national highways

Roads Research Alliance

Progress Report

2025/26

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1. Overview

Foreword

Mike Wilson, Chief Engineer and Executive Director, National Highways

The strategic road network underpins the UK's economy, connects communities and strengthens national resilience. But we are operating in a more demanding environment than ever before – rising customer expectations, increasing delivery, ageing infrastructure, new technology and the imperative to decarbonise are reshaping what the network must deliver, and how we deliver it.

In that environment, research and innovation are not optional. They are fundamental to meeting the commitments of the Road Investment Strategy and supporting wider government ambitions. We will not deliver a safer, more reliable and lower-carbon network by standing still.

It is therefore essential that we continue to invest wisely, balancing curiosity-driven research with a clear focus on impact and adoption. The Roads Research Alliance (RRA) is central to that ambition and, critically, it is an alliance that will continue. The RRA is not a short-term programme but a long-term, collaborative platform through which National Highways, industry and academia work together to address the scale and complexity of the strategic road network. Its continued evolution ensures that research effort and investment remain aligned to real-world needs and deliver tangible value.

The RRA's strength lies in its partners and the commitment they bring. Industry and academic partners continue to invest not only funding, but significant people and expertise, helping to lead research, shape challenges and accelerate delivery. This willingness to co-fund, co-deliver and share data, insight and intellectual property is both a strength and a differentiator. It demonstrates confidence in the alliance as a trusted, neutral space to collaborate, test ideas and turn evidence into action.

The alliance has created a powerful platform for collective leadership. By working openly across organisational boundaries, partners reduce duplication, accelerate learning and move innovation more quickly from concept to deployment. This is what enables research to translate into practical outcomes—whether improving carbon performance, increasing asset resilience or delivering more efficient operations across the network.

The challenge now is impact at scale. As the alliance evolves and broadens participation, we must remain focused on turning evidence into real-world outcomes for the strategic road network. The progress in this report is encouraging, and tangible outputs are emerging. The next step is to embed those insights at scale and demonstrate clear value for today's network while preparing for tomorrow's demands.

I would like to thank all partners for their continued commitment, investment and leadership, and I look forward to seeing the RRA evolve and deliver lasting outcomes to the road network.

Executive Summary

Our organisation

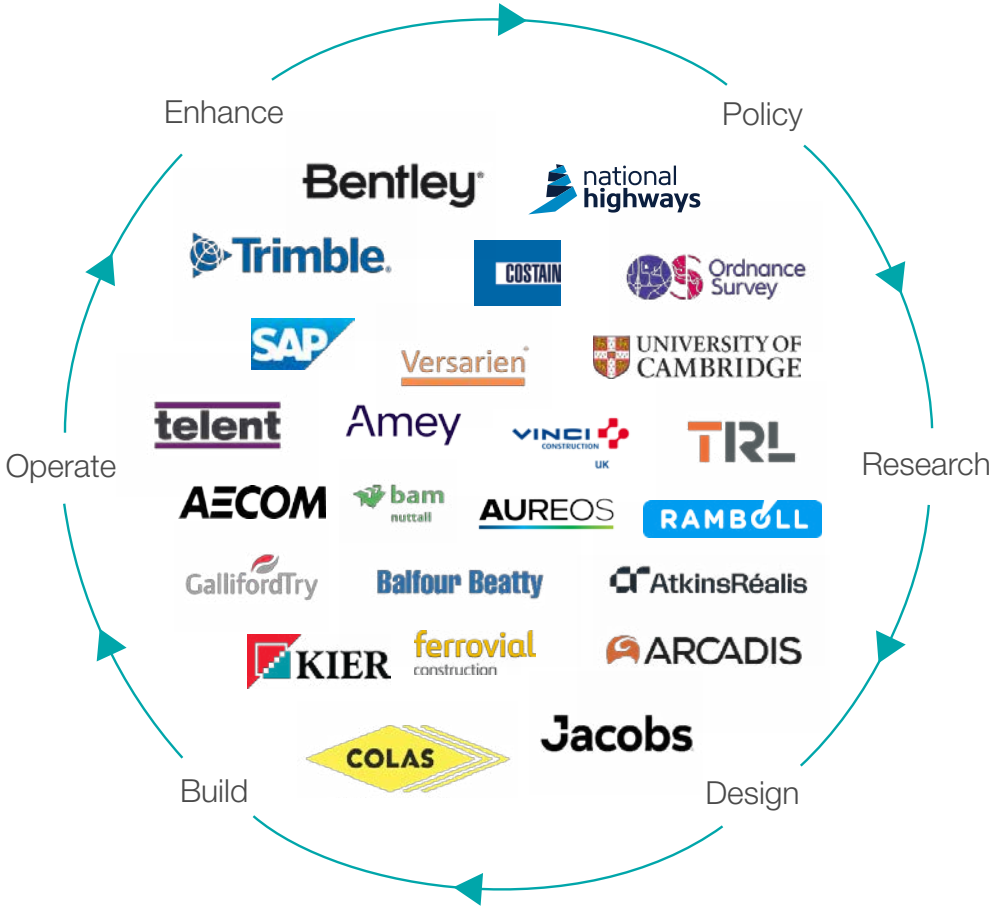
The Roads Research Alliance (RRA) is a collaborative partnership between National Highways, industry organisations and academia focused on delivering impactful, outcome-focused research for the roads sector.

The alliance is composed of National Highways, the University of Cambridge and 22 industry partners bringing together sector leading organisations from advisory, digital and construction and benefiting from cross sector partner expertise. Research is currently delivered through *Future Roads* – a £6.4 million co-invested programme supported by industry and the EU Horizon 2020 Marie Skłodowska-Curie Actions (MSCA) Fellowship Programme, which provides funding for 26 researchers.

How the alliance was established

The alliance's strength lies in the breadth of its expertise, spanning supply chain capability, academic excellence and operational network experience.

This range of insight, including from beyond the sector, enables it to shape, own and deliver research that is both commercially relevant and practically impactful.



Discover button Meet the alliance: an introduction from the team

Our mission

The alliance is a unique collaboration with a mission to enable impactful research across the roads sector. Built on a model of shared solutions, it facilitates internal and external networking and knowledge exchange to ensure research delivers tangible, actionable outcomes.

Our vision

A collaborative, cross-sector alliance that guides and improves the effectiveness of roads research – working together to address sector challenges, increase impact, drive value and leverage investment.

Governance

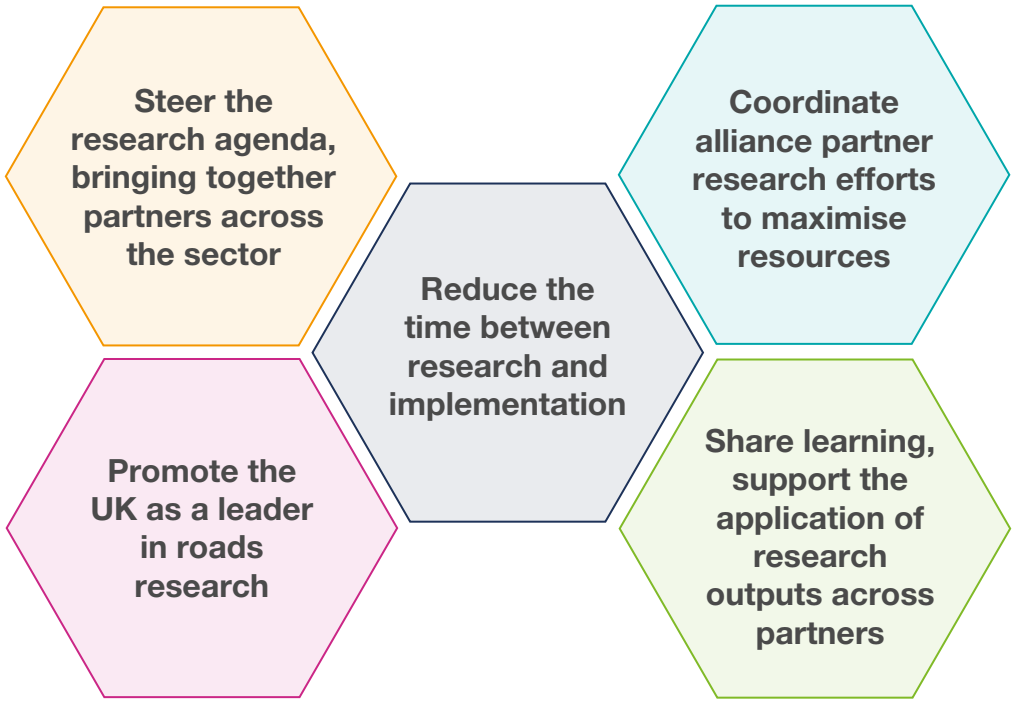
The primary governance body is the Executive Board, which oversees strategy and delivery.

The Advisory Board provides strategic guidance and supports delivery. Further detail is set out in the Leadership and Board section.

Industry participation, namely research supervision and board membership, is provided in kind.

Management of the RRA activity is provided separately by National Highways through the Specialist Professional and Technical Services (SPaTS2) framework.

