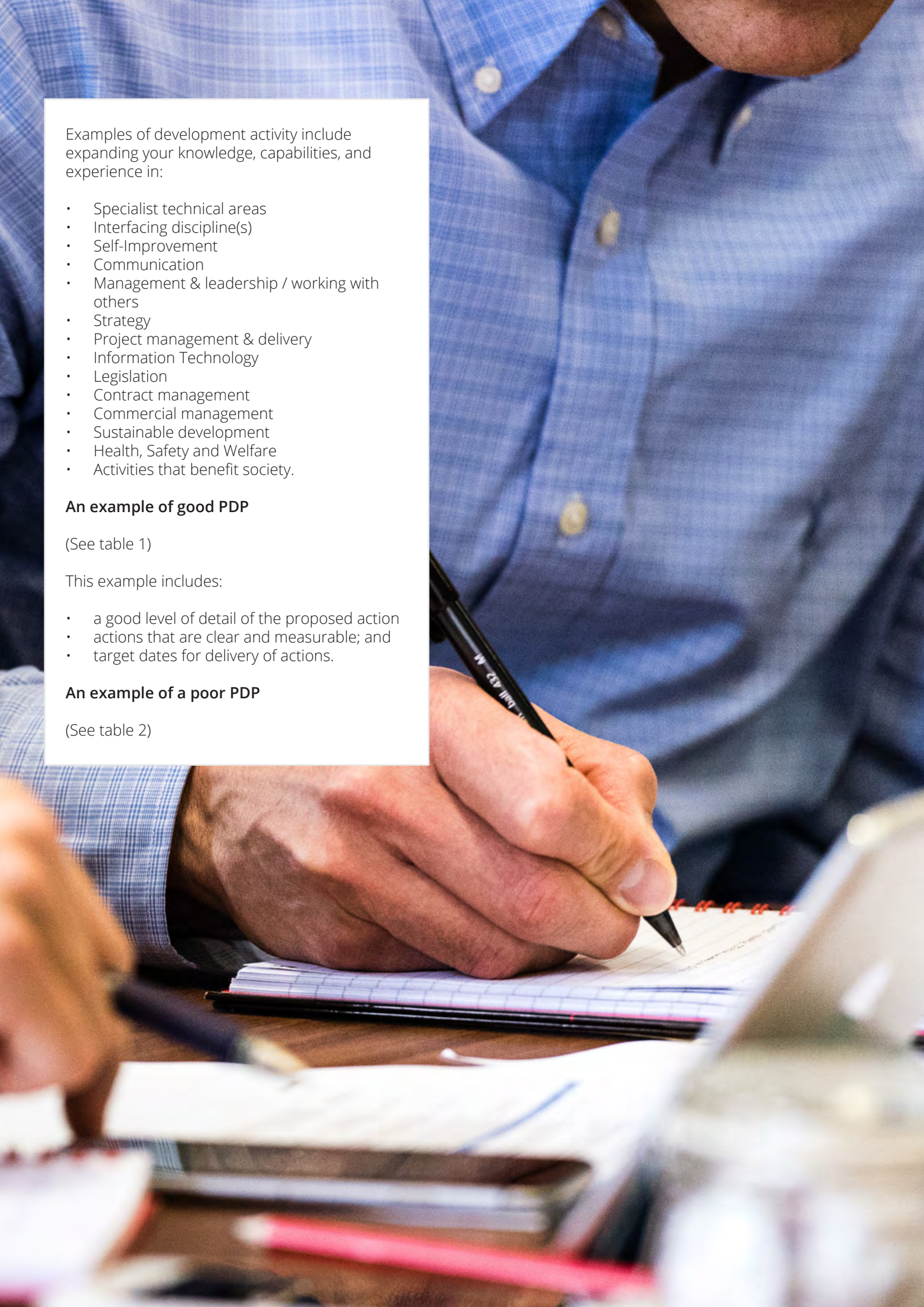
In producing your PDP, you should think holistically; consider what your employer needs, and what society and the law expects of you. Development activities do not have to solely be related to work / career ambition. Personal social activities can also drive development activity that may provide overall personal development. You should consult work managers, peers and colleagues in producing your PDP.

You can build your PDP and development activities using the PWI's 'My CPD' portal. Simply log in to the website and start building your plan.

Whichever template you use, you need to record the following:

- What is the development activity and objective?
- What is the specific action(s) required to achieve the objective?
- What resource(s) do you need to complete the activity?
- How will you assess whether the activity is a success?
- Forecast a date by when you aim to complete the activity.

You will need to regularly review and update your PDP; an annual review is recommended. However, you should not hesitate to add new activities throughout the year as new opportunities and activities arise.



Examples of development activity include expanding your knowledge, capabilities, and experience in:

- Specialist technical areas
- Interfacing discipline(s)
- Self-Improvement
- Communication
- Management & leadership / working with others
- Strategy
- Project management & delivery
- Information Technology
- Legislation
- Contract management
- Commercial management
- Sustainable development
- Health, Safety and Welfare
- Activities that benefit society.

An example of good PDP

(See table 1)

This example includes:

- a good level of detail of the proposed action
- actions that are clear and measurable; and
- target dates for delivery of actions.

An example of a poor PDP

(See table 2)

Joe Bloggs – Professional Development Plan – Revision 3 - July 2019				
Objective / Activity	Action	Resource	Date to be achieved	How achievement will be assessed
2019-01 Achieve IEng PWI	- Review PWI Guidance. - Find sponsor / supporter	- Personal time - Sponsor time - Supporter time - Budget for IEng application fees	December 2020	Successful application and interview
2019-02 Improve track drainage and formation knowledge	- Review technical papers / articles - Investigate if a training course is available - Seek site visit opportunities - Attend seminar.	- Personal time - Employer support for courses.	June 2020	Successful attendance of a course or seminar. Pass associated exams. Reading of relevant technical publications. At least one site visit.
2019-04 Support PWI / Professional body events	- Attend PWI Section meetings - Consider proactive role with local Section.	- Personal time - Employer support for role with the PWI.	December 2020	Attendance at a minimum of four Section meetings. Key role with local Section.
2019-05 Gain more management experience	- Seek opportunity to manage staff - Consider secondment - Look for opportunity to mentor a colleague - Role with local section.	Time applying for new roles and opportunities.	April 2020	Role with some management responsibility established or planned.
2019-06 Development of others	- Seek opportunity to act as STEM ambassador - Contact local schools to help with careers advice.	- Personal time - Employer support for STEM activity - Local school contacts.	December 2020	Interface with work colleague who requires support. Role as STEM ambassador inc training.
2019-07 St Peter's Church Maintenance	Help with St Peter's church maintenance – committee member, fund raising and maintenance activities.	Personal Time	December 2020	Attend maintenance committee meetings, management of maintenance works.
2019-08 Health, Safety & Welfare knowledge & experience.	- Carry out training needs assessment to identify gaps - Arrange the required safety training / refresher - Look for Safety Leadership opportunities - Ensure receive RAIB incident reports.	- Discuss with line manager - Identify training courses - Sign up for email from Gov.UK for RAIB reports.	April 2020	H,S&W training plan. Up to date H,S&W knowledge & understanding. Positive results from any training courses & examinations. Note key recommendations from RAIB reports.
2019-09 Sustainable development	- Refresher on the three pillars of sustainability - Read relevant industry articles - What is meant by climate change?	- Work projects - Personal reading time - Possible training course.	April 2020	Understanding what is climate change. Understanding the three pillars of sustainability.
2019-10 Communication	- Seek opportunity to produce and deliver a presentation - Possible training.	- Discuss with line manager - Discuss with local PWI Section and VP	April 2020	Opportunity for presentation identified. Presentation produced.
2019-11 Railway Infrastructure knowledge & understanding	- Attend industry events - Read publications	- Personal time - Negotiate time away from day job to attend Technical seminars and training.	December 2020	Attend at least one Technical seminar. Ensure read PWI Journal and other relevant publications Attend Rail Live.

Table 1: An example of a good PDP

Item	Action
Health & Safety	Attend the required H&S courses
Site visits	Attend as many site visits as possible
Communication	Attend as many staff briefings as possible
Technical Knowledge	Receive latest 'Clear Route' briefing / training. Read PWI journal.
Personal Development	Look at options to become a Chartered Engineer. Apply for promotion.

Table 2: An example of a poor PDP

Joe Bloggs - CPD Record 2019							
Ref	Date	Activity	Formal or Informal	Effective Learning Time (Hours)	PDP Ref	Key learning points & benefits	Emerging changes & improvement actions
2019-01	DD MM YY	Attend PWI Thames Valley Section meeting. Presentation by Sid Smith on Track Drainage repairs at London Paddington. Networking with Thames Valley Section.	Informal	2	2019-04 & 2019-02	Learnt about the challenges of working at Paddington with gaining access. Noted the impact that poor project planning and delivery can have on local maintenance activities.	Ensure that maintenance teams are engaged in project planning. Check that asset knowledge is up to date – if unsure carry out thorough surveys.
2019-02		Attend PWI Technical Conference - Electrification & Permanent Way Developments, Derby. Papers on Electrification projects – Midland Mainline, Bedford to Kettering, Parr to Rutherglen (Scotland). Electrification Impact on P Way Maintenance Developments in 25KV isolation and earthing. Alternative solutions at Cardiff to enable electrification. Introduction to Railway Industry Association (RIA). PWI Networking.	Formal	6	2019-11	Really good introduction to 25KV OLE systems. The impact electrification has on PWay maintenance in particular the +/- 25mm tolerances. The importance of properly co-ordinated phases of work and the interfacing disciplines. Principles of 25KV earthing requirements. Useful background on benefits of the RIA.	I will make sure on railway journeys I will study in more detail the different type and configuration of OLE installations. Follow up contact I made with Supplier.
2019-03		Mentor session with trainees Janet and John. Reviewing placement activity plus planning future placements and development activity.	Informal	2	2019-06	Further experience mentoring Engineering trainees. Understanding more about how to become involved as a STEM ambassador.	Encourage more graduates to consider STEM activity.
2019-04		Meeting with ABC Supplier to discuss options for track fastening assemblies to resolve track failure concerns on the XXX project.	Informal	2	Extra	Really useful; to discuss ABC Supplier latest products and options to provide a solution for the project problem.	Discuss ABC Supplier proposals with construction team. Investigate options available with other suppliers.
2019-05		St Peter's Church – maintenance committee, reviewing maintenance priorities and planning spire refurbishment.	Informal	2	2019-07	Learnt about the challenges with Death Watch Beetle and old timber structures. Received briefing on applications for Heritage Lottery Funding.	Need to carry out a survey of the poor condition paths around the church. Contribute to the business case for funding applications.
2019-06		Team briefing and Toolbox talk	Informal	1	2019-08	Key H&S issues raised. Lessons arising from RAIB reports – in particular be wary of staff fatigue. Learnt about challenges of survey over long distances and need to allow for earth's curvature.	Always challenge staff and contractors regarding fatigue and need for frequent rests.
2019-07		Fire safety training – required to work on the sub-surface railway	Formal	4	2019-08	Triangle of Fire, Fire Prevention, Fire / Smoke Detection. Tackling fires; experience with extinguishers. Passed end of course exam.	Useful fire safety information to help manage safety at home. Check my fire alarms.
2019-08		Session with PWI Professional Development Officer to discuss options for progressing to IEng	Informal	1	2019-01	Noted recommendation to apply for EngTech membership as a first stage to demonstrate commitment. Noted the Competence requirements for each level of registration.	Progress EngTech application as first step. Find Sponsor and Supporter. Set down evidence to demonstrate achievement of competence levels.
2019-09		TV documentary – Where did CrossRail go wrong?	Informal	1	2019-11	Interesting documentary with key industry commentators and critics contributing to the debate. I noted that the tunnelling was completed mainly to budget and programme, but some stations are approaching 500% cost increase. Also, I was alarmed at the amount of re-work reported. Complexities of integrated different signalling systems was noted but was not covered very well.	I would like to understand more about why some of the stations' costs escalated so much. Also I would like to better understand the challenges of integrating the different signalling systems. I will look for more articles in the railway press.

Table 3: An example of a good CPD record

Date	Item	Hours
DD MM YY	Team briefing	1.0
	Site visit	1.0
	Fire safety training	4.0
	Lunch time presentation by Huck bolts – Supplier	1.5
	Working sidings – Grip 3 meeting	2.0
	Track engineering conference	6.0
	Attending Railtex	6.0
	Standards briefing	2.0
	Software training	6.0
	Health & Safety briefing	1.0
	PTS training	15.0
	2018 - TOTAL	45.5

Table 4: An example of a poor CPD record

Development activities do not have to solely be related to work / career ambition.

Personal social activities can also drive development activity that may provide overall personal development.

What does a good CPD record look like?

There are TWO key parts to a CPD record.

Firstly, you need to record:

- What the CPD activity was - a summary statement
- The date and duration of the activity
- What PDP objective the CPD activity is linked to.

Secondly, it must include a review of the CPD activity. Your reflection and evaluation should include:

- Detail of the activity, including positives and negatives
- Specific personal learning points and benefits from the activity
- What changes, improvements or further action the activity has triggered

Good CPD is a balanced mix of planned Formal Learning and more ad-hoc Informal Learning. A minimum of 30 hours CPD is required each year, of which 15 hours should be Formal Learning.

Examples of Formal Learning include:

- Training courses
- Further education and study for examinations
- Formal research
- Conferences and Seminars
- Producing and delivering papers
- Attending PWI local Section meetings.

Examples of Informal Learning are:

- Site visits
- On job training / experience
- Personal reading
- Documentaries
- eLearning / podcasts
- Coaching or mentoring; developing others
- Contributing to PWI (professional body) affairs
- Professional Reviewing and mentoring
- Contribution to the local community.

The Informal Learning should be a good mix of work based activities, self-learning (eLearning, reading etc), contribution to community activities, developing others and professional body activities.

It is important that members support their professional body by attending PWI meetings and events, plus mentoring the development of others.

It is good practice to review and update your PDP as you complete CPD learning. Good review and evaluation should identify further development activity which should then be added to the ongoing PDP.

An example of a good CPD record

(See table 3)

This CPD record provides detail of the activity and has a good mix of events, balancing work-based activities, self-learning and professional body events. Each activity is evaluated and reflected upon, which will drive future CPD activity and help shape the PDP.

An example of a poor CPD record

(See table 4)

The benefits of 'My CPD'

There are many PDP and CPD templates and formats available for recording your professional development. 'My CPD' enables you to create a bespoke record of all your developmental activity. Entries are created in a manner that captures the key details and prompts timely reflection to ensure all the requirements of good CPD recording are met. It also enables you to produce summaries and detailed reports of your activity, all of which will be accepted by other professional bodies.

Log on to the PWI website now to book yourself onto PWI technical meetings and start building your development plan today!

You can build your PDP and development activities using the PWI's 'My CPD' portal. This is available to all members.

Simply log in to the website and start building your plan.

profeng@thepwi.org



THE YOUNG ACHIEVER AWARD 2020

CALL FOR PAPERS

Submission deadline
31 January 2020

This award is open to all involved in rail infrastructure engineering projects; engineers, project & maintenance staff, graduates, apprentices etc.

Please submit an original paper between 2,000 and 2,500 words on a railway infrastructure project completed between 2013 and 2020.

✉ Submissions and questions: jenny.smith@mottmac.com

1st Prize - £650
2nd Prize - £400
3rd Prize - £250

PAPERS WILL BE JUDGED AGAINST THE FOLLOWING CRITERIA:

Relevance to railway infrastructure
Difficulties overcome
Quality of paper
Amount of innovation
Ongoing benefit to the rail industry
Technical excellence

Winners announced at the
**UTILISING NEW TECHNOLOGY
ON RAILWAYS** Seminar in Manchester
on 4 March 2020

Sponsored by



To be eligible for this award, an entrant must be under 30 years old on 1 January 2020.

