UNIVERSITY OF Southampton

NetworkRail

TRAC24

Researching the totally reliable, affordable, zero-carbon, 24-hour railway

Find out more:
https://www.southampton.ac.uk/engineering/about/index.page

TRAC24

Research leading to a PhD while employed by Network Rail

- up to five NR Technical Officer posts and three University studentships, to carry out research in railway geotechnical and track engineering, and infrastructure carbon accounting
- working alongside a world-leading research team at the new Boldrewood Innovation Campus in Southampton, with links to other leading research institutes
- supervised jointly by University and NR staff
- opportunities to spend periods of time working at Network Rail offices, alongside NR staff
- research outputs are likely to lead quickly to real world trials and potential adoption into standards and practice
- starting salary for Network Rail employees £26,500. For the university studentships we offer an equivalent tax free stipend

Study with the University of Southampton

Since 2003, the University of Southampton (UoS) has led UK research into railway infrastructure. It leads the UK Rail Research and Innovation Network (UKRRIN) Centre of Excellence in Infrastructure and is home to the National Infrastructure Laboratory, part of the UK Collaboratorium for Research on Infrastructure and Cities (UKCRIC). It is also a major centre for research in railway noise and vibration and in railway economics and operations.

Employed by Network Rail

Network Rail (NR) is the owner and infrastructure manager of most of the railway network in Great Britain. The railway is at the very heart of Britain's economy and touches the lives of millions of people every day. Its future success relies on it becoming more resilient and more cost and carbon efficient, and on improving the service passengers receive. It is a significant supporter of applied research and is active in developing the industry's future technical leaders.

Your attributes

Applicants should have at least a relevant UK 2:1 honours degree or its international equivalent. Funding is competitive and we are looking for outstanding candidates, ideally with an existing interest in railways. The selection process will take into account the strength of the whole application including academic qualifications, personal statement, CV and references. Short-listed candidates will be interviewed by the University and Network Rail jointly.

Effect of embankment and subgrade weathering on track performance

In addition to the effects of the gradual equilibration of pore water pressures (often a loss of suction) over the decades following construction, infrastructure earthworks suffer gradual deterioration through weathering type effects. Mechanisms currently thought to be at least partly responsible include desiccation and cracking of a near surface zone, chemical weathering of the exposed surface, a gradual loss of residual suction in clay cycled between certain limits of water content, and a loss of material strength with strain (strain softening). Building on and working with the ACHILLES programme (www.achilles-grant.org.uk), the project will explore the impact of these weathering mechanisms on the efficacy of an earthwork or subgrade as a railway track support, and the resulting effects on track capability and performance.

Academic supervisors:
Joel Smethurst, William Powrie, with input from Fleur Loveridge (University of Leeds).

Carbon accounting in geotechnical solutions of capex funded strengthening across the UK mainline railway

While a suite of standard details exists with regard to the carbon footprint of key materials such as concrete and steel, this information is not fully incorporated into the option selection process for engineering projects. Network Rail aspires to be able to quantify (and monetise) the contribution of embedded carbon by each standard detail and to develop an approach that estimates the construction impacts of each standard detail in terms of its carbon emissions. As part of its aspiration to become carbon neutral NR also needs to be able to design, quantify and monetise the carbon offset schemes required to mitigate the impact of major interventions works. This project will centre on the creation of an assessment tool for asset managers to (1) inform and guide their option selection at a tactical level; and (2) use strategically across their portfolio to demonstrate a journey towards becoming carbon neutral.

Academic supervisors:
Simon Blainey, John Preston, William Powrie

TRAC24 Projects

Rail breaks and track buckles

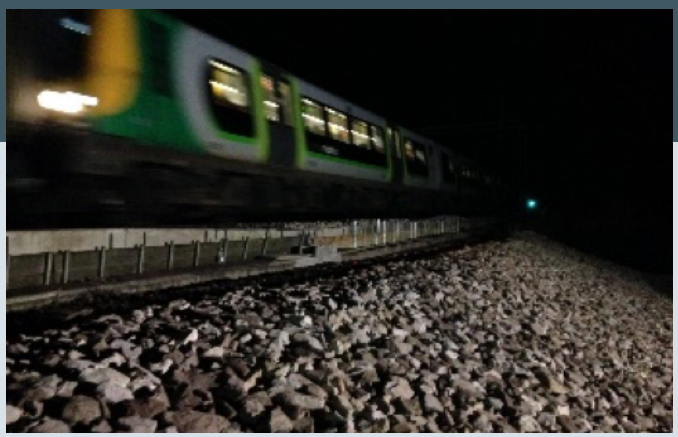
Mean rail temperatures are projected to increase into the mid-40s Celsius within the next 30 years. Current knowledge suggests that increasing the rail Stress Free Temperature (SFT) – the usual response in these circumstances - would have an undesirable but unquantified effect on rail breaks in winter. In particular, the impact of increasing the SFT on the risk of fracture due a pre-existing defect has not been quantified. A further consideration is that a high proportion of track buckles occur on curved track. Hence there is a need to understand the behaviour of continuous welded rail (CWR) on curved track to determine whether sharper curves breathe/creep over the winter/summer cycle. This could mean that a curve may exhibit a high apparent SFT in summer and a correspondingly lower one in the winter. This project will investigate the relationship between rail mean tensile forces and rail fracture risk to understand its potential impact in terms of safety and performance, and recommend how the target Stress Free Temperature value for rail should evolve to meet the challenges of long term climate change in the UK.