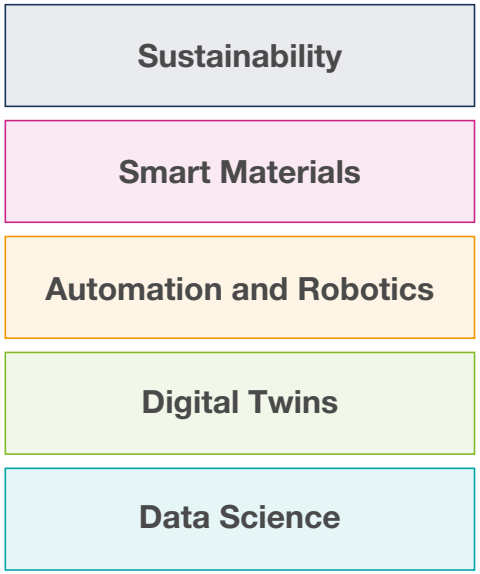
Core programme objectives



Research delivery

At the outset of the Future Roads programme, industry partners and the University of Cambridge identified a set of real-world challenges, which informed the recruitment of the research fellows.

The 26 research projects are organised into five academic themes aligned to these challenges:



Performance

The past year saw the completion of the first Future Roads tranche of research (Cohort 1) and continued progress across Cohorts 2 and 3. We now have 12 active research fellows, with 14 alumni. Many of the alumni have remained in the roads sector, in industry or academia, which has enhanced our wider research network. In total, more than 15 person-years of research were delivered in 2025. More detail can be found in the Our Research section.

Over half of the 26 projects are expected to deliver outputs at Technology Readiness Levels (TRL) 3-6, ranging from experimental proof of concept through to demonstration in relevant environments. Further detail can be found in the Pathway to Impact section.
The alliance has actively supported fellow-industry engagement to help steer research, strengthen relevance, and improve the quality of outputs, as illustrated in our case studies A Collaborative Approach section.
The research has led to the development of novel processes, tools and models. These are covered below in the Research Outputs section.

The RRA Showcase, held at the National Highways Development Centre in Moreton-in-Marsh (29 April 2025), highlighted emerging research, broadened engagement, and demonstrated how outputs can translate into practical benefits for the road network. A panel session at Highways UK 2025 built on this, exploring successes to date and strategies to maximise the alliance's future potential.

An internal engagement exercise across the alliance explored the areas in which it delivers the most value and decided where performance could be improved, with insights informing the future model.
The feedback was clear: the alliance is valued and distinctive. It has connected organisations that would not normally collaborate, enabled knowledge sharing, aligned innovation around shared priorities, and delivered cross-learning of academic and industry disciplines.
There is also a clear need, and opportunity, to improve as we move ahead: for practical research with pathways to deployment, to focus on impact and improve links within the sector.

Looking forward

2026 marks the final year of the current Future Roads research phase, including completion of Cohorts 2 and 3 and the development of the alliance's next phase.

The focus will now shift from a successful collaboration platform into a fully integrated alliance.

Our priorities for the next phase are:

- Outcome-driven and adoption-focused
- A broadened academic and research base
- Greater inclusion and representation across the sector
- Agile and flexible governance that supports project-based clusters
- Clearer communication and stronger knowledge sharing

Meeting the needs for roads research

Paul Doney, Director of Quality, Standards, Research and Innovation, National Highways

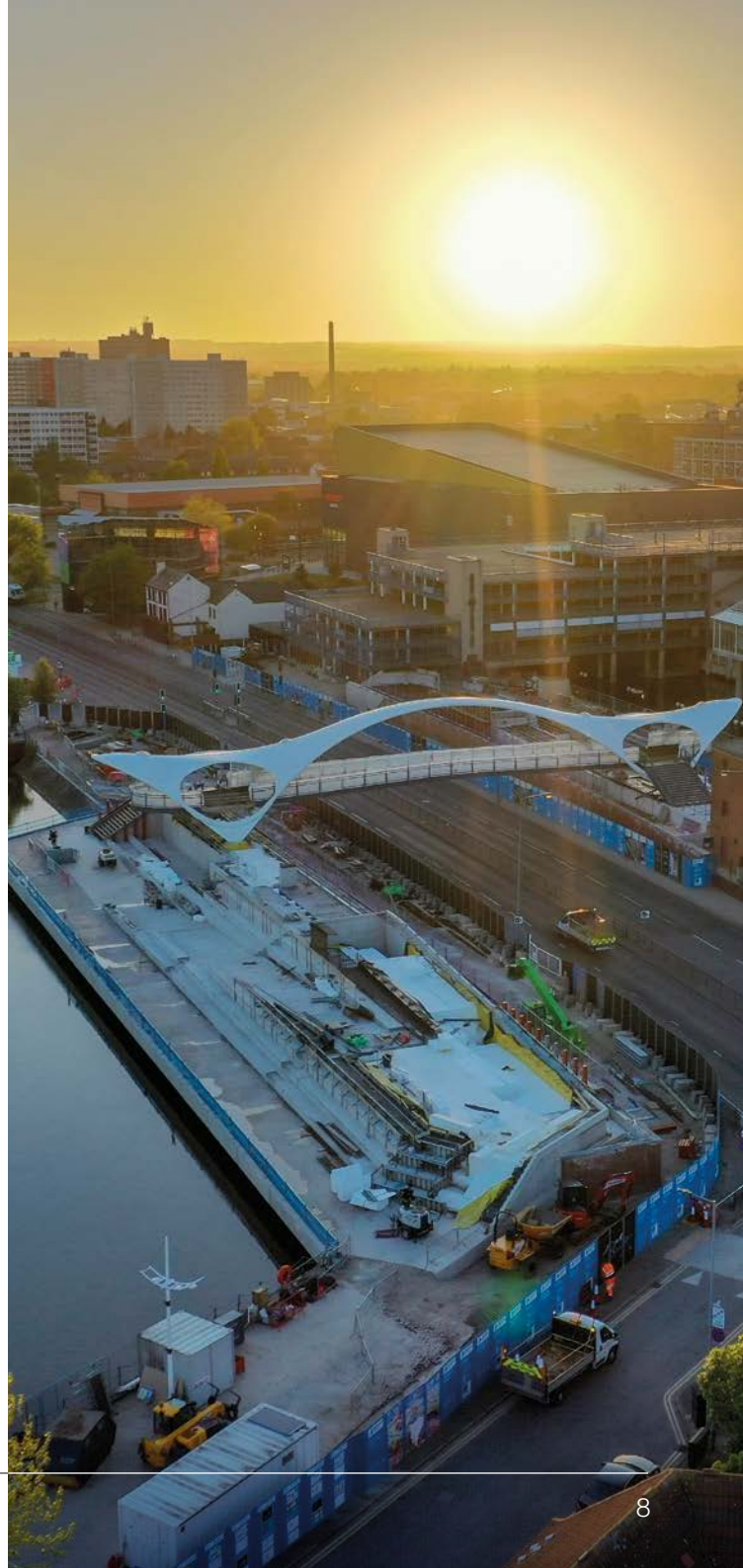
It is important to pause, reflect on where we started, and ask whether we are genuinely set up for what lies ahead. That feels like a fair description of where we are today with the RRA.

When the alliance was established, the intent was clear: to bring National Highways, industry and academia closer together, and to create the conditions for research that could address some of the most complex challenges facing the strategic road network. In many respects, that ambition has been realised. Feedback from partners consistently highlights collaboration as a real strength, and the environment the alliance has created for sharing ideas, data and experience is both valued and effective. It is this collaborative foundation that gives the alliance its unique character and ability to respond to emerging challenges.

At the same time, it is important to be open about the lessons learned. The alliance is now finding its voice, and with that comes clarity about how it must evolve – towards research that is more sharply problem-focused, more clearly aligned to the pressures facing the network, and with better-defined routes from findings to deployment.

The RRA is a key investment within National Highways' wider Innovation and Research portfolio. It supports our commitment to work closely with industry and academia and provides a practical route to align our emerging challenge-led research approach with external expertise and funding.

This next phase is about building on strong foundations, supporting the next generation of researchers, widening participation across the sector, and turning research into real-world impact. With clear focus, effective partnerships, and a shared commitment to outcomes, the RRA is ready to deliver research that makes our roads safer, more resilient, lower-carbon, and more efficient for everyone who depends on them.



2. Performance

The RRA has delivered measurable progress against the roads sector's most pressing challenges – decarbonisation, climate resilience, network productivity and digital transformation. Below is a summary of what the alliance has produced, built and enabled in 2025/26.

Connecting research to the network

Creating the conditions for research to deliver lasting impact on the strategic road network.

- Partnerships formed through the alliance are generating real-world impact beyond the research programme itself. The installation of sensor technology on the **M25 Junction 10 Wisley Interchange** overbridge, carried out by a consortium of alliance partners, illustrates how the RRA's convening role is creating opportunities for practical collaboration on the network that would not otherwise have come together.
- A suite of decision-support tools has been developed to assess road network resilience to flooding and extreme rainfall, including predictive flood models and spatial analysis linking flooding impacts to network connectivity. These outputs provide a ready evidence base to support future maintenance planning and investment prioritisation across the strategic road network.
- Alliance research on winter route optimisation has produced a initial optimisation of **East Midlands winter routes** and is directly informing a digital demand project planned for 2026, with expected financial and carbon savings for the organisation.
- Research outputs align with **six of the nine focus areas** in National Highways' *Connecting the Country* Long-Term Strategic Plan to 2050.