The Permanent Way Institution may change the terms and conditions associated with this award at any time.

Playing a part in your local PWI Section is a great way to become more involved with the PWI and **will count towards your CPD.**

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

We hold over 200 local Section meetings a year!

Find a meeting:
www.thepwi.org/calendar/

Bengaluru
Birmingham
Cheshire & North Wales
Croydon & Brighton
Edinburgh
Glasgow
Irish
Lancaster, Barrow & Carlisle
London
Manchester & Liverpool
Milton Keynes
Nottingham & Derby
North East
South & West Wales
Thames Valley
Wessex
West of England
West Yorkshire
York

OBITUARIES

Gareth Delbridge

1954 – 2019

Eulogy read by Rob Lester, Track Maintenance Engineer Swansea Network Rail, on Friday 26 July in celebration of the life of Gareth Delbridge who was tragically killed whilst at work on 3 July in Port Talbot.

I would like to say a few words on behalf of Gareth's friends and colleagues in Port Talbot P-way. We at Port Talbot are privileged to say that we worked with, befriended and enjoyed the company of Gareth Delbridge – a legend. Over 40 years' service to the railway and not a day on the sick, not a moment to moan about - how could he when he worked in a job he loved so much? Gareth had a few nicknames on the railway: Gaz, Gazza, Dello's and Del Boy. Gareth was also known as one of the 'Railway Children' which included: Mike Lewis, Colin Delbridge and Terry Lewis. All of them respected in every place they worked and made the railway a better a place, thanks to their service and commitment.

We find it hard to speak about Gareth without mentioning Colin. They had a telepathic connection: the rumour was Colin was in charge in work and Gareth called the shots when they socialised. They loved their social life: darts, trips to Scotland and their beloved

Moules Club. They would say "we are off to Church Sunday" and any new additions to the Port Talbot family would accept that they were deeply religious (not saying that they were not), but 'church' was code for the club. Gareth and Colin were a unique team together, skilled and experienced railwaymen who could make the most complex of jobs run like clockwork.

On a nightshift, no matter where they were - usually two miles from the nearest access - there was one piece of kit they were never without. You've guessed it... the tea kit!

Gareth will always be held in the highest regard for his professionalism and leadership amongst our team. Whether they were new starters or experienced, he always commanded the utmost respect. He made such an impact on one of our new starters they simply called him 'Sarge'. Gareth was respectful and had immense pride. At 3:30 every day without fail you would see him cleaning and washing his van. A real example to everyone of the standards we should aim for.

For a so-called oldie, Gareth was always up with the latest technology and would have information on how to watch the odd football game for free. Gareth would have great pleasure on a Saturday night discussing the Cardiff City result, and would love to say his daughter and grandson are season ticket holders.

Gareth was an example of how we would all like to be - a strong, hardworking man, with nothing but good intentions. He would offer advice, humour and would always say it how it was. Gareth's main priority was his family; he was a man who loved his wife, children and grandchildren. A proper gentleman in every way.

You have left a void that can never be filled. There will only ever be one Gareth Delbridge. Sleep tight.

Michael Lewis

1960 – 2019

Michael Lewis was killed alongside Gareth Delbridge whilst at work on 3 July in Port Talbot. Michael is remembered as a dedicated railwayman and active member of the local community. Though not a PWI member, the Institution acknowledges his contribution to the industry and to his local community. Our thoughts and sympathies remain with his friends and family.

As at August 2019, investigations concerning the deaths of Gareth Delbridge and Michael Lewis at Margam on 3 July are ongoing.

Robert (Bob) Laws

1935-2019

It is with sadness that the North East Section marks the passing of Bob Laws on 30 May 2019 aged 84, following a short illness. In August 1960 Bob joined British Railways in the District Engineer's Office at Darlington, initially in the works drawing office and subsequently in the work study section. The Darlington and Newcastle district offices merged in the late 1960s to form the Divisional Civil Engineer's Office at Newcastle and he was transferred there, holding various appointments again in the works drawing office. He was an excellent draughtsman and was heavily involved with the programme of North East level

crossing conversions from wheel operated gates to lifting barriers, achieving road and track alignment improvements during the changeover works. He also undertook design and setting out work for station platform improvements for the introduction of the HSTs. Latterley Bob became Works Planning Assistant and then Works Construction Assistant in the Area Civil Engineer's Office, Forth Banks, Newcastle.

Bob had joined the PWI shortly after starting his railway career and was a very active member, helping the Section in many ways and attending visits both at home and abroad. Bob was a great lover of music, particularly classical and opera. He was a great Wagner fan and attended many performances at opera houses in this country and world wide.

He was an inveterate traveller, using his rail concessions to attend the many concerts. Bob also enjoyed visiting Gerard, one of his sons who lives in Arizona (USA). Sadly Bob's wife died nine years ago after 49 years of marriage, however they were blessed with four sons Stephen, Andrew, Martin and Gerard. Bob's funeral was held at the Holy Family Church in Darlington on 13 June with family, friends, railway work colleagues and PWI members present.

Bob was a well-liked and most amiable man who will be sadly missed, and we extend to his family our sympathy at this difficult time.

Jim Shields
Neville Whaler

Mark Driscoll

1956-2019

It is with great regret that I advise of the passing of Croydon & Brighton Section member Mark Driscoll on Tuesday 30 July, following a road collision whilst pursuing his enjoyment of cycling. Mark had a long and fascinating career in Permanent Way and was known fondly by many in the industry through his time spent at London Underground, Atkins and Mott MacDonald.

During his time at Atkins, Mark was held in high regard for his technical expertise, providing invaluable input to domestic and international projects including Gautrain, Crossrail Bored Tunnels and Taiwan High Speed Railway. Most of all, Mark is remembered by all at Atkins for his helpful positive approach and cheerful disposition. Mark worked at Mott MacDonald from 1988 to 1992 in the UK, and then in Hong Kong until he returned in July 2011 before choosing to retire in April 2018. Mark was a linchpin of the Mott MacDonald track team during these periods, providing technical guidance and development for a number of

the junior engineers and leading a number of complex schemes, working across a number of teams and visiting Malaysia, Singapore, Mozambique, South Africa and Ghana. Even into his retirement, he kept in regular contact with former colleagues within Mott MacDonald and his loss is sorely felt.

Our thoughts are with his family at this time, in particular his wife, Christine, his children Jack, Chris and Clare and his grandchildren.

Colin White and colleagues

OBITUARIES

David Wyld

1940 - 2019

David Wyld was born on 22 February 1940 in Whaley Bridge, Derbyshire.

At the age of 11 he moved to Hull and attended Hull Grammar school. At the age of 16 he moved back to Whaley Bridge and shortly afterwards started work with British Railways in the District Civil Engineer's office in Mount Street, Manchester. He became a member of the Permanent Way Institution on the 7 March 1958 and became a Fellow of the Institution in March 1963. He was an active member of the local group, being Chair during his membership.

He was a keen hockey player and it was on the hockey field where he met Doreen who was to become his wife. They were on opposing mixed teams with David playing in goal when Doreen knocked David over whilst scoring a goal. Shortly afterwards they were married in 1965 and went to live in High Lane on the outskirts of Stockport.

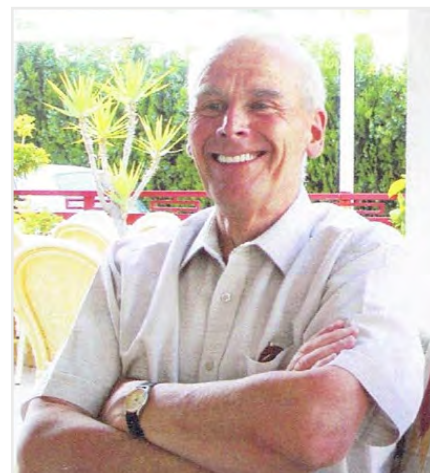
They have two sons, Anthony and Andrew. In 1970 they moved to live in Congleton before moving to Bramhall in 1975 where they were living at the time of his death on 2 June 2019. His long railway career, of approximately 50 years, having started in Manchester was followed by a move to the Liverpool Divisional Civil Engineer's office in 1975 as the planning assistant.

He returned to Manchester after the merger of the Liverpool and Manchester Area Civil Engineer's offices in 1984 as a Permanent Way Maintenance Engineer.

When the offices separated again in 1989, David took on the challenging role of Permanent Way Renewals Production Manager where he took on the technical and man management challenges of introduction innovation such as squadron ballast cleaning and low cost steel sleeper relaying. After a first trial at Glossop, the line from Hazel Grove to Stockport was installed so efficiently that the Manchester Area was granted almost all of the London Midland Provincial Railway renewal budget during the next two years. This changed the future of some of the commuter lines into Manchester that had been mooted for closure and conversion to tram because of their state and cost. His willingness to try new ideas and patience in taking his technical supervisor and workforce teams with him made success possible where other Areas had tried and failed, and led the way for national adoption of the techniques. Manchester was much copied but never equalled.

He moved into Railtrack in 1994 before taking early retirement in early 1997. However, his retirement did not last long because he was back the next day as a railway consultant for Railtrack!

His outside interests included the Scout movement where he rose to be President of the Group from starting out as a cub leader in 1975 in Bramhall. He was also a keen Hull City supporter, no doubt from his teenage years spent in Hull, and attended many home and away matches with his grandson as season ticket holders which they took out in 2002 and visited more than 80 grounds. He also enjoyed organising visits to preserved railways, dinners and Christmas get togethers for retired colleagues.



He relaxed at home with his garden railway, his railway in the loft, gardening and weekends away in his caravan in Port Madoc. Both Doreen and he enjoyed ocean cruising and they should have been cruising this Summer.

His funeral was held on Friday 28 June in the Rowan Chapel of Stockport Crematorium and attended by more than 100 people.

There were many family and friends there including many from the Scout movement and more than 20 railway colleagues, from all departments, who had come to pay their final respects to a well-respected railway engineer. He was always willing to try new things, always calm under pressure, nothing was beyond his ability, respected by all and a good friend to all who knew him.

Bill Pilkington

Alan Blackburn

I'm sorry we have lost Alan and my sympathies go to Anke and family. Alan had a long career on the railway. He was a proud Southern Region man, a PWI member for 48 years and well respected throughout the railway.

I got to know Alan well when I took up the job of Southern Region Permanent Way Maintenance Engineer in 1988, an organisation that Alan was already working in. When I started in the job Alan was very welcoming and we developed a good relationship. I soon saw that he was a knowledgeable, competent and enthusiastic railwayman. Alan had a wide range of duties. When he took on anything new, he would set out to thoroughly understand it and then set out to improve the outcome and as a result he became an expert in the subject. Some of his tasks I particularly remember were:

- He managed a team who planned and undertook the region's pioneering rail grinding programme. The process, although expensive, produced great improvement to the track and is now universally adopted.
- He developed improved processes for vegetation management which had been neglected and was causing problems with overgrowth, dangerous trees falling on the line, protected trees and nesting birds. He employed a respected environmental consultant to advise on best methods and to give talks to influential bodies and the public to demonstrate that the methods being adopted were the best.
- Following the great storm of 1987, Alan used his extensive knowledge of the Southern Region to be flown by helicopter to assess the damage caused to the railway and report back so that repair resources could be effectively mobilised.

Alan was appointed the Southern Region representative on a group set up to agree best

practice for track maintenance and to produce a handbook setting this out for publication and national adoption. There was considerable rivalry between the regions each pushing for their own methods to be adopted nationally. Alan, a proud Southern man, used his knowledge and skill to ensure that Southern's methods and practices were adopted when he could demonstrate and convince the group they were the best. Handbook 5 was published and became the national railway group standard for track maintenance and continued to be the standard for the next 20 years.

Alan retired in 1992 when Southern Region ceased to exist. He continued his railway interests after retirement using his knowledge and skills to the benefit of heritage railways. He was a good friend to me, well known and liked by many others on the railway and will be sadly missed by us all.

Dave Stuckey

PWI ANNUAL GENERAL MEETING MINUTES

Friday 12 July 2019

MacDonald Burlington Hotel, Birmingham, B2 4JQ

ATTENDEES

J Heery, S Barber, A Cooper, A Tappern, G Edwards, K Hatwell, B Counter, L Turner, G Dennis, S Featherstone, S Green, P Kirkland, A Packham, A Stansfield, J Watson, A Wilson, M Wooff, M Pearce, J Scott, P Ebbutt, J Edgley, N Millington, R Antliff, R Spoors, P Benzie, A Pettifer, R Wells, K Illsley, M Mabbett, T Utley, K Newell, A Roberts, M Taylor, P Cave

APOLOGIES

R Hickman, J Dutton, R Quigley, C Green, J Weaver, B Parkinson, J Barlow, B Gardiner, R Kimber, L Garner, S Pearson, K Thurlow, C White, P Ebbutt

MINUTES

ITEM 1: Joan Heery, President-elect welcomed all those in attendance to the annual general meeting of the PWI and spoke of the eventful experience in having the presidential chain engraved and updated. Apologies were received and accepted from those named above.

ITEM 2: The President asked all present to stand if able and observe a one-minute silence to celebrate the lives of PWI members who had passed away during the year. The 28 names read were: Peter White, Dennis Howells MBE, Peter Allen, Donald Lindsay, George Richmond, Archibald MacIntyre, Edward Labrum, Dennis Rapley, Phillip Cooper, Bob Brown, Derek Cairns, Frank Stamper, Malcolm Goldsmith, John Sowden, John Irving, Simon Gilmartin, Ian Brown, George Anthony Eden, David Yule, Ivan Olney, Ernie Carlin, Gerald Summerfield, Alan Blackburn, Robert Laws, David Wyld, Anthony Key, Terrence Yarrow, & Gareth Delbridge: Michael Lewis, killed alongside Gareth in an incident at Margam, was also remembered, though not a member of the PWI.

ITEM 3: The roll call of the Sections took place. All UK Sections were represented except for Ireland and Croydon & Brighton, who sent their apologies.

ITEM 4: The Minutes of the 2018 AGM were proposed as an accurate record by Philip Kirkland, seconded by Gareth Dennis and unanimously accepted.

ITEM 5: Joan Heery took the floor as President-elect and gave her report to the meeting. Joan described her rise to Presidency as very accelerated and the result of a lot of changes within the PWI as an organisation. The retirement of David Packer as CEO and Stephen Barber being successful in interview to take on the post, left a vacancy in the Presidential position as the CEO and President cannot be the same person. Gren Edwards was next in line but unable to take on the role due to other work commitments. Joan was asked to step in and become President and immediately said yes – it is a fantastic honour. Despite a short period as a trainee, Joan said that she is thoroughly enjoying being President.

Joan referred to other changes in the organisation too. We welcome Liz Turner as our Registration Manager – attaining our professional registration licence from the Engineering Council (EngC) requires a dedicated individual to manage all of

that and Liz is doing fantastically. Kerrie Illsley, whilst not new to the PWI, is our new Journal Editor, and Michelle Mabbett joins the team as our Marketing Manager. Joan encouraged attendees to go and say hello to the team.