Academic supervisors:
John Harkness, William Powrie, Louis Le Pen

Performance of fixed diamonds in complex railway S&C

Switches and crossings (S&C) constitute about 1% of the UK railway network by route distance yet account for some 20% of track maintenance and renewal costs. This is partly because by their nature they are complex structures that attract high and otherwise onerous loads. There is however a growing appreciation that they are not generally optimised in a systems sense, and that more could be done by way of improved design and maintenance methods to improve their performance and longevity. Recent research has focused on understanding the real behaviour of switches and how it is influenced by their component parts. This project will extend that work to the fixed diamond element of crossings. It will involve field monitoring of fixed diamonds at 1-3 problematic or other locations on the UK network, to obtain baseline behaviour of actual performance. These data will be used to develop models of crossing behaviour for use in geotechnical and/or vehicle-track interaction (VTI) models, possibly in collaboration with the University of Huddersfield.

Academic supervisors:
William Powrie, Louis Le Pen



Carbon accounting for bridges

High performance construction materials allow longer-life design together with improved life-cycle environmental, social and economic costs. This project will construct validated probabilistic service life models of stainless steel reinforced concrete bridges, which will form the basis for life-cycle cost (LCC) analysis for quantifying potential maintenance cost savings brought about by higher initial investment. Experimental and numerical modelling methods will be used to investigate the structural behaviour of bridges at component and system levels, in order to develop the probabilistic service life models required to develop a maintenance intervention strategy. The LCC analysis will consider societal, environmental and economic sustainability metrics. The LCC will be evaluated using a present value life-cycle approach consistent with the Treasury's Green Book and the Department for Transport's WebTAG tool. A probabilistic approach, based on Monte Carlo simulation and Bayesian hierarchies, will be used and results will be verified with historic bridge data.

Academic supervisors:
Sheida Afshan, Simon Blainey, John Preston

Threshold loading effects on railway ballast

Britain's railways now carry more passengers each year than at any time since the 1960s, on a network that has roughly halved in size. Rail passenger journey numbers have doubled since the mid-1990s. This has resulted in the need to extract as much capacity as possible from the existing network, by running longer, heavier and more frequent trains. There is especially scope to increase the speed and axle loads of freight trains, but there are concerns that to do so might cause an infrastructure maintenance threshold to be crossed. The project will investigate this effect with respect to ballasted track.

The investigation of ballasted track settlement will be based on tests in the Southampton Rail Testing Facility, in which cumulative ballast settlements under millions of load cycles will be assessed as a function of varying axle load and loading pattern /frequency. Experimental data will be supported by various types of modelling, from empirical ballast settlement equations through rheological type models to a finite element/vehicle-track interaction analysis.

Academic supervisors:
William Powrie, Louis Le Pen, Madhu Murthy

TRAC24 Projects

Threshold loading effects on railway subgrade

Britain's railways now carry more passengers each year than at any time since the 1960s, on a network that has roughly halved in size. Rail passenger journey numbers have doubled since the mid-1990s. This has resulted in the need to extract as much capacity as possible from the existing network, by running longer, heavier and more frequent trains. There is especially scope to increase the speed and axle loads of freight trains, but there are concerns that to do so might cause an infrastructure maintenance threshold to be crossed. The project will investigate this effect with respect to the underlying soils.

The investigation of subgrade threshold behaviour will be based on cyclic tests in the hollow cylinder apparatus, in which changes in principal stress direction representative of stress paths in reality can be imposed, supported by geotechnical finite element analyses using an appropriate soil model. In both cases, the findings will be used to assess a proposed increase in freight speed/axle load on the Portsmouth "direct" railway line, for which field data may become available during the course of the study.

Academic supervisors:
William Powrie, Joel Smethurst, Madhu Murthy

Capacity of pile foundations for railway over-line electrification equipment

Up until the early 21st century, foundations for railway over-line electrification equipment (OLE) on UK railways were traditionally up to 5m in length. However, design methods and structures introduced in connection with the Great Western Electrification Programme led to pile lengths up to roughly twice this. The reasons for this have been explored, and the applicability of the traditional empirical approach demonstrated with reference to a limited series of field tests, but considerable uncertainties and opportunity for further economy remain. The aim of this project is to explore the factors influencing the capacity of pile foundations for railway OLE support masts, which may include the effects of an embankment or cutting slope on lateral resistance; soil stiffness and the assessment of serviceability; the impacts of load cycling and gust loading; interactions between lateral, vertical and twist loading; and site characterisation issues. Investigative methods may include field testing, numerical and analytical modelling, and geotechnical centrifuge testing.

Academic supervisors:
David Richards, William Powrie

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Photos courtesy of Network Rail and University of Southampton