Progress towards decarbonisation

Alliance research supports National Highways' target to decarbonise construction and maintenance by 2040.

- New low-carbon, circular pavement materials — including mixes incorporating **100% reclaimed asphalt pavement** and geopolymer binders — have been developed and validated, with partners confirming these findings are informing their approach to lower-carbon pavement strategies on live schemes.
- A **carbon data ontology and intelligent carbon management framework** aligned with PAS 2080 has been developed and validated through a research fellow being seconded to National Highways, with recommendations now informing how carbon data is collected and reported across the supply chain.

Tools and capabilities developed

The programme has moved beyond theory to produce working tools and frameworks that can support delivery.

- An **AI-enabled pavement assessment tool** reduces processing time from hours to seconds, enabling near-real-time condition monitoring — a step-change in operational efficiency for asset management.
- A suite of **flood resilience decision-support tools** enables identification of vulnerable network areas, prediction of disruption impacts, and better planning for extreme weather events at national scale.
- A working **Large Language Model-driven digital twin interface** has been validated on real highways (A55, M11), demonstrating improved condition assessment and operational decision-making accessible to non-specialists.
- A structured framework for **highway digital twin asset information requirements** is in development, providing a foundation for future digital twin standards to enable consistent, interoperable, and future-proof asset data that can be reused across systems, suppliers, and the full asset lifecycle to support better decision-making. Practical relevance has been demonstrated through the development of a vision-enabled roadside vegetation management tool.

Sector capability built

The alliance is strengthening the roads sector's long-term research and innovation capacity.

- **26 world-class researchers** recruited internationally have brought global expertise and research networks to UK roads challenges, delivering more than **15 person-years of research** in 2025 alone.
- **14 alumni** have progressed to new roles, with **5 remaining in the UK roads sector** across industry and academia — including one joining National Highways directly as Concrete and Materials Adviser. Alumni now hold positions at universities including Loughborough, Manchester, Nottingham and Queen Mary London, building a permanent academic network around roads research.
- **60 industry supervisors** across partner organisations have developed research supervision capability, deepening the sector's capacity to engage with and direct future research programmes.
- The alliance has enabled collaborations that would not otherwise exist — including a new initiative between National Highways, Jacobs and the University of Manchester's **CRADLE** robotics centre, which is exploring a world-class platform for automated structural assessment.

Investment leveraged

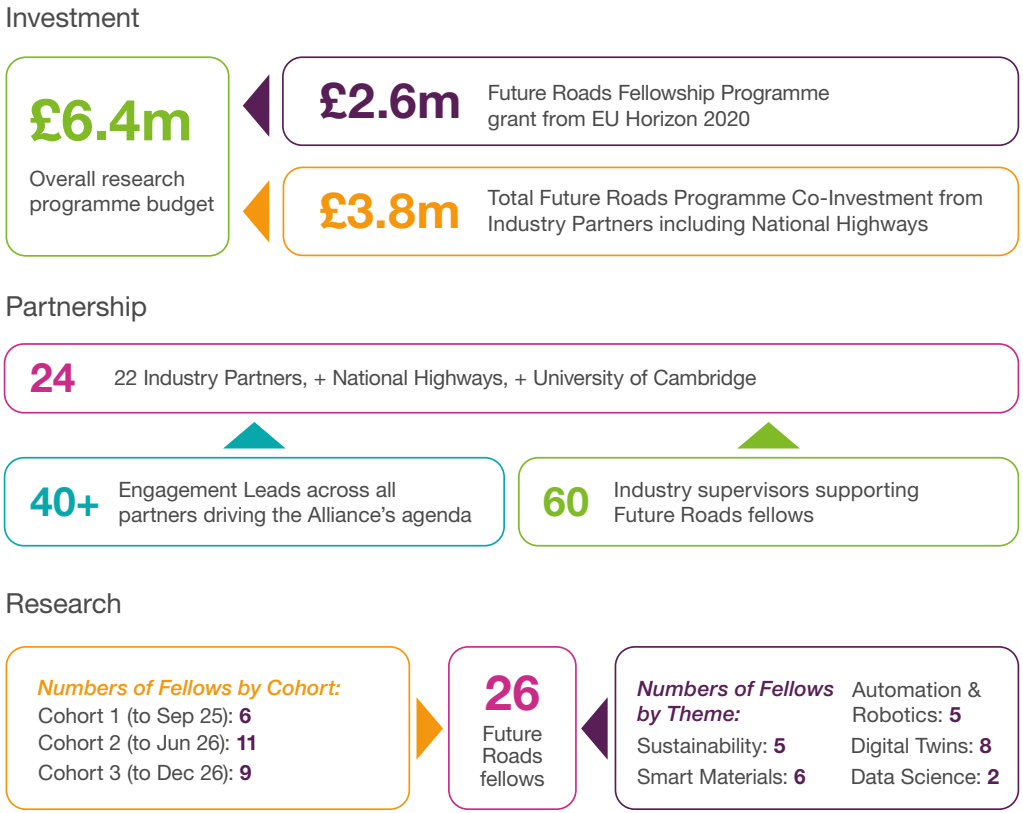
Every £1 of industry investment unlocked £1.69 of additional public and European research funding.

- The £3.75 million committed by industry partners helped secure a **£2.6 million grant from the EU Horizon 2020 Marie Skłodowska-Curie Actions programme** — one of the most competitive research funding sources globally.
- Total programme value of **£6.4 million** was delivered against an industry contribution of **£125,000 per partner** over five years (£25,000 per annum).
- The Showcase event attracted representatives from **17 industry partners, 6 additional universities, the Department for Transport, Local Council Roads Innovation Group** and **Department for Business and Trade** — demonstrating the programme's reach well beyond its formal membership.

Research outputs

- **80+ peer-reviewed publications** (including one white paper and three book chapters) establishing the RRA's research as credible, internationally recognised, and available to the global roads research community
- **Technical training workshops** delivered to industry partners, transferring research knowledge directly into professional practice across the supply chain
- **Two position papers** submitted to public consultations, ensuring alliance research informs national policy and standards development
- **Research collaborations** established with UK and international institutions, extending the sector's access to global expertise beyond the alliance's formal membership

Performance summary



3. Shifting Research to Practice

Reflections on a year of challenges and unexpected strengths

Phillip Proctor CEng MIET, Head of Research, National Highways

As I look back over the past year, what stands out most are the unanticipated positives that have emerged from the RRA. Building a collaborative research alliance across multiple organisations comes with unfamiliar processes, different cultures and new ways of working, but these challenges have been extremely constructive. By approaching them openly and supporting one another, we have learned quickly and adapted together. The important thing is that we are learning collectively, not individually, and every step forward reinforces the value of working as an alliance.

By bringing together research engaged organisations under a unified mission, we have created a space where ideas flow openly across organisational boundaries. Working side by side has also built deep trust: trust that sparks new ideas, strengthens partnerships and unlocks future joint projects that simply would not have happened without the alliance.

This year delivered several standout examples

Our partnership with AtkinsRéalis saw the installation of cutting-edge sensor technology on the M25 J10 Wisely Interchange Integral Bridge Project. By combining this new data with insights from our existing bridges, we are shaping future designs that reduce costs, improve sustainability and enhance safety across the network.

I was also particularly excited to begin a collaborative initiative on the robotic inspection of structures with Jacobs, through their link with the University of Manchester's Centre for Robotic Autonomy in Demanding and Long-lasting Environments (CRADLE). CRADLE blends the industrial experience that Jacobs and their partners have in robotics and autonomous systems with the university's leading research expertise, creating a world-class, long-term platform for innovation in automated structural assessment.

Our collaboration is not limited to technology and infrastructure – it includes skills development too. By co-funding researchers, alliance members are not only supporting vital research today but also investing in the next generation of specialists our sector will depend on. Working together ensures research topics closely match real-world needs, while giving emerging talent early and meaningful exposure to the roads sector and to the benefits of cross-organisational teamwork.

Ultimately, the value of working together is clear. Shared research and developments spread costs, boosts capability across all alliance members and helps cultivate a workforce that is instinctively prepared for collaborative, mission-driven innovation. In doing so, we strengthen the wider ecosystem around us and keep the RRA future-focused, resilient and positioned to lead.

Growing a collaborative research culture

Professor Ioannis Brilakis, PhD CEng MICE, Laing O'Rourke Professor of Civil and Information Engineering, Principal Investigator, Digital Roads of the Future Initiative, University of Cambridge

Building a research and development culture in an industry of low profit margins can be seen as an impossible task. The current difficult economic times have made this task more challenging and catalysed the problem, highlighting the need for greater productivity and efficiency. Research and development (R&D) culture is precisely what is needed to escape the low margins and boost profitability while providing better value for money to clients. This is where I see the role of the RRA.

The past year has been a year of reflection for RRA members. National Highways, first and foremost, is closely reviewing its R&D culture and making a sincere effort to modernise it with support from the University of Cambridge. Others have exploited the opportunity to engage in research via the Future Roads Fellowship Programme.