Joan explained that her plan for her Presidential year is to focus on two areas. In the short time she has been in the PWI, she sees how busy the core team are in delivering business as usual, and the difficulty in also achieving strategic objectives. Accordingly, Joan has picked two which fit the Strategic Plan – firstly to improve relationships with corporate members. Steve Featherstone increased the number – we have 40 with more in the wings – and we now need to talk to them as individual organisations and thank them, but also ask what we can do to help them solve problems in their businesses. The second area is to help the Sections be the best they can be. The Section Secretaries' biannual meeting had taken place earlier in the day and had discussed a wide range of potential improvements. Sections are now mulling over the ideas and in the Autumn will re-group to establish Section-specific two-year development plans. Joan advised that in her Presidential year she plans to visit the Sections; she noted that she has been made very welcome at those she has been to so far. She hopes to visit Belfast, Dublin and Bangalore too.

ITEM 6: Stephen Barber gave a summary of 2018, describing it as a good year, where the PWI moved on significantly. It was the year when all the substantive work towards becoming a professional engineering institution was completed, and we got our licence in January 2019. A huge amount of work was done by the Executive team and our friends in IGEM to complete the paperwork and get through the process for licensing. That is now behind us, but EngC will be back to visit us in December this year. Stephen noted that 2018 saw enormous achievement and expressed his thanks and respect to the team.

2018 was also a year for membership growth, with 3086 members by the end of the year. Growth was particularly strong in students and apprentices, and if the Institution has a direction to go in, it's to get those people in our membership and strengthen the 'youth wing'. This had been the subject of a lot of discussion with the Section Secretaries earlier in the day. Professional Registration went on apace in 2018, with 107 registered at year end (30 CEEng, 22 IEng, and the remainder EngTech). This good performance continues in 2019, where we have already registered 31 – the same number in the whole of 2018, and interest is growing. Our ability to respond to that interest is well and truly established with Liz Turner in the Registration Manager role.

We ran a strong suite of seminars in 2018 – OLE was a focus and we are maintaining that this year and into 2020 too. Stephen particularly highlighted the joint seminar with UEEIV on urban rail in Manchester which was a great success. Our technical training continued to flourish – Stephen noted it as a booming line of business which continues to do very well. We ran the second Practical Trackwork Challenge in 2018 and feedback from the young engineers was extremely positive. This is now a firm fixture in the calendar, with the 2019 event taking place at the Churnet Valley near Leek, Staffordshire. We published the updated S&C maintenance textbook; this should be a significant contributor to making infrastructure even more reliable. Stephen noted

that we had good financial growth in 2018 too, in line with where we want to be as an engineering institution.

Moving to the 2019/2020 strategy and where are we going, Stephen commented that 2018 saw us establish components of our future strategy and that we have focussed on the internal organisation of the PWI. We now have almost all the people we need in post, with the appointment of a Technical Content Manager outstanding but interviews have been held, so the organisation is nearly complete. Our new marketing manager has helped to put together a stakeholder engagement / communication plan which will hold all the threads together, so we are clear on who to talk to, the message to give, and who in the Institution is the focus for that communication. The plan pulls together information on the disposition of our individual and corporate members and how that maps to our Section structure etc. The analysis will feed into other elements of the strategy too. We have also kicked off a project for website replacement; ours soldiers on, but sourcing support for the aged technology becomes ever more difficult.

The training business continues to grow and we have had expressions of interest internationally for our products which we are pursuing, recognising the need to maintain control and ensure we deliver to the same level of assuredness and consistency. Stephen noted that we will maintain financial control too, commenting that as a not-for-profit organisation, we run on wafer-thin margins. Our focus is to put effort and resource back into industry – through activities and knowledge share.

Stephen highlighted the business as usual activity which keeps the PWI running. In 2017 we implemented free membership for students and apprentices, which was great as it encouraged a big growth, but the challenge now as they reach the end of their courses is converting those free members into paid memberships. Whilst the conversion rate looks quite good it is too easy to get sanguine and the centre and Sections need to engage with our student members and make sure the PWI is relevant to their ongoing careers.

Having become a recognised Professional Engineering Institution, ongoing effort and activity is required to maintain that status. Our Academic Panel and Membership Committee is working with the Executive on policies and procedures ensuring they are up to date and efficient. We will have a review from EngC in December, and we need to be fully prepared for that – able to answer all their questions and demonstrate that we have closed out the conditional actions they gave us when they awarded us our licence. We have a lot of seminars planned: for 2020 a joint plant seminar with UEEIV; another on Electrification given the earlier extraordinary success; and possibly one on surveying and survey data management, a sphere in which technology is moving on very quickly. Looking back just four years to our last one on this topic, some of the "new technology" discussed then has been rendered obsolete by more recent developments. We are also planning an 'Applying Innovation' seminar for March 2020.

Stephen noted wider member engagement, and our desire and need to stay close to them. At the Section Secretaries meeting we spent more than half the day thinking hard about how to meet that challenge – growing engagement and leaving members in no doubt about the value they receive from the PWI. Stephen concluded by saying that



Expert supplies for every job

Balfour Beatty offers a wide range of components for rail construction and maintenance projects.

Our products include:

- Rail sections
- Sleepers and timbers
- Track smalls
- Industrial switches and crossings

To find out how we help our customers find the right part for their job, visit:

www.balfourbeatty.com/tracksupplies

Balfour Beatty

For more information, contact us:

e: tracksupplies@balfourbeatty.com

t: 0114 241 5000

he intends the PWI to maintain growth and that 2019 is looking good. That said growth is not at the explosive rate it was in 16/17/18: the Institution is now in evolution not revolution and we need to learn to continuously improve.

Questions from the floor were invited, but none raised.

ITEM 7: Stephen introduced the proposed change to our Articles of Association, explaining that the amendment was an EngC requirement as part of our licence award and is a perfectly reasonable and possible addition:

47(1) The Institution shall pay due regard to regulatory bodies within the rail industry and the engineering profession.

The subsequent sub-clauses have been renumbered accordingly. It was approved at PWI Board Meeting on 6 November 2018 and is proposed for formal acceptance.

Comment: Are alterations to the following clauses limited to the renumbering?

Response: Yes – they have simply been renumbered and there is no alteration to the wording.

The changes to the Articles of Association were proposed by Steve Featherstone, seconded by Martin Wooff and approved unanimously.

ITEM 8: The Directors' Report and Accounts to 31 December 2018 was presented by Andy Tappern who joined the PWI as Finance Director in January 2019. He is Finance Director (IP Western, Wales & Crossrail) at Network Rail and has worked in the railway industry for 32 years.

Andy gave a high-level overview, indicating that 2018 was another good year of income growth at nearly 15% and the overall net profit position gives

a small surplus. A key part of our income growth is our subscriptions, up 7% in the year – which is a mix of individual and corporate subscriptions. The other key area is training which has seen a 40% increase. This is in line with our strategy and it's good to see growth continuing in the first half of 2019: good performance. Andy noted that textbook sales have declined by one third, which may be a trend given society's move into the digital age and is something we will have to keep an eye on as we move forward.

Andy explained that costs have also gone up, but that is as expected when income is going up. He expanded on a couple of areas: training income has increased, so the costs have increased. Future delivery for new courses is also being implemented. Conversely, costs are decreasing in textbook publishing, which is in line with that reduced income. Administrative expenses are up due to a couple of key areas – executive team costs increased largely due to the increase in time spent by Brian Counter in developing and undertaking the training, and to a related increase in associated team activity. The cost of national meetings increased as a meeting traditionally held in December, shifted into January moving costs from 2017 to 2018, and the Board held a one-off strategy day too.

Andy noted that our debtors increased, driven by corporate membership renewals and sponsorship of 2019 seminars. All the outstanding invoices have been settled and there are no issues on debtors. The intangible assets are the development work for the Engineering Council licence. The fluctuation in investments is caused by the revaluation of the M&G fund investment which happened to dip down just as we hit year end. A few days later it was back up to its previous level.

COMMENT: What is the cause of the difference in 'website and email' within administrative expenses?

RESPONSE: There is a difference of £1400, which comes from a reduced number of development days and no longer continuing with certain software subscriptions, such as 'Go To Meeting' as it was not utilised.

COMMENT: Please can you explain the reference to the additional national meeting?

RESPONSE: The six-monthly Section Secretary meeting used to be held in December. However, the Winter 2017 meeting took place in January 2018 instead, moving costs which would traditionally have fallen in 2017 into 2018.

COMMENT: The accounts are to 31 December 2018, but commentary referred to March 2019.

RESPONSE: We held a seminar in March 2019, but some prepayments were received and invoices raised in late 2018 which fell ahead of the seminar.

The adoption of the Directors' Report and Accounts for year ending 31 December 2018 was proposed by Martin Wooff, seconded by Gareth Dennis and carried unanimously.

ITEM 9: Stephen Barber said that he was very pleased to propose Joan Heery for our President for 2019/2020, who has served her apprenticeship superbly. Joan was welcomed unanimously to a round of applause.

ITEM 10: John Edgley was invited to say a few words before a vote took place on his nomination as Deputy President.

John said that he began life on the railway in 1991 and worked up to become a Track Engineer through Network Rail and its predecessor organisations. After conversations with Stephen Barber, Steve Featherstone and Joan Heery he decided it was time to offer his support and contribution to the PWI's development. He is

interested in the development of competency management within Network Rail and the wider rail sector and intends to focus on that area in due course.

COMMENT: The PWI has had previous experiences of losing Presidents quickly due to the pressure of work. From the citations, both Deputy President nominees appear to have demanding jobs. Are you both confident that you will be able to serve the PWI as is expected of the President, in addition to the 'day job'?

RESPONSES: John Edgley confirmed that he would absolutely be able to do so (unless run over by a bus!). He is passionate and has ensured that he has got the right air cover in the office to enable this to happen.

Nick Millington (second nominee) also confirmed that he spoke with Stephen Barber, Joan Heery and Steve Featherstone: he noted that they are good mentors, and that he has deliberately opted to take the two-year "presidential apprenticeship" so that he will be ready to contribute fully in his presidential year.

Gren Edwards asked to say a few words on his position. Gren stated that he was chuffed to bits to take the role of Deputy President and did so at a time when he was in a role which had a significant support team around it. He was at a big blue-chip company and could rely on the team to release him to carry out the role. Now, working in a much smaller company, he has found it increasingly difficult to get to meetings. Gren had no doubts in saying 'yes' at the time, but due to the change in his working pattern, began to realise that he would

not be able to provide the level of commitment he had originally foreseen. He raised this change of circumstances with the Board. Gren expressed his thanks to Joan for taking over in the Presidency at such short notice.

John Edgley's appointment as Deputy President was proposed by Steve Featherstone, seconded by Alison Stansfield and carried unanimously.

ITEM 11: Nick Millington was invited to say a few words before a vote took place on his nomination as Deputy President. Nick noted that he began in industry two weeks after his 16th birthday and he is now the Head of Maintenance Delivery for Network Rail's Western Route, responsible for a team of 1500 people and 2200 miles of railway which they keep going by hook or by crook. Through the PWI there is an ability to learn and the PWI is a brilliant way of bringing on good practice. Nick has personally supported professional development pathways and now has 19 apprentices working for him. Nick will bring experience of maintenance, projects and plant to the Institution and is honoured by the invitation.

Nick Millington's appointment as Deputy President was proposed by Andy Cooper, seconded by Malcolm Pearce and carried unanimously.

ITEM 12: Andy Tappern's appointment as Non-Executive Director responsible for Finance, replacing Anit Chandarana, was proposed by Philip Kirkland, seconded by Gareth Dennis and carried unanimously.

ITEM 13: John Dutton's re-election as a Non-Executive Director was proposed by Alison

Stansfield, seconded by Malcolm Pearce and carried unanimously.

ITEM 14: Stephen Barber's appointment as an Executive Director was proposed by Andy Packham, seconded by Steve Featherstone and carried unanimously.

ITEM 15: Brian Counter's re-election as an Executive Director was proposed by Gren Edwards, seconded by Jack Scott and carried unanimously.

ITEM 16: Philip Kirkland's re-election as Vice President for Great Britain was proposed by Steve Featherstone, seconded by Gareth Dennis and carried unanimously.

Joan Heery closed by recognising Steve Featherstone's major contribution to the development of the PWI. Steve now steps off the Presidential chain and leaves the Board. He has been a fantastic advocate for the PWI and has helped enormously with professional registration and our partnership with IGEN, technical conferences, and increasing the number of corporate members. There is a great deal for the PWI to be grateful to Steve for. The meeting showed its appreciation of Steve in the traditional manner.

The next AGM will be held on Friday 3 July 2020 at the McDonald Burlington Hotel in Birmingham.

PWI BOARD MEETING MINUTES

Thursday 18 July 2019

GWR Board Room, Paddington, London

ATTENDEES

Joan Heery, Chair & President (JH)
Gren Edwards, Past President (GE)
John Dutton, Non-Executive Director (JD)
Andy Cooper, Non-Executive Director (AC)
Andy Tappern, Non-Executive Director (AT)
Paul Ebbutt, Vice President (PEB)
Steve Whitmore, Membership Committee Chair (SW)
Stephen Barber, CEO (SBa)
Kate Hatwell, Operations Director (KH)
Brian Counter, Technical Director (BC)
Michelle Mabbett, Marketing Manager (MM) (1130 arrival)
Liz Turner, Registration Manager (LT)

APOLOGIES

Colin Wheeler, Non-Executive Director (CW)
John Edgley, Deputy President (JE)
Nick Millington, Deputy President (NM)

MINUTES

The meeting opened at 1100 with a welcome to all present and apologies noted from those absent. JH ran through the safety procedures for the venue.

NON-EXECUTIVE REPORT FOR OCTOBER JOURNAL

JD agreed to write the Non-Executive Summary for the October Journal.

ETHICS, INTEGRITY & SAFETY

No matters reported.

2 MAY 2019 BOARD MINUTES & ACTIONS

The Board were happy that the minutes were a proper reflection of the meeting and were agreed and approved.

The Board discussed the criteria for Fellowship and whilst not being too prescriptive, this is met through a combination of positions held, years' experience, professional registration, and contribution to industry.

Agreed for the Executive team to revisit the requirements to provide greater clarification and return to Board for approval, and to run a Journal article in Jan 2020 explaining the proposition.

CEO REPORT

SBa commented that his report highlights how hard the team have been working and that much has been delivered in the first two quarters of

2019. Most of the team are part time and he was sure hours had been put in that have not been billed, particularly given the level of activity and flexibility that the team demonstrate when setting up / taking down at exhibitions and supporting at seminars. SBa noted that he is proud of the team and their performance.

JH agreed, expressing amazement at how so many things get organised in a small amount of time. This requires a high degree of organisational competence, and the team has it.

KH noted the work of Kerrie Illsley (KI) and Sara Green (SG) which is often not as visible. The extent of KI's contribution has become more obvious and it is important to recognise her. She is very efficient and on-the-ball, understanding what the Institution and its members need. She has come up with a series of creative and positive ideas and carried them through to delivery. SG's contribution is phenomenal too.

SBa noted that he had visited four Sections and JH has attended more too. There are interesting differences between Sections – some are very professional with a good turn out, but others need to be encouraged to think carefully about what they are offering, where, and when. We must strive to get working engineers through our doors and into Section meetings.

The Section Secretaries' meeting was good; all contributed and there were great conversations so all could see and hear what other Sections are doing: action plans will follow. It was stressed that Sections are our visible brand, that consistent delivery is important, and that these are critical areas for focus. Section Secretaries and Vice Presidents were invited to the meeting, however attendees noted a need to consider how to better communicate and engage with Section Chairs as there is currently no formally established communication route from the PWI Executive to these important roles. Attendees also noted that some Section Secretaries have been in the role for many years due to the absence of obvious successors, and felt that the Institution should aim for members to take on the role for a more limited time span as part of career development, rather than feeling shackled to them forever. It was again noted that the time and place of Section meetings should suit the demographic they serve.

GE noted the importance of professional, well-attended and consistent meetings to manage the risk of bad press and poor reputation.

JD suggested that the importance of Section committee roles could be picked up in professional registration and considered as part of the applications – their contribution to industry and society.

SBa highlighted the Engineering Council (EngC) Group B & C PEI meeting he attended. It was interesting in terms of the information cascade by EngC and the wider picture of how we are regulated and managed. There is a lot in the fallout from the Grenfell Tower tragedy.

Early indications from the Hackett review, and the conclusions of the ICE In Plain Sight report focus particularly on the area of assurance of continuing professional competence. This presents opportunities which we have majored on in terms of specialist engineer training and a focus on technical subjects for seminars and Section meetings. It looks as if the assurance around CPD is going to have to get tougher. All PEIs are in the same position, and we need to consider what might be coming and the additional work this will involve.

JD noted the two part-time Technical Content Manager appointments and asked if there are any budget implications. KH confirmed that the roles are contained in budget.

2019 FINANCIAL ACCOUNTS

KH provided a brief commentary to the year-to-date accounts presented. AT noted that it was a really good, well written report which explains what has gone on. GE agreed. JD noted that it is hard to pull back from Q1/Q2 overspends, so well done. AT noted that it was good to see that we were now close to budget but cautioned care with overhead costs. Noted that team activity reduces in the Summer months and that there is a peak of specialist training in Q4, so performance should dip and then recover.

In response to a query from GE, BC advised that the Birmingham-Doncaster High Speed college is rebranding to become an educational establishment for rail and it is on our radar to connect with them.

KH advised that work on the 2020 budget will begin in September, with KH / SBa / AT to develop by mid-October, ready for presentation at Nov Board for approval and sign off. We will then see the full year effect of having the complete Executive team in place.

TECHNICAL REPORT

BC presented his report:

- Professional Registration - 38 professional registrants year-to-date and Membership Committee and Academic Panel are running well. The report back from the Engineering Council Liaison Officer is excellent and we have a good reputation there. We are holding our annual Reviewers meeting and training exercise on 14 Nov and have started to audit Reviewers. Our Governance is well developed and on a par with other PEIs.
- Apprenticeships – currently working with a major contractor, formulating their "EngTech ready check" at end point assessment. There is considerable potential for this to be a strategic area of activity for the Institution. In the short / medium term we will use our expertise to undertake readiness assessments and will talk to other corporate members about future opportunities.
- Seminars - next seminar is on High Speed on 2 October at University of Birmingham. The Rail Engineering Conference in Edinburgh was excellent, helping to build further links and there was a lot of international interest in the PWI; Russel Kimber was brilliant.

NetworkRail

Certificate of Acceptance

PA05/06884

Mirage
Rail

MOBILE INDUCTION RAIL WELDER



Deployable from lightweight RRV
Poka Yoke - Error proof welding
Significant safety benefits over current welding systems
Substantial environmental benefits
No flame, No sparks, No fumes, Low noise
Multi modal modular design
Rail Bend Test Rigs & Outsourced Testing

NOW ACTIVELY LOOKING FOR GLOBAL SALES & SERVICE PARTNERS

COME SEE US ON

STAND
NUMBER 423

3-5TH DEC | 2019 | SYDNEY

AusRAIL PLUS
Conference & Exhibition

WORKING IN PARTNERSHIP



Keep up to date and find out more: ☎ 01782 642200 🌐 www.mirageservices.co.uk ✉ info@mirageservices.co.uk

- ACo supported the suggestion to promote end point assessment EngTech readiness checks to corporates – seems a strong proposition and could include a feature in the Journal. Also suggested that we liaise with HR departments, as it is an employee development issue, not just a technical one.

REGISTRATION REPORT

LT noted, in addition to BC's commentary on this area:

- We are making good progress in opening two additional routes to registration: a pilot cohort on the Experiential Learning route to Chartership are preparing their submissions; and the Academic Panel has guided and approved the Track Engineering Diploma as suitable further learning for Incorporated Engineer registration
- Our CPD Audit is underway with requests to review a sample of active members' and registrants' CPD records made and responses due 22 July, with feedback and moderation by our Professional Development Committee
- Our Engineering Council Licence Review is set to take place on 17 December 2019 and preparations for that are underway. We hope the outcome of the Review will lead to the issue of a five-year licence.

MARKETING REPORT

MM first expressed her apologies for being late to the meeting. Q2 has been dominated by meetings and events where there has been good opportunity for stakeholder engagement, but a different approach for big networking events is being considered. Work is continuing on the engagement piece / membership mapping throughout the Institution's network, and how we fit with the wider industry.

At the Section Secretaries meeting we spoke about brand marketing and getting involved in social media, and there is more work to do there. It is a good opportunity to rebrand and digitalise, and to build internal awareness of digital communications and how to utilise social media. A lot came out from the meeting as it was a good opportunity to meet the Section Secretaries and hear their concerns and worries. We plan to hold an online workshop in the Autumn covering a host of digital skills. Ultimately, we need to get more young people as members, so we need to communicate through social media and engage with them.

Section Secretaries are being encouraged to ask for help from their more "tech-savvy" members which would get them involved and taking responsibility. The mapping piece and engagement strategy will clearly demonstrate our younger demographic and how important it is to grow it through social media and the digital communications world. Board members noted that it is important that they are seen to be on message with this and would welcome an invitation to join the online workshop. Also noted the importance of monitoring social media and securing access control.

2020 SUBSCRIPTIONS

At a very well attended Technical Board on 9 July, corporate members were asked to vote on proposals and they unanimously voted to increase corporate membership fees and said lots of supporting things in the process.

The corporate member subscriptions for 2020

were approved as:

<u>Membership level</u>	<u>2020 fee</u>
Small	£2,140
Medium	£5,350
Large	£10,700

The PWI Board approved individual member subscriptions for 2020 as:

<u>Membership grade</u>	<u>2020 fee</u>
Apprentice / Student	Free
Apprentice / Student with Journal	£20
Member	£82
Reduced Rate Member (65 and a half or older at 1.1.20)	£33
EngTech Member	£82
IEng / CEng Member	£131

<u>Fellow grade</u>	<u>2020 fee</u>
Fellow	£110
Reduced rate Fellow (65 and a half or older at 1.1.20)	£43
EngTech Fellow	£110
IEng / CEng Fellow	£175

Board members noted that we are losing members as a result of corporate decisions to only reimburse one PEI fee per employee. We need to target recruitment at those engineers who aren't currently a member of any PEI.

Board members noted that our professional registration application fees are significantly lower than ICE and there is a risk that individuals perceive that they are paying for something inferior. However, our registration fees are competitive with IMechE and this was the measure used when they were set in 2015.

Registrants do have to be members first, so there is that additional cost. The PWI's rates are set with reference to market rate, with a longer-term return through subscription income. Dual membership should be encouraged through lower rates: there is less review work for such applications.

Board members noted that professional registration application fees have been static since 2015 but agreed that fees will be held at the current rates for the next 12 months.

RISKS AND OPPORTUNITIES REGISTER

Board members noted the changes and updates since last presented.

- Risk Area O1 - MM and KH had a positive meeting with Premier IT and confirmed they are fully committed to support us until we are ready to transition over to new suppliers. They have a lot of experience with transitioning and the cost of getting data in one file is part of our contract with them. To get the data formatted could be 1-2 days development, which needs to be built into website project costings
- Opportunity Register should contain top three target areas over the next 12 months. These are currently: corporate member development; marketing and social media strategy; and specialist engineer training. Changes within the rail industry consequent on the Williams review, HS2 construction, and NR reorganisation may provide other opportunities.

2023 STRATEGY UPDATE

SBA introduced his update paper, noting that six months have passed since Board endorsed

eight Strategic Objectives and set out intended outcomes under each to deliver within the five-year window. We have been working to put a plan in place to start to deliver elements, but the last six months have been hectic for a number of reasons, particularly putting the new team in place (itself a Strategic Objective) and trade shows and seminars.

Strategic Priorities 1 and 2 are identified as highest priority - recruitment of new team members, and prioritisation of work and strategy to improve relationships with corporate members and the development of our offering to them. We have advanced the prioritisation of our work on the website and our presence in the virtual world too, due to risks there. SBA has created a Work Breakdown Structure (WBS) to help understand how much of the Institution's resource is used on "business as usual" activity, and to then consider how available resource can be deployed across the Strategic Priorities. Taking each in turn:

- New team - The recent interviews for the Technical Content Manager (TCM) role mean we have completed the new team. Both TCMs will be in place and up and running by September.
- Corporate member strategy – we continue to operate the Technical Board and the last few meetings have been excellent: the corporate members attending are engaged and interested. There has been an excellent series of presentations and information is passed on that would be difficult to obtain from any other forum. It is hard to measure how that information is then disseminated back through industry though. Attendees receive the presentations (sometimes redacted) and they are free to make whatever use of them they wish, but that is a matter we leave to them. MM would like to look at the robustness of our document distribution processes so that members' receipt of information is more clearly assured.
- SBA, KH and JH plan to meet the 42 corporate members face to face and run through a structured agenda at each meeting to understand what corporate members value about the PWI and what more we could do to add to that value. This is targeted for completion in February 2020 and will be followed by a process of review, categorisation, learning, and responding. We hope to get some strong steers on corporate member aspirations by Christmas.

- Website and virtual presence – KH is leading with MM and KI in support. SBA is maintaining a strong interest in this critical workstream. An outline plan is in its early days but is conceptually about right. We are in the process of testing that plan with industry insiders; we met Premier IT this week and are meeting with a freelance website developer in early August. The intention is to keep the website simple, dynamic and flexible (not overly complicated and content heavy). We intend to look closely at functionality, prioritising and selecting only those that are critical in the first instance. GE advocated that the project be taken in stages and that delivery timescale should not be prioritised over ultimate efficiency and effectiveness. He also recommended looking carefully at commercially available software tools and bolt-on sub-systems (eg Eventbrite to manage bookings).

- The intention is to trial the functional specification with members and bring a specification to Board in Nov / Jan. This

will give a year to work on implementation and deliver the new website around the turn of the year 2020/2021. The Board noted that the project must progress despite the seemingly ever-changing technology.

- Sections - MM work on stakeholder engagement will look at structures / communication methods and if they match the shape of the organisation and the shape of our client base. Before we take strategic decisions on the shape of the organisation, we need to understand where the PWI sits within the industry and within its potential membership. That will not stop us doing sensible things – eg a recent request to open a Devon & Cornwall Section (the current closest is Swindon-based “West of England”). There is also a void in East of England and, as part of our strategy, we need to understand if there is a need there. Board noted that North Wales has renamed itself as Cheshire & North Wales and has relocated its primary venue to Crewe – to take core activity to where the bulk of working age engineers are.
- Section Secretaries' discussion topics included their roles and responsibilities and those of Chair and committee members. There were great ideas about engaging younger people, who are our organisations' future. The Section Secretaries noted that the London Section runs a technical paper competition known as “Techs Factor” with awards presented. It was suggested that this competition could be extended onto a national level, holding regional heats, with a final held at a major railway centre. An annual technical seminar delivered by Young Persons was also suggested.

- The Executive team will return to Board in Nov / Feb indicating where Sections have got to with their local plans, but it will be early 2020 before clear strategic options on how to go forward can be presented. There is a lot of work to do through the Autumn to develop the underpinning information for those decisions.
- Competency Management Scheme (CMS) – as the TMCs were recruited later than hoped, BC has had to shoulder the burden of work so the amount of progress on this strategic initiative has been hampered. Work will begin in the Autumn.
- Technical Knowledge Base – this has not moved forward as we needed TCMs on board to do the work. The Hub is currently a collection of technical documents and there is much to do to turn it into a user-friendly resource. Over the last few years our strategy has been to write technical books and we believe that the information is still wanted, but perhaps not in book form. Access to technical information is a USP for our membership. We intend to use the TCMs (who bring different, but complementary strengths) to develop content, but this will need time and investment.

The Board agreed that there should be a short story in the January Journal to communicate what has been agreed and provide an update on the eight strategic priorities so there is a clear audit trail from the development of the strategic threads through previous Board decisions and the work of the Executive.

KH questioned if the appetite for technical seminars is waning and enquired whether Board members are aware of anything on the horizon – eg a danger of industry fatigue with seminar

topics? KH wondered whether we should promote the recording of seminars or attempt to run a webinar? We need intelligence from others on topics and need to talk to corporate members on this. BC noted that a couple of specialist areas seem topical, as there is a shortage of knowledge to maintain and improve.

FELLOWSHIP APPROVALS

The following members' Fellowship applications were ratified:

- Kevin Hope, Network Rail (Sponsoring Fellow – John Edgley)
- Paul Mountford, Arcadis (Sponsoring Fellow, Jason Grocott)
- Dr Mohamed Wehbi, Network Rail (Sponsoring Fellow, Levente Nagy)
- Gareth Evans, Network Rail (Sponsoring Fellow, John Edgley)
- Tara Scott-Turner, Network Rail (Sponsoring Fellow, James Dzimba)

AOB

AT enquired about 2020 meeting dates. These are usually circulated in September – a week will be identified and availability sought.

GE asked if a map of the Sections was in existence, with the perceived boundaries. This is part of MM's mapping exercise. He suggested that more regional information should be available so that members can identify what is going on in their wider area.

NEXT BOARD MEETING

Tuesday 12 November 2019 (11:00 – 15:00), AECOM, Aldgate Tower, Leman Street, London, E1 8FA, followed by the Annual Celebration Event (18:30 – 20:30) at the Institute of Directors, Pall Mall, London.



INNER PANEL **ELIMINATING** THE FLANGE GROOVE

veloSTRAIL – extremely safe crossing for cyclists, wheelchair users, inline-skaters, baby carriages and trolley bags.

- **veloSTRAIL** inner panels are available in 600 mm and 1,200 mm and are designed for train speeds up to a **max. of 70mph for the UK with full Network Rail Product Acceptance.**

- excellent compression of “flange groove”, even at very low temperatures (tested down to – 25 °C) coupled with high load capacity in road direction for safe crossing of individual users.

STRAIL (UK) Ltd. – Richard Whatley

Tannery Lane // Send // Woking // GU23 7EF // Great Britain // Phone +44 (14 83) 22 20 90 // Fax + 44 (14 83) 22 20 95 // richard@srsrailuk.co.uk





Registration with the PWI



Journey with us.

If you would like to become a professionally registered engineer we provide a scheme that has been developed in partnership with the rail industry including Network Rail and Transport for London, tailored to the requirements of a rail engineer.

As the rail industry's dedicated infrastructure engineering technical institution, the PWI is committed to ensuring that its process for professional registration adds value to the applicant, their employer and ultimately the rail industry.

Every applicant is assessed against the UK Standards for Professional Engineering Competence (UK-SPEC) requirements, as set out by the Engineering Council, but as a PWI applicant, in addition to demonstrating your rail engineering competence, you will also need to demonstrate your commitment and contribution to proactively improving safety.

The assessment process, known as a professional review, starts with a written application, which is tailored according to the grade for which you are applying. Once this has been reviewed, IEng and CEng applicants will be invited to attend a professional review interview and providing the registration criteria are deemed to have been met, candidates will be recommended for registration.

Professional registration is open to any competent practising engineer or technician. Different levels and pathways to registration are available, depending on the individual's experience, training and qualifications.