This has been the first research engagement experience for many, helping them understand the research process and its challenges.

Several realisations have come about:

1. R&D is not just about technology – modernising regulations and investing in market maturity are just as important
2. R&D is not a product; paying for it is not enough; active engagement is even more important for success
3. R&D is about trying multiple ideas and failing so that one of them can truly succeed and become a game-changer
4. There are multiple routes to market and understanding them and their appropriateness for a given project is key to success.

Much of this value is stemming from the Future Roads Fellowship Programme. As we reached the end of 2023 and completed the recruitment of the third cohort of researchers, the programme achieved a significant milestone. Our focus shifted towards effective research management and impactful outcomes. With the active engagement of

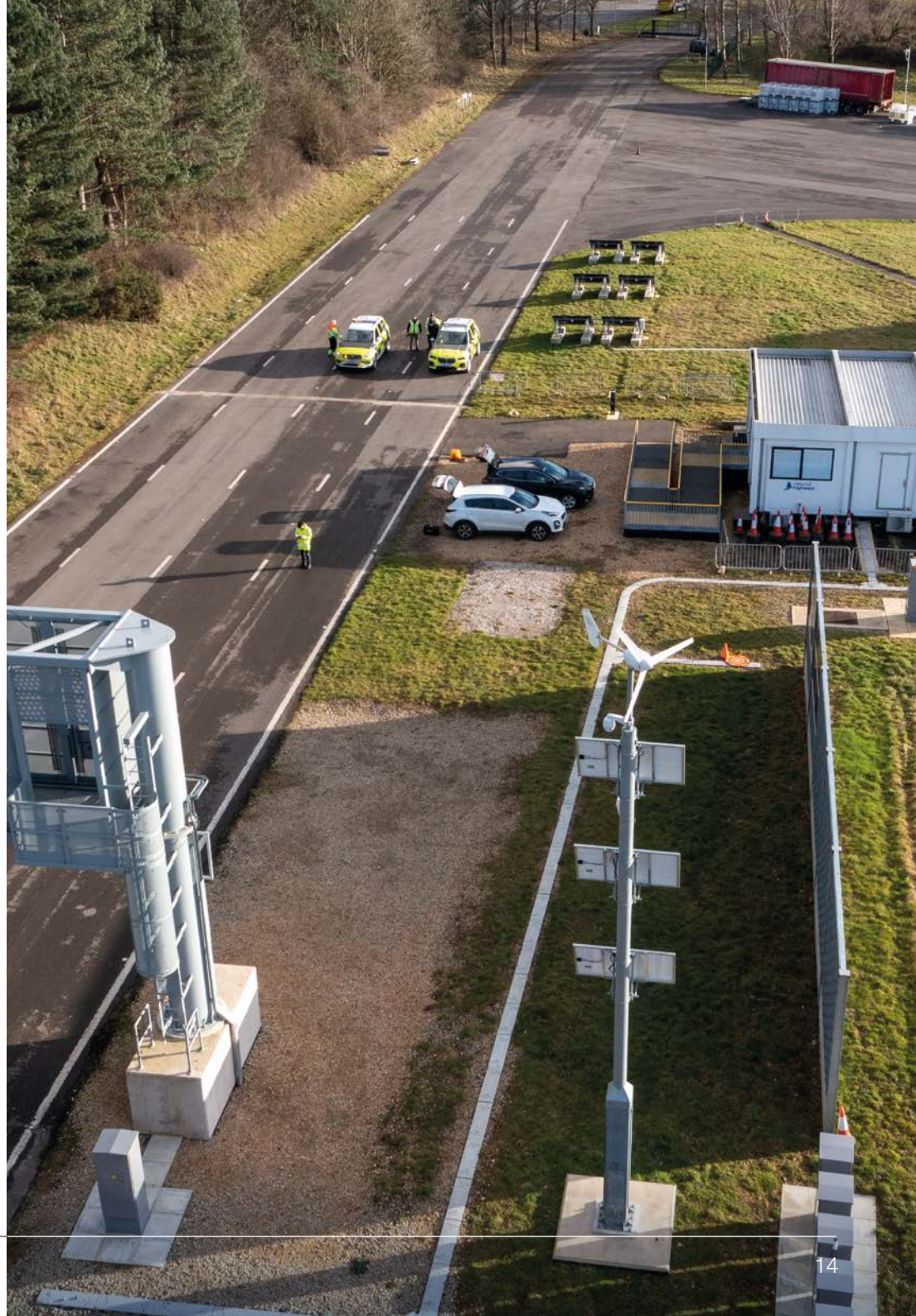
26 post-doctoral researchers and 22 industry partners, the full potential of our collaboration is becoming evident, promising great advancements in the near future.

The past year has been marked by increased engagement with our industry partners, highlighting the crucial role of industry supervision within the fellowship programme. This emphasis has led to a noticeable expansion of established industry supervision arrangements. The exchange of data, site visits, and the invaluable time and expertise of our industry supervisors have significantly enriched our research efforts, ensuring real-world relevance and applicability.

We're committed to continuous improvement and have actively listened to feedback from all stakeholders. In response, we've made changes to supervision arrangements, enhancing relationships with industry partners and ensuring that the research fellows' research remains closely aligned with industry needs.

The breadth of research activities at the University of Cambridge relevant to the RRA agenda is expanding beyond the boundaries of the Future Roads programme, opening possibilities for new collaboration. Our fellows are engaged in cutting-edge projects that promise to drive innovation and address critical challenges in the sector.

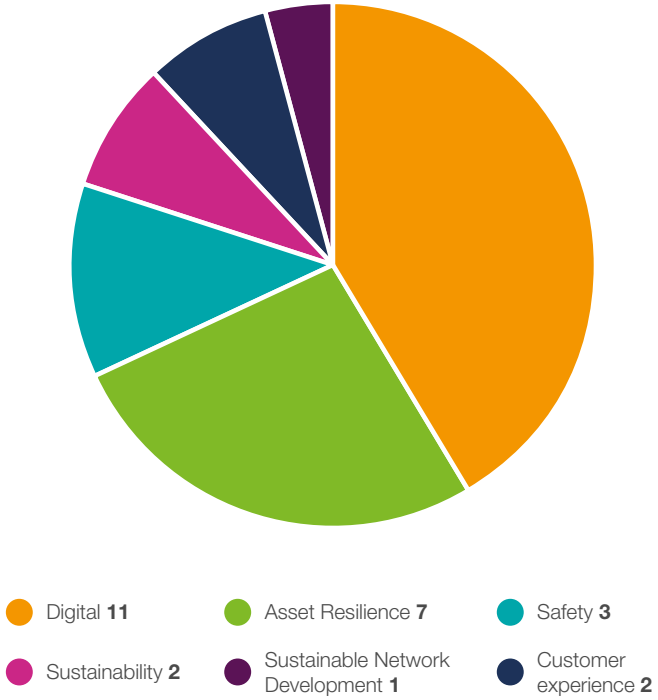
We are proud of our alumni cohort, composed of former fellows who have advanced their careers at renowned institutions in the UK and worldwide. This growing network continues to expand our reach and influence, fostering ongoing collaboration and knowledge sharing across the industry.



Pathway to impact

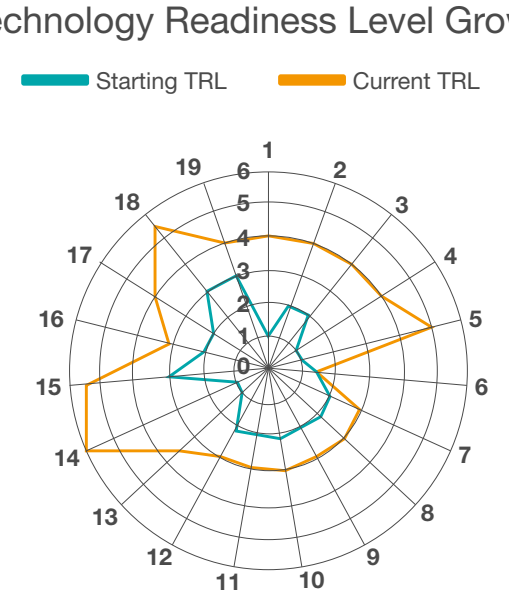
Research projects within the Future Roads programme are commissioned in response to challenges identified by the alliance's industry partners and continue to be guided by them, ensuring ongoing relevance to sector needs.

While recognising that research is often a long-term investment, the alliance balances immediate sector priorities with longer-term strategic objectives. Within this strategic context, projects have been mapped against the focus areas set out in National Highways' *Connecting the Country: Our Long-Term Strategic Plan to 2050*[*]. The 26 research projects align with six of the nine focus areas.



Assessing Technology Readiness Levels (TRLs) ensures that research projects are evaluated, appropriately funded, resourced, managed, and supported for transition to real-world application.

Nineteen of the research projects' current TRLs have been researcher assessed and compared to the starting TRLs to provide an indication of progress to date.