Further information www.thepwi.org
PROFESSIONAL REGISTRATION MANAGER
profeng@thepwi.org
01277 230031 option 2

CHECK YOUR ROUTE TO REGISTRATION

Engineering degree accredited with the Engineering Council?
Apply immediately.

www.thepwi.org/professional_registration_pages/how_apply

Hold qualifications that are not listed with the Engineering Council?
Apply for an assessment through our Academic Panel.

www.thepwi.org/professional_registration_pages/academic_assessment

No formal qualifications, but an abundance of experience?
Apply through Technical Report Option route.

Open to any rail infrastructure engineer seeking to fill their academic gap.

www.thepwi.org/professional_registration_pages/technical_report_option

SUPPORTED BY

NETWORK RAIL &
TRANSPORT FOR LONDON



ENGINEERING TECHNICIAN

(EngTech)

APPLICATION FEE £60

Engineering Technicians have a practical understanding of engineering skills and techniques as well as the ability to solve engineering problems. They are the people who turn engineering ideas into reality, playing a key, hands-on role in all aspects of the industry.

Our EngTech application process is open to anyone who meets the EngTech competence and commitment criteria.

Apply now and join the prestigious group of internationally recognised Engineering Technicians at www.thepwi.org/professional_registration_pages/-_engtech_application

INCORPORATED ENGINEER

(IEng)

APPLICATION FEE £190

Incorporated Engineers maintain and manage applications of current and developing technology, and may undertake engineering design, development, manufacture, construction and operation. Incorporated Engineers are variously engaged in technical and commercial management and possess effective interpersonal skills.

Find your route to registration at www.thepwi.org/professional_registration_pages/which_route

CHARTERED ENGINEER

(CEng)

APPLICATION FEE £190

Chartered Engineers develop solutions to engineering problems, using new or existing technologies, through innovation, creativity and change. They might develop and apply new technologies, promote advanced designs and design methods, introduce new and more efficient production techniques, marketing and construction concepts, or pioneer new engineering services and management methods. Chartered Engineers are variously engaged in technical and commercial leadership and possess effective interpersonal skills.

Find your route to registration at www.thepwi.org/professional_registration_pages/which_route

SECTION CONTACTS

BIRMINGHAM**Chair** David Webb**Deputy Chair** Craig Green**Secretary** Richard Quigley 07715 132267**Secretary** Tim Atkinson

timothy.atkinson@networkrail.co.uk

richard.quigley@networkrail.co.uk

MEETING VENUE

2nd Floor, Network Rail, Baskerville House,
Broad Street, Birmingham, B1 2ND
Lunchtime meetings 12:30 for a prompt
12:45 start - 14:00 finish. Evening meetings
at 17:00

CHESHIRE & NORTH WALES**Chair** Peter Veryard**Secretary** Lynne Garner 07494 753652

lynnegarner79@icloud.com

Secretary Alastair Roberts

07494 75365

a.roberts@aegis-cert.co.uk

MEETING VENUES

The Town Crier Inn, City Road, Chester,
CH1 3AE at 18:30 light refreshments at
18:00 & Crewe Arms Hotel, Nantwich Road,
Crewe, Cheshire, CW2 6DN. Meeting from
16:15 to 17:45 with tea, coffee & biscuits

CROYDON & BRIGHTON**Chair** Tim Kendell**Secretary** Colin White 07845 316042

c.white@chaucerrail.co.uk

MEETING VENUE

Mott MacDonald House, Sydenham Road,
Croydon, CR0 2EE, at 17:30 for 17:45 start.

NORTH EAST**Chair** Sid Lewis**Secretary** Vacant**Acting Secretary** Phil Kirkland

0191 203 3162

phil.kirkland@nexus.org.uk

MEETING VENUE

Newcastle College Rail Academy, William
Street, Felling, Gateshead, NE10 0JP at
16:30 Refreshments from 16:00

EDINBURGH SECTION**Chair** Russell Kimber**Secretary** Bob Gardiner 07771 828811

bobrail65@gmail.com

MEETING VENUE

Upstairs function room of The Scots Guards
Club, 2 Clifton Terrace, opposite Haymarket
Station, Edinburgh, EH12 5DR at 18:00

GLASGOW SECTION**Chair** Tom Wilson**Secretary** Vacant**Acting Secretary** Jim Watson 07590

929107 glasgow@thepwi.org

MEETING VENUE

WSP Offices, 7th Floor, 110 Queen Street,
Glasgow, G1 3BX at 17:30 refreshments
from 17:00

IRISH SECTION**Chair** Cathal Mangan**Secretary** Joe Walsh 00 353 872075688

pwiirishsection@gmail.com

MEETING VENUES

The Ashling Hotel, Parkgate Street, Dublin
8, Ireland; The Prince of Wales Hotel,
Church Street, Athlone, Co. Westmeath -
located in the centre of Athlone Station;
The Brookfield Suite, Hilton Hotel, 4 Lanyon
Place, Belfast - located across the road from
the main entrance to Central Station

LANCASTER, BARROW & CARLISLE**Chair** John Parker**Secretary** Philip Benzie

p.benzie@yahoo.co.uk

MEETING VENUES

Station Hotel, Butler Street, Preston, PR1
8BN (adjacent to Preston station) 17:30 for
18:00; Royal Station Hotel, Market Street,
Carnforth LA5 9BT (adjacent to Carnforth
station) 17:30 for 18:00; Network Rail, North
Shore Road, Whitehaven CA28 6AX at 1600
for 1630; Network Rail, Upperby Yard, Tyne
Street, Carlisle CA1 2NP at 16:00 for 16:30

LONDON**Chair** Sean Tarrant**Secretary** Thomas Utley 07885 732231

thomasutley@tfl.gov.uk

MEETING VENUES

10th Floor, London Underground, 55
Broadway, London, SW1H 0BD, above
St. James Park tube 17:30 for 18:00 &
Transport for London, 5 Endeavour Square,
Stratford, London, E20 1JN 17:30 for 18:00

MANCHESTER & LIVERPOOL**Chair** David Woods**Secretary** Richard Wells 07817 302652

richard.wells@tonygee.com

MEETING VENUE

Manchester Metropolitan University, Room
E0.05, John Dalton Building, Chester Street,
Manchester, M1 5GD at 12:30 for 13:00

MILTON KEYNES**Chair** John Edgley**Secretary** Kevin Thurlow 07802 890299

kevin.thurlow@networkrail.co.uk

MEETING VENUE

Auditorium, The Quadrant, Network Rail,
Elder Gate, Milton Keynes, MK9 1EN at
17:00

NOTTINGHAM & DERBY**Chair** Paul Richards**Secretary** John Garlick 07532071727

jgees01@btinternet.com

MEETING VENUES

Aston Court Hotel, Midland Road, Derby
DE1 2SL at 17:30 & Jury's Inn Hotel, Station
Street, Nottingham NG2 3BJ at 18:30

SOUTH & WEST WALES**Chair** Andy Franklin**Secretary** Andrew Wilson 07974 809639

southandwestwales@thepwi.org

MEETING VENUE

Network Rail's Offices, St. Patrick's House,
Curran Road, off Penarth Road, Cardiff,
CF10 5ZA at 17:15

THAMES VALLEY**Chair** Jeremy Smith**Secretary** Richard Antliff 07804 329497

richard.antliff@gmail.com

MEETING VENUE

Network Rail's Davidson House Offices,
Forbury Square, The Forbury, Reading,
RG1 3EU at 17:45. Refreshments available
from 17:00

WESSEX**Chair** Andy Jones**Secretary** Kenneth Newell 07771 668044

kenneth.newell@btinternet.com

MEETING VENUES

The Rose and Crown, Columbo Street,
Waterloo, London, SE1 8DP from 17:15 for
18:00 & The Eastleigh Railway Institute, 2
Romsey Road, Eastleigh, Southampton,
SO50 9FE, from 17:15 for 18:00 & Network
Rail Offices, Waterloo Station, London, SE1
8SW from 17:00 for a prompt 17:15 start

WEST OF ENGLAND**Chair:** Nick Millington**Secretary:** Vacant**Acting Secretary** Steve Pearson

steve.pearson@networkrail.co.uk

MEETING VENUE

Engine Room, Atkins, 5th Floor Milford
House, 1 Milford Street, Swindon, SN1 1DW

WEST YORKSHIRE**Chair** Morris Smith**Secretary:** Martin Wooff 07487 652622

pwi@tail-lamp.net

MEETING VENUE

The Pullman Room, The Cosmopolitan
Hotel, 2 Lower Briggate, Leeds, LS1 4AE
from 18:00

YORK**Chair** Ian Kitching**Secretary** Gareth Dennis 07951 918236

york@thepwi.org

MEETING VENUE

Network Rail Meeting Rooms 0.1 George
Stephenson House, 1 Toft Green, York, YO1
6JT at 17:00 for 17:30 start.
Access the office from the Railway Memorial
entrance side of York Council West Offices,
or through the white gate opposite the York
Railway Station main entrance.

SECTION MEETINGS NOVEMBER - JANUARY 2019

Always refer to the website for the latest meeting information



**Mon 4 November
LONDON**

CIRAS (Kerry Dolan, CIRAS)
TFL, 5 Endeavour Square,
Stratford, London, E20 1JN

**Wed 6 November
THAMES VALLEY
Filton Bank Capacity**

Enhancement (FB4T) (John Hilliard, Associate Director, Engineering Integration Ltd)
Network Rail's Davidson House Offices, Forbury Square, The Forbury, Reading, RG1 3EU

**Thu 7 November
CHESHIRE & NORTH WALES
Level Crossings - Suitable and Sufficient Risk**

Assessments (Andrew Allen, Senior Engineer, Aegis)
Crewe Arms Hotel, Nantwich Road, Crewe, Cheshire, CW2 6DN

**Thu 7 November
EDINBURGH
Blackford (Highland Spring) Rail Facility** (Andrew Blakeley, Senior Project Engineer, Network Rail)
Upstairs Function Room, The Scots Guards Club, 2 Clifton Terrace, Opposite Haymarket Station, Edinburgh, EH12 5DR

**Mon 11 November
SOUTH WALES
Wheel Rail Interface** (Andy Vickerstaff, Senior Wheel Rail Interface Engineer, TFL)
Network Rail's Offices, St. Patrick's House, Curran Road, off Penarth Road, Cardiff, CF10 5ZA

**Tue 12 November
CROYDON & BRIGHTON AND WESSEX JOINT SECTION MEETING
Tramlink Infrastructure Maintenance** (Ian Hale, Infrastructure Manager, Tramlink) Mott MacDonald House, Sydenham Road, Croydon, CR0 2EE

**Tue 12 November
NORTH EAST
Edinburgh to Glasgow Improvement Programme - Overhead Line Electrification (Mark Churchill, Principle OLE, Amey Consulting)**

Newcastle College Rail Academy, William Street, Felling, Gateshead, NE10 0JP

**Thu 14 November
BIRMINGHAM
The Journey from Asset Management to Maintenance** (Rebecca Fasham, Assistant Track Maintenance Engineer, Network Rail)
2nd Floor, Network Rail, Baskerville House, Broad Street, Birmingham, B1 2ND

**Tue 19 November
NOTTINGHAM & DERBY
Track / Bridge Interaction** (Dr David Rhodes)
Jurys Inn Hotel, Station Street, Nottingham NG2 3BJ

**Wed 20 November
GLASGOW
Gauging and Recent Developments** (Speaker TBC, Network Rail, Scotland Route)
WSP Offices, 7th Floor, 110 Queen Street, Glasgow, G1 3BX

**Tue 3 December
WESSEX
High Output: Developments for CP6** (Ben Brooks, High Output Alliance Director, Network Rail)
Network Rail Ltd, Basingstoke Campus, Gresley Road Basingstoke, RG21 4FS

**Wed 4 December
LONDON
Gauging Historic Infrastructure for the 21st century** (Bridgett Eickhoff, RSSB)
10th Floor, London Underground, 55 Broadway, London, SW1H 0BD

**Wed 4 December
THAMES VALLEY
Annual Social Event & Christmas Railway Quiz** (Hosted by Colin Brading & David Brace)
Reading Railway Club, 6a Station Hill, Reading RG1 1NB

**Thu 5 December
CHESHIRE & NORTH WALES
Infrastructure: A System of Parts** (Roy Hickman, Senior Consultant, Fugro & PWI)
Vice President, North West England)
Crewe Arms Hotel, Nantwich Road, Crewe, Cheshire, CW2 6DN

**Fri 6 December
EDINBURGH
Technical Visit to Pilot Brewery, Leith** This is a ticketed event - please contact Bob Gardiner bobrail65@gmail.com or Russell Kimber Russell.KIMBER@networkrail.co.uk to register your interest.
Pilot Brewery, 22 Jane Street, Edinburgh EH6 5HD

**Mon 9 December
SOUTH WALES
Filton Bank 4 Tracking Project** (John Hilliard, Associate Director, Engineering Integration Ltd)
Network Rail's Offices, St. Patrick's House, Curran Road, off Penarth Road, Cardiff, CF10 5ZA

**Wed 18 December
GLASGOW
Glasgow Queen Street Renovation** (Neil Hamilton & Steve Bruce, Network Rail)
WSP Offices, 7th Floor, 110 Queen Street, Glasgow, G1 3BX

**Wed 8 January
THAMES VALLEY
Annual Joint Meeting with IMechE**
Network Rail's Davidson House Offices, Forbury Square, The Forbury, Reading, RG1 3EU

**Mon 13 January
LONDON
Tram Train Initiative (Tim Kendell)**
TFL, 5 Endeavour Square, Stratford, London, E20 1JN

**Mon 13 January
SOUTH WALES
High Output Track Renewals: Ready for CP6** (Ben Brooks, Doug Swinney & Dave Deeley, Network Rail)
Network Rail's Offices, St. Patrick's House, Curran Road, off Penarth Road, Cardiff, CF10 5ZA

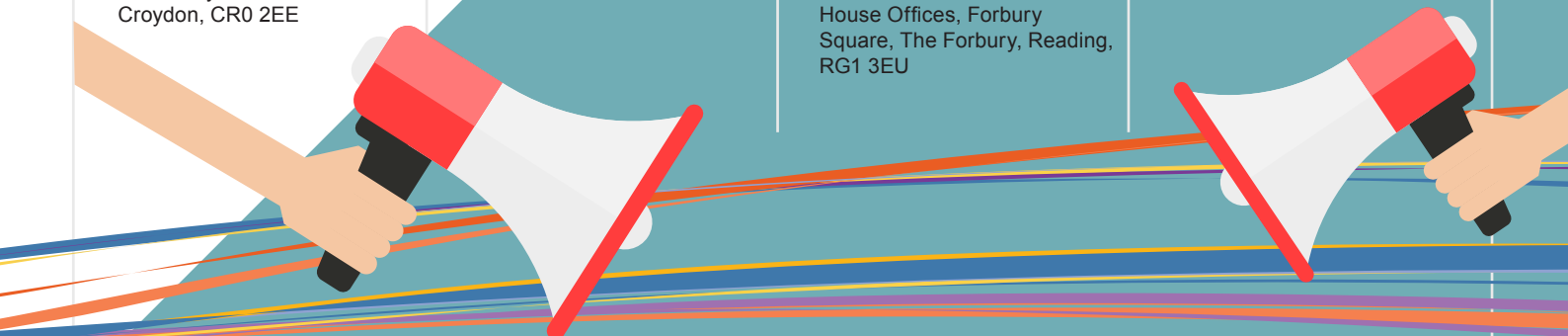
**Tue 14 January
NOTTINGHAM & DERBY
Omnisurveyor / Plain Line Pattern Recognition** (Steve Tait & Andy Willetts, Omnicom Balfour Beatty)
Aston Court Hotel, Midland Road, Derby DE1 2SL

**Tue 21 January
WEST YORKSHIRE
High Output Track Renewals - Ready for CP6** (Ben Brooks, Network Rail)
The Pullman Room, The Cosmopolitan Hotel, 2 Lower Briggate, Leeds LS1 4AE

**PWI YORK
SECTION NEEDS
YOU!!**

**WE ARE LOOKING FOR
VOLUNTEERS TO JOIN THE
PWI YORK COMMITTEE.**

Please contact Gareth Dennis, York Section Secretary, to express your interest on +44 (0)7951 918236 or york@thepwi.org



A round up of recent activities in our Sections.