TRL Key

1) Basic principles observed
2) Technology concept formulated
3) Experimental proof of concept
4) Technology is validated in a laboratory
5) Technology validated in representative environment
6) Technology demonstrated in representative environment

* https://nationalhighways.co.uk/our-roads/future-roads/connecting-the-country/

Our research

Dr Nevena Vajdic, Future Roads Senior Project Manager, University of Cambridge

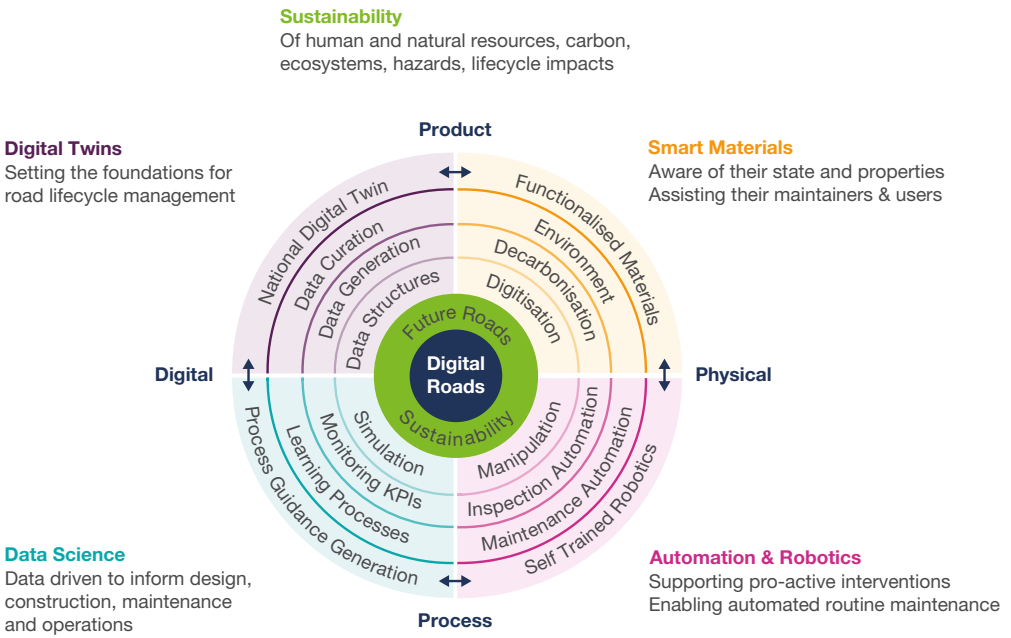
The RRA's research portfolio is currently built around the Future Roads Fellowship Programme at the University of Cambridge. Funded through Marie Skłodowska-Curie fellowships, the programme attracts outstanding post-doctoral researchers from across the world. These research fellows bring deep expertise and established research networks, enabling the UK to draw on leading global knowledge and perspectives from top universities worldwide.

Focusing on industry-defined challenges, the programme addresses key themes including sustainability, automation and robotics, smart materials, digital twins and data science. It supports the vision of a system of digital- and data-driven road management.

Discover button more on the Cohort 1 projects

Discover button more on the Cohort 2 projects

Discover button more on the Cohort 3 projects



Research outputs

The projects have produced a diverse portfolio of outputs spanning a range of TRLs, reflecting the inherent nature of research where exploring new ideas leads to outcomes with varying success.

This focus on translating research into usable tools, frameworks, and evidence will continue throughout 2026.

The following are a selection of the research projects highlighting their **outputs** – what the research has delivered – and their potential **outcomes** – the change if the outputs were developed to implementation.

Project	Data science and digital technologies for intelligent carbon management in the whole life of highway assets. Dr. Jinying Xu	**TRL 6**
Outputs	A carbon data ontology and a proposed intelligent carbon management system framework aligned with PAS 2080 that support carbon management across highway asset lifecycles, evidenced through a white paper. Insights from a secondment at National Highways informed practical recommendations for digitisation and carbon data governance.	
Outcomes	A standardised carbon data model and management framework that enables real-time carbon tracking across highway assets, supporting consistent reporting, better decision making, and reduced emissions in line with PAS 2080.	

Project	Measuring and enhancing the resilience of urban transport infrastructure networks to climate change. Dr. Jie Liu	**TRL 4**
Outputs	A suite of decision-support tools and frameworks to assess road network resilience to flooding and extreme rainfall. Key outputs include network-level resilience indicators, predictive flood models for the strategic road network, and national-scale spatial evidence linking flooding impacts to access to essential services and equity considerations.	
Outcomes	Provides a decision-support framework for climate resilience, enabling identification of vulnerable network areas, prediction of disruption impacts, and better planning for extreme weather.	

Project	LLM-driven Multi-Agent Framework for Enhancing Human-Digital Twin Interaction in Built Infrastructure Management. Dr. Linjun Lu	**TRL 4**
Outputs	Developed a large language model-driven, multi-agent framework for interacting with highway digital twins demonstrated by a working system integrating specialist agents for data retrieval, analysis, and decision support. This was validated through real-world case studies (A55, M11) showing improved condition assessment, prioritisation, and operational efficiency.	
Outcomes	An AI-driven interface to improve access to digital twins that allows users to interact through natural language, improving accessibility to non-specialists, decision accuracy, and operational efficiency.	

Project	A graph-based approach for road digital twinning. Dr. Junxiang Zhu	**TRL 5**
Outputs	A reusable, graph-based representation of building information management (BIM) data, enabling scalable organisation, querying, and analysis of infrastructure information. The outputs establish a technical foundation for linking BIM with digital twins and advanced analytics, overcoming limitations of file-based BIM workflows and supporting large-scale operational decision –making.	
Outcomes	A graph-based data structure for BIM and digital twins, enabling scalable data integration, advanced analytics, and more flexible decision making.	

Project	Zero waste geopolymer pavement. Dr. Abbas Solouki	**TRL 4**
Outputs	Low-carbon, highly circular rigid pavement and repair materials, including mixes with 100% reclaimed asphalt pavement and waste clay-based geopolymer/limestone-calcinated clay-cement binders. Outputs include material characterisation datasets, optimised mix designs with a strength-prediction model, and a fibre-reinforced geopolymer repair agent suitable for field application.	
Outcomes	Low-carbon, circular pavement materials, using geopolymer binders and recycled and waste resources, to reduce emissions, waste, and reliance on virgin materials whilst maintaining performance.	

Project	An innovative zonation-based, machine-learning methodology for studying the interactive impacts of traffic, microclimate and natural hazards on pavement deterioration. Dr. Ze Zhou Wang	**TRL 5-6**
Outputs	A standalone software prototype for rapid interpretation of traffic speed deflectometer data. The AI-enabled framework reduces processing time from hours to seconds, enabling near-real-time pavement condition assessment, alongside identification of downstream applications and implementation challenges.	
Outcomes	A rapid, AI-enabled pavement assessment tool that supports near-real-time condition monitoring and more targeted, cost-effective maintenance.	

Project	Establishing asset information requirements for road digital twins. Dr. Varun Kumar Reja	**TRL 4**
Outputs	A structured set of information requirements covering highway maintenance stages and influencing factors, intended as a foundation for future digital twin standards. Demonstrated a scalable overgrown vegetation management solution and produced a validated framework suitable for decision-support tools within digital twin environments.	
Outcomes	An automated, adaptive digital twin that updates asset information requirements, responding to changing asset condition, operational priorities and policies based on three dependent facets: a decision-orientated framework that assesses asset management objectives to data needs, vision-based roadside vegetation management, and a structured articulation of pavement asset information requirements.	

Project	Enhancing equity, diversity, and inclusion in active mobility: a study on under-represented groups' perspectives in road infrastructure planning in Cambridge. Dr. Khashayar Kazemzadeh	**TRL 5-6**
Outputs	A register of factors affecting equity, diversity, and inclusion of road users, alongside an experimental video-based assessment embedded in a digital twin of London. Generated comparative datasets capturing cyclists' experiences across London, Cambridge, and Oxford to inform inclusive transport planning.	
Outcomes	A modelling framework, linking dynamic visual features to subjective responses, that measures and models user experience (for example, safety and inclusion) within digital twins, enabling more inclusive and user-centred transport planning.	

4. A Collaborative Approach

Partnership to impact: research fellows working with industry

The RRA shows that when research fellows and industry partners work closely together, better research follows. Combining academic expertise with real-world insight allows ideas to be tested, accelerated, and turned into solutions with genuine impact. The case studies show how trust, shared goals, and regular collaboration drive more relevant, higher-quality research.