Reports may be abbreviated for publication in the Journal. Full versions can be downloaded from our website:

www.thepwi.org/technical_hub/section_activities

EDINBURGH SECTION

7 March 2019

Penmanshiel tunnel collapse recovery, 40 years on

Jim Summers and Keith Brown

Jim commenced the evening by informing the audience that one of the key drivers for the track lowering and slab tracking of Penmanshiel tunnel was to enable 8'6" container traffic. Following the 17 March 1979 collapse, one of the first operational priorities was to halt the imminent scrapping of eight electric locos and to start writing an emergency timetable (by hand) to try to provide some form of alternative service, due to the ECML being closed. Prior to fax machines, many of these emergency train timings were delivered by hand to signal boxes etc. Even Waverley station's Solari flipping destination boards had Euston temporarily stuck onto them. At the time, there were a number of reasons that the ECML could remain permanently closed but for the importance of Edinburgh's Craigentinny depot facility. Even in 1979, drivers' route knowledge and driver training of different train classes was a challenge in itself. With the timetable along the Edinburgh to Carstairs diversionary route proving very challenging, the 16-mile block section at Cobbinshaw was improved by the installation of a temporary intermediate signal box.

Keith was brought into the team due to his tunnel lowering and surveying experience. The remit was to develop and deliver a scheme to enable the ECML to re-open, as briefed by senior engineer George Craig. Of the four potential options, failure was not one of them. Armed with traditional surveying equipment and a hallade gang, the team were able to establish the start of a baseline design. It was not until later that the game-changing idea of a track lift in the region of three metres was proposed. This lift enabled the new track alignment to sit much closer to the tunnel, so whilst still requiring the re-alignment of the A1 road, including a new A1 bridge, the scale of the extent was much reduced.

Keith completed the final design on the overnight train down to BR HQ at Marleybone and was given the green light to proceed. By 7 May 1979, construction had commenced and formal financial authority eventually followed.



ANNUAL INTER SECTION QUIZ

Russell Kimber presents the Hadrian's Shield to the Glasgow Section team (Jim Watson, John Oates and Tom Wilson). Photo by Jim Watson

This officially allowed 200,000 tonne of rock and 100,000 tonne of soft material to be excavated, and a syphon was created to host the Pease burn. With the track in place, the hallade scheme proved the track was found to be within 100mm tolerance of the baseline scheme. Incidentally Edinburgh Section Secretary Bob Gardiner located one of the 40-year-old wooden pegs whilst on a recent site visit. The line was re-opened via the new diversion ahead of plan on 20 August, only five months after the collapse.

Retired guest Ian Hetherwick (who has recently celebrated his 90th birthday) closed the evening by sharing his own recollections of the event which he was also heavily involved in, and influenced how tunnel inspections and works were to be carried out in the future. Keith raised a toast to Gordon Turnbull and Peter Fowler, the two workers who were lost in the tunnel along with the gentleman who lost his life working on the new A1 bridge. A vote of thanks and congratulations was given to Jim, Keith and Ian by Section Chair Russell Kimber for an outstanding presentation, which was kindly seconded by all present.

4 April 2019

Transport for London (TfL) track – developments since 2010 & President's address - building on our strengths
Stephen Barber, CEO PWI

With over 1000km of track and nearly 1000 primary S&C units (not counting the depots), the networks infrastructure is substantial. General passenger numbers continue to increase, and it is predicted that this trend is set to continue, with routes such as the Northern line significantly increasing above the others.

There are unique challenges faced by Transport for London (TfL) in comparison with the main line network, such as its routes having 20 to 50% bullhead rail and curves down to 60m radius. To add to what was already challenging to maintain, the introduction of "night tube" services on five lines affected Saturday night track access, with more lines to follow.



ANNUAL INTER SECTION QUIZ

Russell Kimber makes a presentation to Jack Scott on his retirement as Glasgow Section Secretary after 39 years in the post. Photo by Jim Watson



ANNUAL INTER SECTION QUIZ

Jack Scott and Joan Heery

The methodology used in TfL was traditional and had not changed for many years. This provided the opportunity to move to risk and analysis-based philosophy. Moving forward, the vision and strategy became: reliability, capability and availability. A common misconception on the underground system is tonnage. Although axle loads are lower, cumulative tonnage is high due to frequency,

such as 42 MGTPA on the Victoria line. As rail defect detection and management had some reliability issues, the move to "B" scan data recording was taken along with magnetic flux interference methodology. With rail sleepers' centres commonly being 1050mm spacing and a high population of bullhead rail, rail break numbers were six times higher than of flat bottom. Even a 10mph ESR would commonly close down the operational service. Due to an unacceptable number of broken junction fishplates, the move was made to use forged transition rails as standard. Other infrastructure also has its own peculiarities, with six different types of signalling and even unique trains for every line makes compatibility an interesting exercise.

As the years have progressed new methodology, such as using a permanent gantry crane to relay Walthamstow crossovers, is now being utilised. Other developments include retrofit intermediate elastomeric check baseplates and a reduction in maximum cant. Similar to the issue with early mortality in fabricated crossings due to weld repairs, the following basic principle applies: to create the correct solution, it's all about understanding the risk, in detail.

Stephen delivered his President's address by informing the audience that the PWI now has achieved its own independent Engineering Council registration. The Institution is keen to represent the broad range of parties involved in the rail infrastructure, at all scales. The evening was closed by Stephen promoting

the development of new and younger members to gain from those with longer-term experience. A vote of thanks was given to Stephen by Section Chair Russell Kimber for an excellent presentation and his address, which was kindly seconded by all present.

2 May 2019 Edinburgh Waverley Capacity Enhancements William Storey, Story Rail

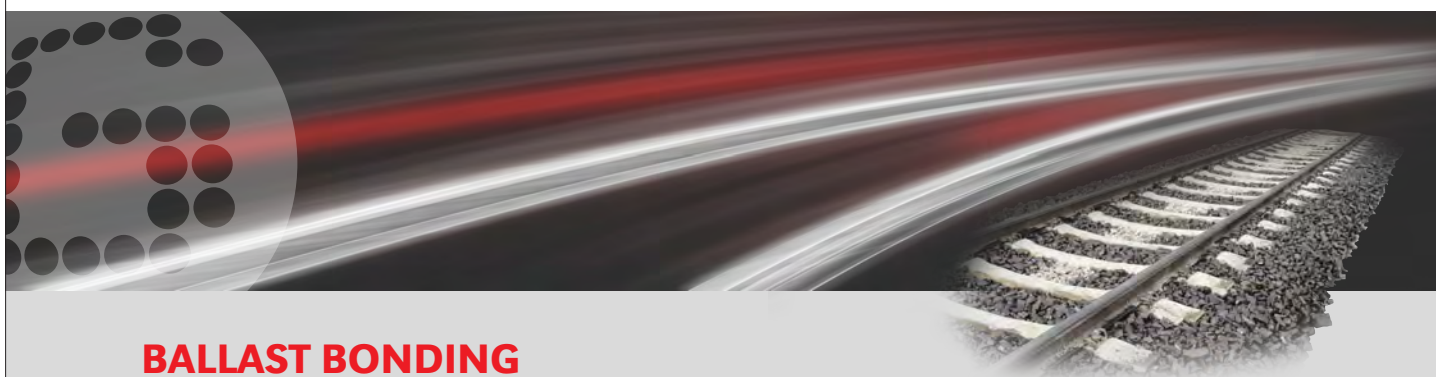
William started by providing a background to the drivers for the project, including the predicted annual passenger growth over the next five years to 40 million, based on what has already been a steep increase in the last five years from 20 million to the present day 30 million. Another key driver was the introduction of new train fleets such as the IEP Azuma and the ScotRail 385 electric services.

The works originally commenced with the platform 12 extension and the commencement of the platform 11 escalator relocation. This was initially started by Carilion Rail until the company unexpectedly closed for business overnight.

Story Rail were brought in to continue the multidisciplinary work, whilst starting the extension of electrified platforms 5 and 6 and the associated S&C. The works also included provision of a new electrified crossover and signalling at the west end of platforms 10 and 11 to provide increased operational flexibility. The provision of the new parallel link bridge

and relocating the escalators to their more central position was captured on time lapse video, providing a feel for the constraints of the site within the safety hoarding whilst the station operated as normal. The start of August 2018 deadline was successfully met, just in time for the start of the Edinburgh festival, where passenger numbers can reach over six million in that month alone. The platform 5 and 6 works had their own challenges including locating a 50m³ void which had to be filled, removing 16,000t of spoil and placing 7,000t of new stone. With timescales pressing, the early sections of the platform were constructed using traditional block and brick until pre-cast units were available. 70 engineering trains from the Leith loading facility were utilised to convey these materials due to road access restrictions in a very congested city centre site. To provide additional platform capacity, the provision of short sections of frangible platform to the rear of the two new buffers was provided.

William finished by saying the project had always been aware of the infrastructure and operational challenges regarding access constraints, but during the new year extended possession, when this was thought to be the least challenging, the logistics of accessing the station site through the crowds of thousands partying on the Waverley bridge proved to be quite a feat in itself. Edinburgh Section Chair Russell Kimber gave William a vote of thanks for a very interesting "on the doorstep" presentation which was warmly seconded by the members.



BALLAST BONDING

Enhanced track stabilisation via a structurally engineered adhesive

- » Ballast bonding is a method of track stabilization provided by applying a sprayed adhesive to a ballasted area, maintaining an open matrix while also heightening lateral stability and increasing contact forces between the ballast.
- » From creating beams of bonded ballast on tight radius curves, providing ballast retention, and creating transitional areas, ballast bonding is the key solution to a variety of common rail issues.
- » Ballast bonding has been proven through various rounds of testing to provide higher lateral resistance than both unbonded ballast and Lateral Resistance Plates.
- » The solution additionally maintains the efficient drainage capabilities by creating a cohesive matrix through which liquids can easily flow.

RAIL JOINING

RAIL SERVICES

MEASUREMENT

TOOLS & MACHINES

EQUIPMENT

MEMBER OF  **GOLDSCHMIDT**
THERMIT GROUP

www.thermit-welding.com

PERMANENT WAY INSTITUTION MEMBERS SAVE £5

ON A SUBSCRIPTION TO **MODERN** railways



Established for 50 years, **Modern Railways** has earned its reputation in the industry as a highly respected monthly railway journal. Providing in-depth coverage of all aspects of the industry, from traction and rolling stock to signalling and infrastructure management, **Modern Railways** carries the latest news alongside detailed analysis, making it essential reading for industry professionals and railway enthusiasts alike.

TO CLAIM YOUR

DISCOUNTED SUBSCRIPTION

Simply enter code **PWIMR** in the coupon code box at the checkout page when ordering online at:

www.keypublishing.com/shop



Alternatively, call: 01780 480404 quoting code **PWIMR** to the operator

Lines open 9.00-5.30pm Monday-Friday. All details correct at time of going to press. Offer ends 31st December 2019. *Offer not valid on Direct Debit subscriptions.

GLASGOW SECTION

29 May 2019

Highland Mainline Enhancements

Robert McCafferty (BAM Nuttall) and Chris Doig (Network Rail)

Chris described the background to the project development and the stakeholders' aspirations (hourly service in each direction between Perth and Inverness, with a reduction in journey time). He highlighted the history of the predominantly single line route from Perth to Inverness including closures and singling in the 1960s, the partial redoubling in the 1970s as part of the oil "boom", followed by the rationalisation of crossing loops in the 1980s. While initial development was undertaken around class 170 DMUs with differential speeds and "distant signals at green" scheme, development became more challenging when the new franchise operator chose to utilise short HST sets for their services from Glasgow and Edinburgh to Inverness. This resulted in a rethink of the plan.

Through timetable modelling, all scheduled crossings could take place at Pitlochry and Aviemore leading to the enhancements at these locations. Key was the simultaneous arrival of trains in the crossing loops partly enabled by the introduction of double yellow distant signals and by the reconfiguration of platforms at Pitlochry. At Aviemore a key element was the introduction of an improved NR56v Hy-drive operated switch. Reliability of the loop entry point was deemed critical.

Significant development work took place on the switch configuration and operating system to overcome previous issues.

Chris mentioned future aspirations for further enhancements including the potential to reinstate previously recovered loops, a dynamic loop at Ballinluig, line speed improvements and route re-signalling. Robert described several of the construction issues at Pitlochry and Aviemore. At Pitlochry both platforms were extended northwards and shortened at the south, to negate the need for track monitoring and CRT management, a cross wall design was prepared with foundations well outwith the track support zone; and having worked well it is being utilised elsewhere. Sections of the legacy platforms remained at Pitlochry and were subject to gauging work; not straightforward due to the station having "listed" status and sections of cope with little to no overhang with several stages as a result of track renewals and rerailing of existing 98lb with 56kg rail.

At Aviemore, staging of the works was challenging as disruptive track access had been agreed prior to a design being finalised, and the need to work around "fragile" legacy signalling equipment that was required to remain operational but could not be "lifted and shifted".

Throughout the staged works at Aviemore the existing loops were required to be kept fully operational, resulting in both S&C being installed in advance and secured out of use.

Haulage for ballast and spoil became an issue resulting in the need to import ballast by road and stockpile on site. A comprehensive Q&A session and discussion followed with a vote of thanks by John Oates.

15 June 2019

County Hotel, Carlisle

Annual Inter Section Quiz

By Grieg McMillan, Contractors Engineering Manager (Design), Rail Systems Alliance Scotland.

The PWI annual Inter Section Quiz took place on Saturday 15 June in Carlisle with teams representing Lancaster, Barrow & Carlisle, Darlington, North East, Edinburgh and Glasgow Sections taking part. For the fifth consecutive year the Glasgow Section team won the "Hadrian's Shield". The Institution President, Joan Heery, acted as scorekeeper while Jack Scott was the Question Master.

A formal presentation was made to Jack Scott by Russell Kimber on behalf of the PWI to mark his retirement as Glasgow Section Secretary after 39 years in the post (see photos).

It is with great pride and a tinge of sadness that the Glasgow Section announce the retirement of the Section Secretary and honorary life member, Jack Scott. Jack has been an active officer of the PWI for 39 years. Having joined the PWI in 1977, Jack has taken on several key official roles within the PWI including Secretary and Journal editor amongst others.



railcare

The Railvac and Ballast Feeder System industry concept delivers increased re-ballasting capacity. Always non-intrusive, with the track in situ and without disconnections!


www.railcare.co.uk

For some Section members he has been the Section Secretary for the duration of their lives so far!

In recent years Jack also took on the organisation of very successful international visits on behalf of the PWI. These included trips as far as South Africa and Australia.

For most, it's hard to think of the Glasgow PWI Section and not immediately think of Jack. Not only renowned at the Glasgow Section, Jack is well known throughout Scotland and indeed much of the UK from his attendance at PWI AGMs and conferences.

Although stepping down from official duties, Jack will remain an active member of the Glasgow Section and will not be a stranger to our meetings. On behalf of the PWI and particularly the Glasgow Section, we thank Jack for his service and commitment to the PWI for the past 39 years. We wish him all the best for the future and look forward to welcoming him to forthcoming Section meetings.

LANCASTER, BARROW & CARLISLE

12 February 2019

**Blackburn New Diesel Maintenance Depot
Greig McMillan, Arcadis**

The Chair introduced Greig McMillan, who began by explaining the involvement of Arcadis in the project. This began at GRIP 3 stage in 2015 and continued through to GRIP 8 stage in 2018. Greig explained further that the need for

a new depot in Blackburn arose from the wish to concentrate diesel multiple unit maintenance facilities in the light of the completion of several electrification schemes in the North West. The client for the project was Northern and the site available was the former King Street coal depot, which was constrained and accessed by a sharp curve from its junction with the main line. The design of the facility was to include six sidings, each capable of accommodating five coach multiple units, and also a carriage washing plant located between the main line connection and the sidings.

Sidings 1 and 2 formed the refueling point and were constructed using slab track, and Sonnevile LVT was chosen for the purpose; the track through the carriage washing plant was constructed similarly. As in main line applications, a transition length from slab to standard track was necessary within the depot. It was also necessary to reconstruct a life-expired bridge over a local road, which was located between the sidings and washing plant, using pre-cast concrete. However, the scope of works was changed during the project by the need to lengthen all sidings to accommodate Class 195 units (carriage length 24.0m), which were longer than the Class 158 units (carriage length 23.2m) for which the facilities were originally intended. This resulted in revised elements of the design, the most significant of which was the adoption of a half scissors crossover between the throat of the sidings and the carriage washing plant, due to the reduced length now available; other elements included the relocation of buffer stops on sidings 1 to 4 and the re-assessment of structure clearances.

After the conclusion of the presentation there was a period of questions and discussion about the project, and finally John Parker gave the vote of thanks to Greig for his efforts in giving the presentation.

12 March 2019

**Edinburgh to Glasgow Electrification
Mark Churchill, Amey**

The Chair introduced Mark Churchill, whose involvement in the scheme occurred during service as an overhead line engineer with Alstom, spending periods on site during 2017 and providing field support in 2018. The electrification project was carried out by ABC Electrification consortium, in which Alstom provided expertise in power distribution, wiring train operations and overhead line (OLE) field engineering, Babcock was responsible for piling operations and OLE structures, and Costain for OLE civils works and overall programme management.

This electrification scheme comprised a key sub-project of the overall EGIP programme, covering over 93 route miles between Newbridge Junction (connection with the completed Bathgate electrification) and Glasgow Queen Street via Falkirk High. The OLE construction depot was located at Cadder Yard (east of Bishopbriggs station), which was rail connected with good road access. The scope of electrification works included the provision of a new feeder station from the national grid at Greenhill, new track sectioning cabins (and alterations to others) and new OLE works throughout.



BATTERY RAIL DRILL LD-16B-RPE RAIN PROOF

*Combination of a Powerful Battery
& Visual Effort Optimiser give very
high no. of cuts per charge*

*Use with Cembre CY Quick push/
turn Broach Cutters minimises
cutter consumption and effort*

*Very low acoustic & HAV impact
benefits both environment and
operator*

*Rainproof cowl & bright work area
lighting help avoid operational
interruptions*



Battery Drill Video



CEMBRE MACHINE PCMD-FC FOR PANDROL FC, FE, FCX

*Easily lifts sleepers to assist
FC, FE & FCX clip insertion*

*Power Optimisation Control
reduces noise, HAV and fuel
consumption*

*Designed for use on
3rd and 4th Rail systems*

*Setting without tools,
bright work area lighting &
improved ergonomics assist
operator convenience*



Cembre Machine
for Pandrol Fastclip
Video



t: +44 (0) 1675 470 440
e. sales@cembre.co.uk
w. www.cembre.co.uk

You Tube This is Cembre



Mark went on to give a detailed account of the OLE wiring process. A basic structure is the tension length, over which the contact and catenary wires (the latter supporting the weight of the contact wire) are held in tension by a Tensorex auto-tensioning device. These tension lengths are anchored at their mid points and overlap successively to form a continuous contact wire along the route. The contact wire alignment is staggered between successive masts to minimise pantograph wear, and pantograph clearance gauge comprises three profiles (static pantograph, swayed uplift pantograph and electrical), of which the last-named is used for safety clearance gauging of overline structures.

The electrification structures were installed by the Kirow piling train operated by Babcock, which could install 610mm diameter piles (length 8m, outreach 10m) at a rate of 20 minutes per pile and portals at a rate of 90 minutes per structure. The overhead wires were installed by the Alstom wiring train, which was capable of running the contact and catenary wires out together at a rate of 1,600m per shift. In addition, a rigid bar contact system replaced the contact wire in Winchburgh, Falkirk and Queen Street tunnels in association with track lowering. The post-installation process of snagging was achieved by the use of cab videos in association with verification measurements of wire heights and staggers on site. Pantograph checks were carried out with an instrumented pantograph mounted on test coach MENTOR with the OLE earthed and isolated. After short circuit testing and section proving the OLE was live at all times.

John Parker gave the vote of thanks to Mark for the opportunity to hear an account of OLE engineering at a Section meeting, which was much appreciated.

9 April 2019
21st Century Track Engineering: Facing The Challenges
Stephen Barber, CEO, PWI

The Chair welcomed Stephen Barber to the meeting both as speaker and newly appointed PWI Chief Executive. Before the start of Stephen's presentation, the Section held its annual general meeting.

Stephen began by giving an overview of the underground component of the railway network managed by Transport for London (TfL), which consists of 250 route miles (six deep and four sub-surface tube lines) for passenger use and 650 track miles with 985 points and crossings. One particular feature of the network is the proportion of bullhead rail which is employed, which is as high as 60% and 50% on the Northern and Bakerloo lines respectively; another is the severe curvature of certain lines such as the Bakerloo, which possesses no fewer than 28 checked curves of less than 200m radius. Indeed 15% of the total network exhibits curves of radius less than 400m. A feature of the network today is the reduced opportunity overall to carry out maintenance due to the recent introduction of night services, as possessions of four hours only in length (or less) are now possible.

Stephen continued by detailing the vision for the future of track engineering developed by TfL, which addresses three key technical

and logistical challenges to the operation of services on the underground network. The first challenge is to increase the reliability of maintenance procedures: improvements such as the introduction of 'B-scan' data recording to the management of rail defect detection mean that surface cracking as far as 7mm down into the rail head can be monitored and measured, replacing the traditional 'find and fix' ultrasound detection method which was carried out through track patrols. Broken rails are changed at the rate of one per night. Another policy is the re-engineering of components on renewal, demonstrated by the supply chain research which is currently underway in order to develop a new fastening system to replace the 'mills' keys which currently fasten bullhead rail to sleepers (breakage rate 200,000 annually), particularly since bullhead rail is to remain in front line service for a further five to ten years.

The second challenge consists of developing both strengthened and quieter forms of track. The track on the Victoria line, for example, can now support 42 million passenger tons per annum. The need for quieter track has also increased since the advent of overnight services. The third challenge involves the need to develop new processes and techniques to accommodate the reduced availability of the network for maintenance operations in the light of overnight services.

Stephen concluded the presentation by outlining the organisational and business challenges now facing the PWI. Following a stimulating period of questions and discussion the vote of thanks was given by John Parker.

18 May 2019
Section Visit to Ravenglass & Eskdale Railway
Philip Benzie, PWI Lancaster Barrow & Carlisle Section Secretary

On Saturday 18 May a party of Section members visited the Ravenglass & Eskdale Railway in order to travel on the line and also to visit two sites of track relaying which had taken place during the Winter. On arrival at Ravenglass station the permanent way foreman, David Moseley, gave an interesting introductory talk which detailed the history of the line and its current operating and track maintenance regimes. The route between Ravenglass and Dalegarth is almost seven miles in length and has operated using three gauges over part or all of its length at various times since originally opening in 1875; these are three feet, standard gauge and fifteen inches, the last-named forming the gauge today throughout. The party travelled to Miteside Halt on the 12:10 service in order to inspect Miteside up and down loops, where relaying had taken place over a one-week period in November 2018 by means of a combination of permanent staff and volunteers. Here new ballast was used to replace 'Murthwaite dust', which comprises very fine ballast from the former Murthwaite stone crushing plant on the line; hardwood sleepers with Pandrol clips were installed in combination with rails acquired from the former Ministry of Defence railway at Eastriggs depot. See photo 1.

On travelling onwards to Dalegarth the party was able to visit the second relaying site, where a curved alignment located between

stone walls from the station platform end as far as Dalegarth cottages had been relayed over a one-week period in January 2019. An additional feature at this site was the construction of a retaining wall, using 14 feet long former main line crossing timbers kept in place by welded rails, in order to reduce the proximity of adjacent road vehicles to the railway alignment. Here new ballast was again used to replace Murthwaite dust, together with heavier hardwood sleepers and rails from Eastriggs; it was hoped that these measures would remove the tendency of the track to wander out of alignment in hot weather. The completion of these two sites leaves only one site on the line, at Walk Mill, where Murthwaite dust is still in place.

There was also an opportunity to walk from Dalegarth cottages to the original terminus of the line at Boot on the original three feet gauge alignment. After returning on the 14:50 service from Dalegarth, members of the party were able to look round the well-presented museum adjacent to Ravenglass station, which has recently benefitted from modernisation. They also expressed their thanks to the Ravenglass & Eskdale Railway, and David in particular, for the warm welcome which they had received and his accompaniment as guide throughout, which had provided a most enjoyable and interesting day. See photo 2.

SOUTH & WEST WALES SECTION

13 May 2019
St John Ambulance First Aid
David Ball, St John Ambulance in Wales

Acting Chair Emma Holst welcomed David Ball, Training Officer for St John Ambulance in Wales who gave a presentation, demonstration and personal reminiscences on First Aid at Work, Rest and Play. The speaker and topic were arranged at short notice due to the non-availability of the original speaker.

David explained that the need for first aid was recognised as an afterthought of the industrial revolution and the dangerous situations that workers and the public found themselves in. Railways were no exception and hand injuries were especially common, so competitions for the best first aid response was supported by the railway companies. The St John Ambulance Association was formed in July 1877 to teach first aid in large railway centres and mining districts. St John Ambulance in Wales was formed in 1918.

A presentation and demonstration then followed on the responses that first aiders can offer in day to day situations. Our speaker reminded his audience that the first aider's safety was paramount since nobody wanted to have to deal with two casualties! Stop, Look and Listen was the first drill and then talking and possibly shouting at the casualty was the next action if all was safe, to discover the symptoms.

Whether your Secretary could remember the actions and in the correct order is debateable but maintaining the airway by tilting the head back, determining and maintaining the patient's breathing, checking for circulation, and looking for signs of severe bleeding were all covered by David with lovely tales from his own experiences.



Lancaster Barrow and Carlisle Section
Photograph 1: Miteside loop looking east following relaying



Lancaster Barrow and Carlisle Section
Photograph 2: Dalegarth relaying site and sleeper retaining wall

Using his audience and models to demonstrate responses, David used Bill Langsford to show how to move someone to the recovery position and then using models to demonstrate CPR (Cardiopulmonary Resuscitation) his audience could practice the resuscitation procedure using the models. Present teaching is for 30 heart compressions followed by 2 mouth to mouth if possible. Also discussed was choking, but the finale of the presentation was the AED (Automatic External Defibrillator) discussion as a way of re-establishing the heart rhythm. Having seen these 'boxes' on the wall the Secretary and the group now know what they do, how to get at them and use them, and that they are not as scary as they might seem.

As with so many aspects of First Aid, being able to assist is to possibly save life. The consequence of too harsh resuscitation leading to a damaged rib is better than the casualty not living to tell the tale.

A sincere vote of thanks was given to David by all present for a very enlightening evening to learn new talents that all hoped they would never have to use.

THAMES VALLEY

Thames Valley Section Secretary retires

Malcolm Pearce retired from the post of Thames Valley Section Secretary at the end of June. At the Section meeting on 5 June, Chair Jeremy Smith pointed out that Malcolm had supported the Section for nine years in this role, thoroughly pursuing the Section's business of meeting and visit arrangements, general administrative duties and in other ways, contributing greatly to its friendliness and cohesion. He presented Malcolm with a beautifully framed photographic collage of Section activities that Malcolm had been engaged in during his period of office; Malcolm appearing of course in every image. In accepting this token of appreciation, Malcolm assured the meeting that it would have a place of honour in his home, that he relinquished his role with some feeling and would continue to support the Section and the PWI in any way that he could, including remaining as an active committee member.

1 May 2019

Buffer Stop Design - Hints and Tips

Jeremy Smith, Managing Director, H J Skelton & Co Ltd

The PWI Practical Trackwork Challenge 2018 - Rothley, Great Central Railway
Malcolm Pearce, Balfour Beatty

Our Chair Jeremy Smith, introduced "Buffer Stop Design - Hints and Tips" with a brief description of H J Skelton & Co Ltd which supplies various components and materials to the rail industry, and is the UK and Eire supplier for the range of buffer stops designed and manufactured by A Rawie GmbH & Co KG based in Osnabrück, Germany. These he would describe.

Jeremy explained the technical aspects of design, based on the guidance in Railway Industry Standards, and their equivalent in Eire, including stated ranges for speed, deceleration, maximum longitudinal movement and train weight, the latter for example:

Network Rail:	Lightest train 46 tonnes Heaviest train 3460 tonnes
LUL:	218 tonnes to maximum 300 tonnes
IÉ:	Lightest train 67 tonnes Heaviest train: 900 tonnes.

Criteria for an application at a particular location is provided by the client via a standard questionnaire, including specifications of train weight, approach speed and contact area so as to calculate the stopping process and to choose the most appropriate buffer stop type.

Dissipation of the kinetic energy in the train on striking the buffer stop, and the resistance of the latter to rotation and disintegration, are essential elements to consider. Design and (following acceptance of the offer of supply by the client) manufacturing is carried out by Rawie. Arrangements for delivery and installation guidance are made by H J Skelton, including the provision of Certificates of Acceptance and Conformity.



Malcolm Pearce (right) receives a presentation from Thames Valley Section Chair Jeremy Smith upon his retirement in June from the role of Section Secretary for Thames Valley

Jeremy showed examples of the different types of buffer stops available - fixed, fixed hydraulic, friction hydraulic and friction - and some one-off specials. He described in detail the structure of a friction element, and the calculation for an example of the type installed at Blackburn depot. Four short film clips followed of trials carried out on various types of buffer stop: Bradford in 1945, Upminster in

1992, St Pancras in 1997 and Japan in 2007. Jeremy summed up with "energy in a moving train will not magically disappear on striking a buffer stop. It has to be dissipated through full assessment, appropriate design, and installation to rigorously applied standards".

Our Section Secretary Malcolm Pearce presented "The PWI Practical Trackwork

Challenge 2018 - Rothley, Great Central Railway". The Trackwork Challenge has been established by the PWI as an annual event to benefit inexperienced individual members and is supported by Corporate Members. Malcolm showed how participants are introduced to the practicalities of site design and plant operation.

An illustrated report of the 2018 event appeared in the April PWI Journal, and a more detailed account with an extended range of images appears on the PWI website technical hub. Malcolm's presentation encompassed both these reports. A Q&A session provoked considerable discussion. Richard Antliff proposed the vote of thanks.