From secondment to solution: developing AI-empowered BIM interoperability through industry collaboration

Dr Mengtian Yin, Future Roads Fellow in Digital Twins, University of Cambridge

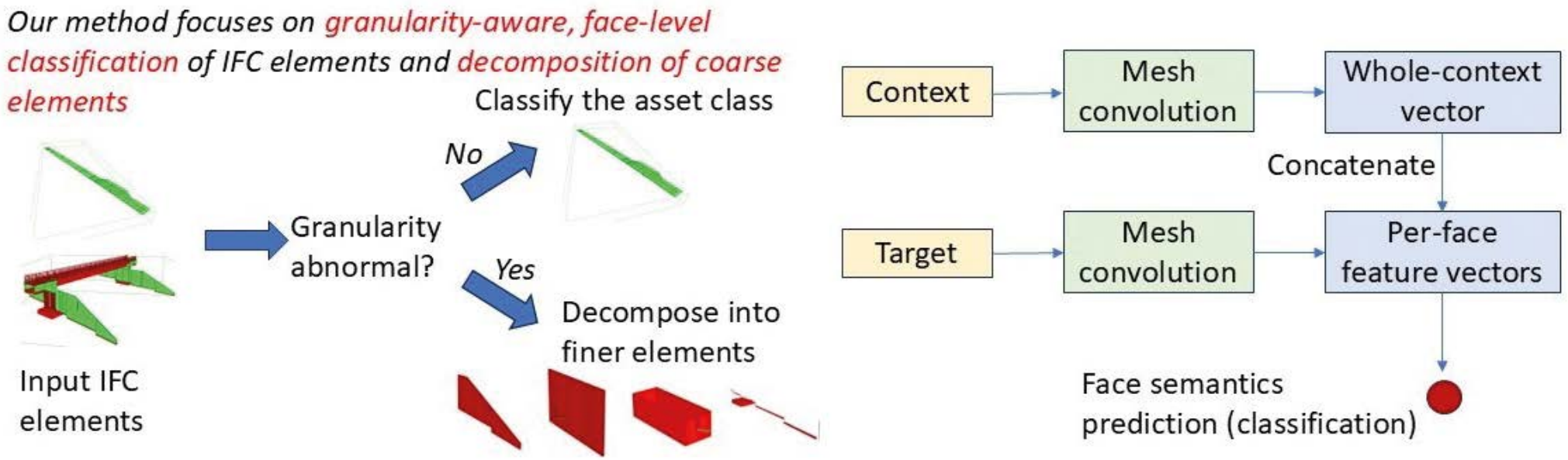
Mengtian's research is exploring the minimum viable product (MVP) of a digital twin for road inspection and maintenance.

I am Dr Mengtian Yin, a Marie Skłodowska-Curie fellow in the Digital Roads of the Future programme at the University of Cambridge. My secondment with Trimble, supervised by Kieran Mulvey, focuses on developing models using advanced data methods to automatically organise and classify building information modelling (BIM) data. The work also aims to improve how different systems share and understand this data, supporting National Highways asset information needs. While the technical aims are clear, the most valuable aspect of the secondment has been the collaborative relationship itself.

Working side-by-side with an industry supervisor has allowed academic research to connect directly with the realities of digital delivery. Kieran's guidance helped shape the work into something both technically rigorous and practically usable. Our weekly discussions created a space for open thinking, quick iteration, and honest feedback. This led to several tangible outcomes. For example, when early experiments showed inconsistencies between asset definitions, we jointly developed a crosswalk approach that now forms the backbone of the demonstrator pipeline for asset handover. This solution emerged not from a single idea, but from combining Trimble's product knowledge with Cambridge's research on semantic modelling.

The collaboration also strengthened the research itself. Access to Trimble's platforms (for example, Quadri), workflows, and quality expectations made it possible to validate the methods in realistic project settings, an opportunity rarely available in academic work. At the same time, Trimble benefited from early insights into automated classification and quality-assurance strategies that reduce manual rework and support scalable asset delivery.

Proposed framework overview



Overview of a geometric AI-based approach for automatic infrastructure – BIM information delivery

Overall, this secondment demonstrates how a strong relationship, built on trust, transparency, and shared goals, can turn a technical challenge into a mutually beneficial partnership, producing outcomes that neither side could achieve alone.

"Supervising the secondment was an opportunity to engage directly with leading academic research and explore how emerging methods can be translated into practical solutions. The collaboration sharpened my understanding of the assumptions behind research approaches and reinforced the value of close alignment between innovation and real-world delivery."

Kieran Mulvey,
Trimble – Research Supervisor

Building transport resilience to climate hazards through industry engagement

Dr Jie Liu, Future Roads Fellow in Sustainability, University of Cambridge

Jie's research measures and enhances road network resilience to climate hazards.

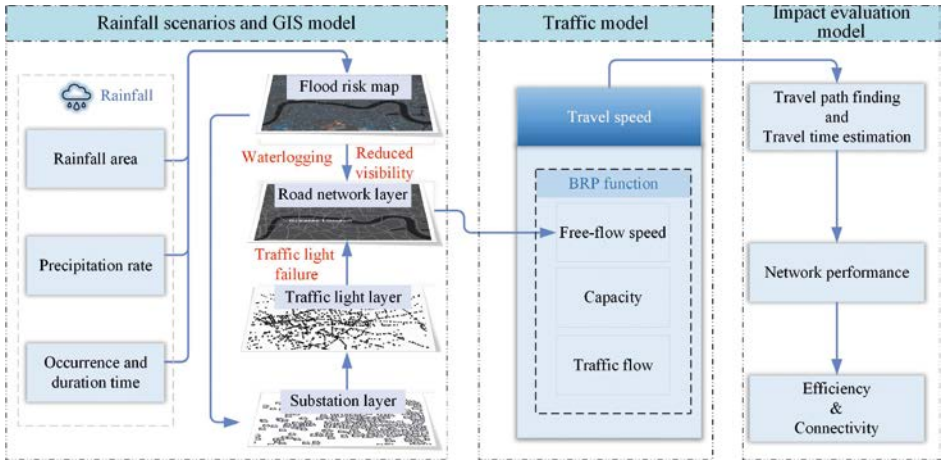
My fellowship focuses on transport resilience within the context of climate change. Throughout this journey, collaboration with my industry supervisors, Olly (Dr. Oliver Thomas of Colas) and Federico (Dr. Federico Perrotta of AECOM), has been essential in turning academic ideas into useful and practical outputs, by shaping the direction of my research, getting access to critical data, and providing supportive working relationships.

As researchers, we are naturally drawn to new theories and methodological innovation, but it is easy to lose sight of how these ideas translate into real decisions in road operations and asset management. Olly and Federico help me bridge that gap by continually asking practical questions – can an operations team use this, and would an asset manager rely on it to prioritise investment?

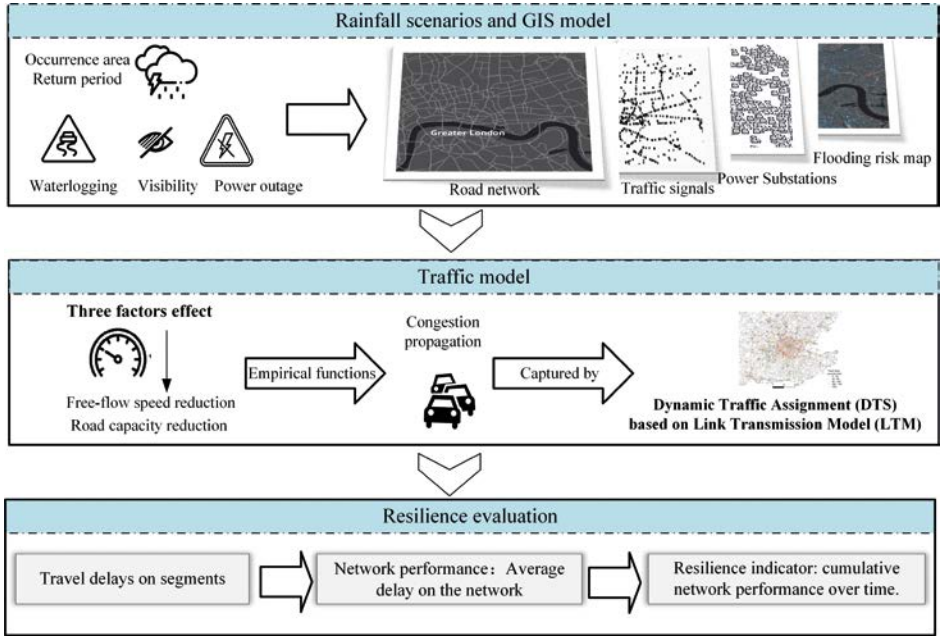
Guided by this, our work pairs innovation with direct applicability: (1) we quantify flood impacts and network resilience across South East, East and Greater London using highways Key Performance Indicators (vehicle delay and speed); (2) we estimate flood-related road damage costs under different flooding scenarios; and (3) we predict flood severity and locations on the National Highways network using multi-source data. These outputs are designed to support maintenance planning and investment prioritisation, making the research questions sharper and the results more decision ready.

The partnership has also been vital for data and insight. My industry supervisors have worked hard to identify and share historical traffic and flooding data, and to explain how these datasets are generated and used in practice. This has greatly strengthened the robustness and credibility of our models.

On a human level, their encouragement has mattered just as much. When I get stuck, they help to explore possible solutions with me; when progress is made, they celebrate it. That shared sense of purpose makes the research not only stronger, but also much more enjoyable.



Extreme rainfall impact Evaluation



Network resilience evaluation under extreme rainfall

"Supervising Jie and his research has been an incredibly rewarding experience. This has been true two-way learning, which has given me the opportunity to share my own experience, ensuring that research outputs are relevant to the challenges the sector faces but, also, allowing me to deepen my understanding of new advanced data analysis methods for measuring and enhancing the resilience of road infrastructure under extreme weather events. This has introduced a new data-driven approach to network modelling, providing National Highways with powerful tools to identify criticalities and inform more effective responses, both from the strategic and tactical sides of the business.

"Through publications at national and international events, as well as in scientific journals, the project has not only supported invaluable knowledge transfer across the sector, but has also delivered tangible value to National Highways, its peers, the supply chain, and customers. It has done so by improving the sector, enabling it to adopt more predictive types of approaches to network management that enhances the resilience of critical infrastructure, such as the strategic road network."

Dr. Federico Perrotta,
AECOM – Research Supervisor

"Colas Ltd entered the programme in a supervisory capacity, aligned with the second cohort of research fellows, and it has been a pleasure to engage with Jie and his project in supervisory capacity over this time. In particular, it has been very rewarding to see the research directions evolve as the collaboration and mutual understanding between the industry and academic partners have strengthened. More generally, the opportunity to engage directly with fundamental research is very different to the conventional R&D activity pursued within the UK highways sector, enabling different perspectives and overcoming barriers to operational implementation of future innovations."

Dr. Oliver Thomas, Colas – Research Supervisor

Reality-checked research: how industry collaboration can improve innovation

Dr Abbas Solouki, Future Roads Fellow in Smart Materials, University of Cambridge

Abbas' research is exploring the use of low-carbon concrete alternatives, such as geopolymer, for rigid pavement production.

From the very first call and application, I recognised that the Future Roads Programme would thrive on industry input. I understood early on that my work would need to address real problems that matter to practitioners, not just theoretical questions.

Throughout our meetings, my industry supervisor became my reality check. Every idea went through a practicality filter. When I developed concepts for low-carbon, zero-waste pavements, we discussed implementation challenges together. How would this work on site? What about curing conditions in British weather? Could logistics support this at scale? These conversations prevented me from disappearing into purely scientific territory. Instead, the project evolved into something genuinely useful. Having access to experienced industry voices shaped my research to bridge the gap between laboratory innovation and field application.

Durability and performance testing became critical to making these new binders credible. To tackle this properly, I secured a secondment with National Highways, investigating whether existing durability protocols could reliably assess low-carbon binders. This initiative study produced practical findings that will be published at the SASBE/FR/BDTSC 2026 Joint Conference in Cambridge, giving industry a clear path forward for material validation.

Geopolymer mortar specimens containing waste calcined clay or pure clay

None of this would have happened without genuine collaboration. Soft skills mattered as much as technical knowledge. Both sides knew what we wanted to achieve and communicated openly about getting there. My industry supervisor committed real time and passion to this work, not just token involvement. That investment made the difference between another academic paper and research that practitioners can actually use.

"The individuals – research fellows and supervisors alike – benefit tremendously from this relationship. Fellows gain invaluable exposure to real-world challenges, learning to adapt their research to industry needs and developing professional skills such as project management, stakeholder engagement, and communication. Supervisors, meanwhile, are invigorated by the fresh perspectives and intellectual curiosity that fellows bring, often discovering new approaches and solutions that can be applied within Arcadis and the wider industry."

Mark Murrin-Earp, ARCADIS – Research Supervisor

How research has shaped our thinking

Prof. Matt Peck, Director of Innovation – Transportation, AtkinsRéalis

The research carried out by the alliance has played a meaningful role in informing decisions in our investigations at AtkinsRéalis. The main impact confirmed that our investigations have been following the right path, evidenced by alignment between researchers' approaches and our own, or demonstrated that the challenges we have identified are real, evidenced by research projects focusing on the same problems.

There are a number of practical illustrations:

- Jie Liu and Zizhen Xu's work on preparing for floods and managing the impact they cause has confirmed that our approach to analysis is aligned with theirs
- Munkhbaatar Buuveibaatar's work on the framework for digital twins (DT) follows the loosely coupled conceptual model we use for our own DT development work
- As does Mengtian Yin's work on the minimum viable product for a DT, including the need for a common ontology and a wider data sharing architecture
- Shirin Malihi's work on the development of a DT that can cope with uncertainty is useful, as it confirms our thoughts that developing analytical models that can cope with uncertainty are needed
- Kai-Fung Chu's work on multi-agent, autonomous vehicle systems is a useful step forward in investigating how to control – in real-time – pseudo-chaotic vehicle interactions
- Chapa Hewa Sirithunge Pelendage's work on human–machine interface is an important confirmation of the need to understand how people and machinery interact. As her work develops to consider construction site-based interactions, it will further inform how best to use robotics systems in a manner safe for human based construction environments.
- Xiang Wang's work on alternative methods for road condition survey and assessment supports a belief that a multi-sensor approach to asset monitoring is needed. Also, the modelled potential of survey platforms to predict in alignment with surface fluctuation and IRI assessments is encouraging.
- Junxiang Zhu's work on graph-based DT is useful and shows interesting potential and means to improve DT query performance. It also confirms my theory that suggests that graph-based pre-processing is necessary to improve query response performance.

This is also the case across the partner organisations. For example:

- John Armintage of Ramboll was pleased to invite Jinying Xu to present to various teams on carbon data research, and this was positively received, improving their thought processes around how to manage these datasets
- Vahid Afroughsabet of National Highways observed that his own and Abbas Solouki's work on developing innovative lower-carbon concrete pavements aligns well with National Highways' concrete roadmap and supports National Highways' approach and ability to meet its 2040 construction and maintenance decarbonisation targets

- Philip Farrar of Galliford Try noted that Abbas Solouki's research into zero waste geopolymer pavements has helped reinforce their approach to integrating higher proportions of recycled materials into pavement strategies. His findings have also informed early thinking around performance-based methodologies and trial planning, supporting their ambition to adopt lower carbon, circular solutions on future schemes.
- Yue Xie's initial research into temporary traffic management and road traffic collisions assisted Galliford Try with broadening their risk assessment and items to consider for the design of temporary traffic management. Galliford Try will continue to run with this and feed into the wider industry.

Working with researchers on weather preparedness

William Beazley, Severe Weather R&D Specialist, National Highways

The National Winter and Severe Weather Team (NWSWT) have been collaborating with Cambridge University research fellows over the last 12 months in scoping and developing an optimisation algorithm that would improve winter service efficiency across our network. This is an important stepping stone in our effort to digitise our service leading to auto-salting and dynamic spreading in future years that we believe can result in financial and carbon savings for the organisation.

The output from this initial feasibility study provided significant learnings on several key aspects: (1) the current level of our mapping information within National Highways and what needs to be improved; (2) the significant computing power required to produce a single optimisation with an innovative bi-level solution to overcome this limitation; and (3) a basic optimisation of our East Midlands winter routes. The strong relationship between the NWSWT and Cambridge fellows alongside the invaluable learnings and outputs developed over the last year will prove significant when we come to commission a digital demand project through our Digital Services/Digital Labs colleagues later in 2026.

Alongside this project, we've also been steering a severe weather resilience task with one of the researchers to build an understanding of the impacts of severe weather on our network. The current focus is heavy rainfall and flooding with outputs from the project helping us identify how we are best able to mitigate reduced network connectivity issues that are likely to become more frequent in a changing climate.

The modelling delves into how travel time increases dependent on different types of flooding and the impacts this may have on different emergency services as well as our customers. There are several other research projects within National Highways focusing on similar flood aspects on the network and this research will provide further support for identifying vulnerable and strategic locations. The project is expected to move into other severe weather types in 2026, such as high winds and winter hazards.