5 June 2019

President's visit

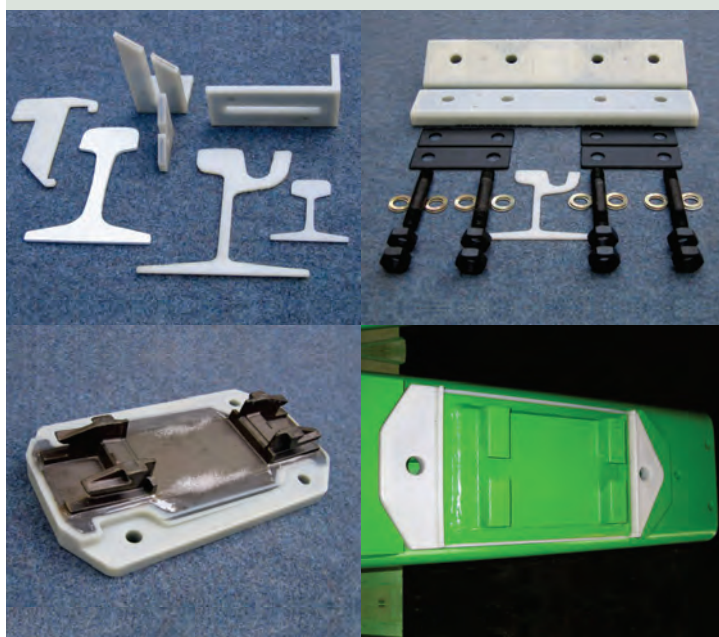
Joan Heery

High Output Track Renewals - Ready for CP6

Doug Swinney, Network Rail High Output Team Senior Programme Manager, Western and Wales.

We were pleased to welcome Joan Heery, PWI President. Joan felt that the scope in the PWI for driving technical excellence was considerable, through its reputation, industrial standing and core values of learning and sharing knowledge. Social aspects were vital, including maintenance of these in retirement. All staff, whether on the tools or in the office, should feel they can be part of the PWI.

TENCONI



Manufacture of Insulated Rail Joints in Hardomid for Railways and of special hollow sleepers

TENCONI plastic division is the only manufacturer of the high quality insulated rail joints also called 'BENKLER' joints. The pieces are produced also in small batches, according to customers' specifications and needs.

TENCONI steel construction department has a reputation of excellence also for the manufacture of special hollow sleepers, low friction slide chairs, insulated base plates and many other railway products.

TENCONI SA
Mechanical Workshop
CH-6780 Airolo

For more information contact:
Sales manager: Fabrizio Lucchini
Tel: +41 91 873 30 00
Mobile: +41 79 435 59 84
Email: lucchinifabrizio@tenconi.ch



www.tenconi.ch

Increasing membership among younger people was one of her primary objectives.

Doug Swinney presented "High Output Track Renewals - Ready for CP6". He had extensive responsibilities in the high output track renewals operations. An in-house approach, innovation and strong supply chain are key to the High Output operation.

Doug explained that High Output was a national organisation within Network Rail renewing track and ballast on eight NR Routes, currently with five operating bases at Swindon, Crewe, Doncaster, Newcastle and Stratford, with plans for another at Millerhill. Four delivery teams operate a fleet of six core Systems (trains) over a 7-day 52-week year. The Systems comprise four Ballast Cleaning trains (BCS) and two Track Relaying trains (TRS). Teams aim to deliver strategic programmes of track renewal and rebalasting work to improve track quality and minimise likelihood of future speed restrictions. They usually work in short duration access windows midweek and longer blocks at weekends, handing back at high speeds to minimize passenger disruption. Adjacent Line Open (ALO) working is often pursued, usually with a 20mph restriction on passing traffic and lines reopened at up to 80mph. Reopening at line speed, where higher, is feasible but usually comes at a cost of lower output.

High Output trains raise significant logistical issues of pathing, supplies of materials and plant spares and, of course, reasonable daily

travel distances for staff. The trains are large and complex. Preferred routes to sites are not always gauge compliant. Best utilisation is achieved when works on a Route can be packaged together. The overall programme is detailed for at least 12 months ahead. Doug explained many technical details of the train vehicles and their performance abilities.

Skills among the High Output teams range widely, for example plant operators, apprentices, supervisors, works managers and plant maintenance engineers. They are backed up by people with a wide range of disciplines looking at design (done in-house at York), PW delivery, OLE and 3rd rail issues, and train planning. Good staff terms and conditions are important to sustain good teams and similar terms are expected among sub-contractors. Great care is given to Health & Safety issues, a detailed example being protection from ballast dust generated by the processes.

After a wide-ranging Q&A session a vote of thanks was given by Mark Howells.

WESSEX SECTION

4 June 2019

Rail Management Toolbox
Bobby Sidhu, Senior Asset Engineer,
Wessex Route

The June meeting and AGM of the Wessex Section was held at Eastleigh where Colum Cavanagh, Asset Manager (Track) Wessex Route introduced his Senior Asset Engineer,

Bobby Sidhu, who gave his excellent presentation "Rail Management Toolbox" relating to the Wessex Route.

The Wessex Route consists of 1300 track miles and includes Waterloo, which handles 100 million passengers per annum, and Clapham Junction, the busiest rail interchange in the world. South Western Railway, the principal TOC, operates a large fleet of Desiro trains which are not very rail-friendly and this, combined with high tonnages, produces considerable rail wear and spawns rolling contact fatigue (RCF). Bobby explained how hitherto rail management had been largely reactive. In particular, inspections for RCF are currently verified visually, following which an action-plan is drawn up for removal within the prescribed time, using either grinding or rerailing.

The CP6 strategy for rail management is to be pro-active; highly necessary as traffic volumes increase whilst access for maintenance decreases. Such pro-active management will have the effect of extending rail life and ensuring earlier arrest of the development of RCF. The UTU (Ultrasonic Testing Unit) is now equipped with eddy current probes, which produce subsurface RCF crack depth data. The data is recorded at the same time as the ultrasonic suspect data is recorded. The eddy current RCF data is then used to plan in the mitigation for the removal of the RCF from the track. This could be via grinding, HSM (High Speed Milling) or rerailing.



40 Couper Street, Glasgow, G4 0DL
T: 0141 552 5591 F: 0141 552 5064
E: enquiries@maximpower.co.uk
W: www.maximpower.co.uk

TRACK MAINTENANCE EQUIPMENT



Master 35® Impact Wrench & Tool Carrier

Specifically designed for use in a railway environment.

Will remove/fit Chairscrews and Fishplate Nuts in under seven seconds and with our Safety Quick Release Auger Attachment can be easily converted into a Wooden Sleeper Drilling Machine.



Lase Align

Switch tip alignment
Track Slewing
Switches
Crossing Nose Alignment
Rail Dip Measurement



Stoneblower

Hand held stoneblowing has been used for over twenty years.

It provides a quick and efficient way to correct settlement by filling the voids caused by train movements, track instability, climatic conditions and wet spots



Rusty Clip Remover

Designed for Green Zone working to remove seized 'P' and 'E' type Clips from their housing.

Useful in tunnels, under bridges, level crossings, coastal areas where it is difficult to remove Rusty Clips

A new rail scanner – the Sperry B-Scan – delivers 3D images which are far more informative than the old A Scan ultrasonic traces and, as if that were not enough, it is also fitted with GPS. Another new piece of kit is a 64-stone grinding train (the C44) which in a single pass at 55 mph can cover 10 to 15 miles of preventive grinding per night. Reactive grinding however requires multiple passes hence the distance covered will be shorter. A better alternative to grinding is milling of the railhead using the high speed milling train to restore its original factory profile. With two milling cutters per rail, working dry (thus not leaving cutting oil on the running surface) it can remove 3-5mm at up to 5mph with the swarf being hoovered up and recycled. There is only one milling train in the country at present, so it is in much demand, but Wessex have secured 60 shifts this year.



West of England Section: Gauging - RSSB, standards and making things fit
Neil Gofton, RSSB

WEST OF ENGLAND SECTION

19 June 2019

Gauging - RSSB, standards and making things fit

Neil Gofton, RSSB

On June 19, after welcoming our new PWI President Joan Heery and Vice-President Paul Ebbutt, Gilles Moullec welcomed Neil Gofton from the Railway Safety and Standard Board (RSSB) in front of a packed conference room. Neil Gofton started his presentation by outlining the role, vision and mission of his organisation and its aspirations for the rail industry.

This was followed by an analysis of the purpose of Group and Industry standards and their links to technical specifications for interoperability. Neil went on to explain the process for reviewing RSSB standards, providing an example around changing the requirement of platform height.

Neil explained the expectation from RSSB committees regarding deviation applications and common issues relative to the quality of the submissions. Following a short explanation on assessment of 'reasonable opportunity',

Neil spoke of some of the difficulties of delivering compliant gauging on a railway with legacy infrastructure and rolling stock, explaining the need for trade-off between gauge clearance and stepping distance in platforms.

At the end of the meeting, Neil answered questions from the floor before being thanked by Gilles for a very interesting and informative presentation.



Remote Condition Monitoring

Critical Rail Temperature Management

Earthworks Management

 **FINDLAY IRVINE**
Experience - The Difference

www.findlayirvine.com

PWI Golf day

Everyone had a great time at Lutterworth Golf Club in July. The event fell on a fabulous sun drenched day, seeing a packed field with players vying for the prestigious PWI awards. The trophies and prizes were presented by our former President Steve Featherstone and the winning team from 'The Lazy Lobbers' included Andrey Carey, Andrew Horan, Mark Banks and Derek Wolfendale.

A big thank you to our sponsor Selectequip, organisers, and hosts for yet another successful PWI golf day.



Site Visit at Gloucester Blockade

Back in July, the PWI team was thrilled to be invited to Gloucester Station where the S&C South Alliance (Network Rail, Colas and AECOM) was modernising the track layout in a 9-day blockade. Sarah Fraser, Project Manager for Network Rail and Ryan Ballinger, Production Manager for Colas Rail kindly showed Joan Heery, Stephen Barber and Michelle Mabbett around the site.

It was a great opportunity to understand the intricate planning that sits behind such schemes, and to see large-scale work underway.

Six point ends are being renewed using CEN56 units on concrete bearers and one CEN56 turnout is being heavily refurbished. Track installation is being carried out using a Kirow1200 rail crane operated by Colas. Signalling work includes upgrading points actuation equipment using a mix of High Performance Switch Systems and In-bearer Clamp Locks.

One aim of the project is to reduce the long-term maintenance burden by eliminating sub-standard ballast depths on a bridge at the west end of the layout. The revised vertical geometry, including lifts up to 200mm, requires a total of 310m of major modification to platforms 2, 3 and 4. Points heating is being upgraded with a new District Network Operator cubicle and cable route. One highlight of the project is the extensive use of low energy site lighting: powered by a mix of batteries and solar panels, project lighting is virtually diesel-free.



The PWI team is very grateful for inside-access during such a critical time and we wish our colleagues at Network Rail, Colas and AECOM well with the rest of the project.

The Barry Railway its docks and successors

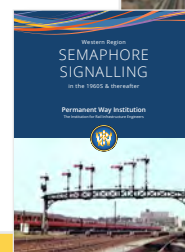
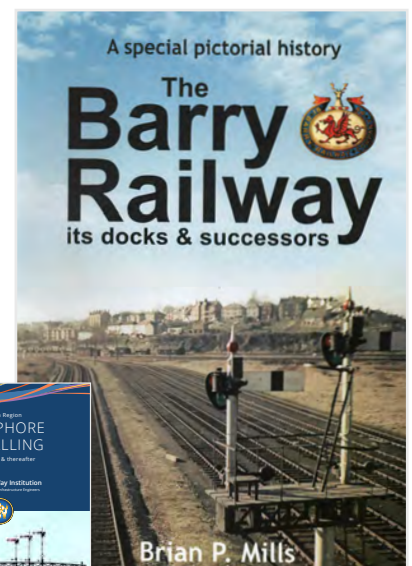
This special pictorial history book written by Brian Mills includes five detailed, hand-constructed maps and over 228 colour photographs, solely from the author's photo collection, most of which highlight the topographical features of the locations depicted and generally devoid of traffic. It illustrates and describes the civil engineering aspects and railway signalling & telegraph facilities over former and present times. A large percentage of the on-track records of the 1960s were made possible with official authorisation by British Railways, Western Region and more recently, Network Rail, Wales Route.

The earlier Barry docks hydraulic coal handling and mechanical equipment is described in detail with much reference to shipping and also some of the town's essential civil engineering services evolved due to the rapid expansion of the town, coupled with the docks construction after 1885.

The birth of the Barry heritage railway following 1994, is described in detail in text and photographic records. A foreword is compiled by John Buxton of Cambrian Transport Ltd, who, amongst other Railway Infrastructure activities at home and abroad, currently runs the Barry Tourist Railway.

This book will soon be available from www.bryngoldbooks.com

Brian's earlier book, Western Region Semaphore Signalling in the 1960s and thereafter, is available in the PWI shop.



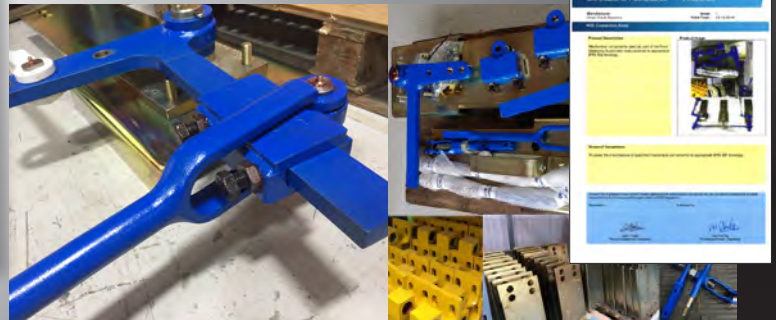


NEW
for 2019

DIRECT TRACK SOLUTIONS LTD - SPECIALISTS IN THE SOURCING OF PERMANENT WAY MATERIALS



ONLY Network Rail approved manufacturer and supplier of polecat CCTV column PA 05/07011. Used extensively on CCTV monitored/controlled level crossings.



Direct Track Solutions Ltd are now fully approved by Network Rail to manufacture & supply the full range of CEN56E1 (113LB) Full depth & CEN56E1/CEN54E1A1 Shallow depth mechanical points operating equipment to the full suite of BRS-SM & RT60 drawings. Finished where appropriate in prominent Signal Blue, so they are instantly recognisable. PA05/06926



WATCH THIS IN ACTION
www.directtracksolutions.co.uk/waterjet_cutting.html

Highly accurate Water Jet cutting allows us to cut a variety of standard and bespoke S&C pads from a variety of material. Bed Capacity 1500 x 1500mm and the ability to cut a maximum thickness of 300mm.

CONTACT US NOW FOR INFORMATION

Our team of specialists are ready to take your call and help with any enquiry you may have.

+44(0)1246 810198
info@directtracksolutions.co.uk
www.directtracksolutions.co.uk

- . P-Way Materials
- . POE Parts & Kits
- . S&C Pads
- . Polecat CCTV
- . Product Development

Direct Track Solutions Ltd
Unit 1C, Midland Place,
Barlborough,
Chesterfield,
S43 4FR

Brand new manufacturing facility based 2 minutes from the M1 at Junction 29A, Markham Vale.





EXPERTS IN TRACK INSTALLATION.

We recently delivered a twin track upgrade from Gateshead Tunnel to Felling Station – more than one mile of track renewals across four separate areas with the worksite passing through three stations.

“

**...YOU HAVE ALL MADE
A HUGE DIFFERENCE AND
LIFE IN TRACK ENGINEERING
HAS BECOME MUCH EASIER,
WELL DONE TO ALL.**

Glenn Melvin, Principal Engineer

CONTACT

lauren.douglas@stobartrail.com
www.stobartrail.com