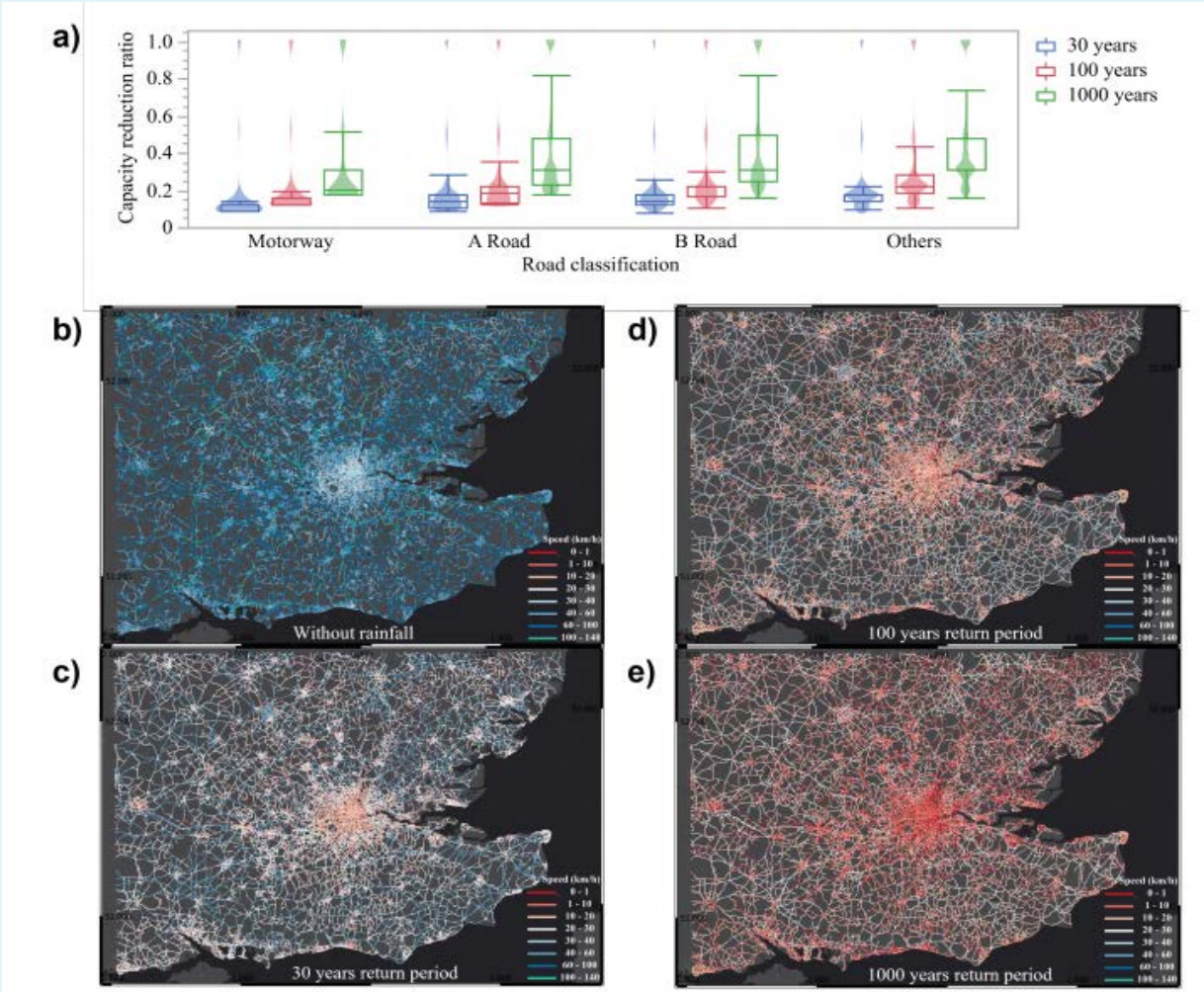


Fig 3 Impacts on road segment performance in extreme rainfall scenarios with 30, 100, and 1000 years return period under average "luck" conditions. a) capacity reduction ratio of road segments by road classifications. Roads are classified into M road (motorways and trunks), A road (large-scale transport links), B road (complements to A roads), and Others (C and unclassified roads). Travel speed on road segments during **b)** baseline scenario without rainfall, **c)** 1-in-30-year, **d)** 1-in-100-year, and **e)** 1-in-1000-year rainfall scenarios, respectively.

Road segment performance in extreme rainfall events

Bridging research and practice in carbon management

Through the RRA, Saroj Bhatoa, Head of Strategic Delivery for Strategic Procurement at National Highways, collaborated with Dr Jinying Xu, a Future Roads Research fellow, to explore how academic research in carbon management could be applied to the collection and assessment of supply chain carbon data.

This work was initiated to bring specialist expertise into the measurement and management of carbon, with Dr Xu's research into industry-based carbon data models providing a strong alignment with the requirements.

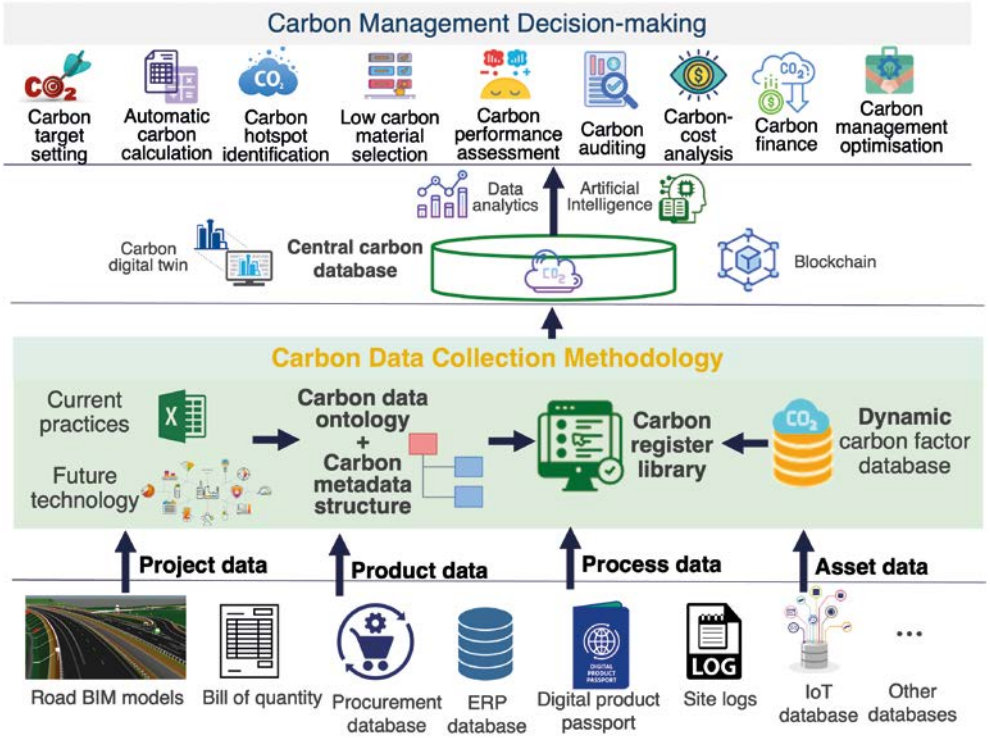
The collaboration created an opportunity to translate research theory into practical application within a live operational environment. This included direct engagement with industry challenges – particularly the reliance on highly manual processes for collecting carbon data. The work examined how theoretical methodologies could support the automation and standardisation of data collection in ways that are feasible in practice.

The collaboration also highlighted the gap that can exist between research and real-time application, while demonstrating the benefits of early engagement between researchers and practitioners. A key insight was that, although there is often an ambition to implement large-scale change, a phased approach is typically more practical and achievable.

Several recommendations were identified to improve carbon data collection and sharing, including increased collaboration across the supply chain, clearer and more consistent reporting frameworks, enhanced data sharing and centralised databases, and stronger alignment between cost and carbon objectives.

Overall, the partnership demonstrated the value of a two-way relationship between research and industry to developing practical, impactful solutions to complex challenges.

Discover button Listen to this work being discussed at our RRA 2025 showcase.



Carbon decision making framework

5. What Next

Developing the alliance: feedback, progress and priorities

We undertook an engagement exercise with alliance partners to understand requirements for the future RRA model, while also benchmarking what is working well and where we need to improve. This built on similar engagement carried out at the end of 2024 and reflects our commitment to continuous improvement.

The feedback provides a clear picture: the alliance is valued as a unique and positive space for cross-sector collaboration, with strong foundations already in place. At the same time, partners highlighted opportunities to strengthen how the alliance operates and delivers impact.

What we are doing well

A trusted, collaborative community

The RRA has successfully created an open and collaborative community of leading organisations across the sector. Partners consistently described the alliance as a valuable space where organisations are willing to share knowledge, align around common challenges, and work towards collective solutions.

> ***"The Alliance has been effective in bringing together a group of like-minded organisations that share a clear understanding that innovation is key to addressing existing challenges."***
>
> *Dr. Stefano Cavazzi, Ordnance Survey*

A recognised and credible platform

External communications, showcases and representation at events such as Highways UK have helped establish the alliance as a brand. Partners value National Highways' convening role and the credibility this brings.

The alliance is increasingly seen as a trusted platform for:

- Connecting organisations that would not normally collaborate
- Sharing insight across industry, academia and the supply chain
- Building alignment around long-term innovation priorities

> ***"The RRA has provided a noteworthy platform of shared vision and collaboration, which has brought organisations together in the pursuit of continuously improving the highways sector and the outcomes it delivers."***
>
> *Will Waller, Arcadis*

Enabling collaboration through an open IP model

The alliance's open intellectual property approach is widely valued. Partners appreciate the opportunity to share know-how and the potential to access Intellectual Property (IP) generated through research.

Where we need to focus next

Partner feedback also highlighted several areas where we must improve to strengthen the alliance to increase impact and long-term value.

Moving from network to true alliance

While the culture is positive, some partners perceive the alliance as operating through a hub-and-spoke model rather than as a fully collaborative partnership. Strengthening shared ownership, co-creation and partner leadership will help realise the full intent of the alliance.

Broadening representation

There is a clear opportunity to widen participation to strengthen the research base and sector relevance, particularly through:

- Greater academic involvement
- Increased Small to Medium Enterprise (SME) participation
- Stronger engagement with local authorities and devolved administrations
- Closer links with funding bodies

Improving operational relevance and adoption

Some research is perceived as too conceptual, with unclear pathways to deployment. Opportunities include:

- Clearer routes from research to implementation
- Greater use of secondments
- Earlier involvement of operational stakeholders

Strengthening clarity, continuity and visibility

Partners also identified the need to:

- Reduce confusion with other research programmes
- Improve communications and external visibility
- Evolve research project objectives
- Improve handover of knowledge
- Increase transparency around available IP

The Future Roads debate at the Cambridge Union

Moving to a new model

The future sector context and the need for change

England's road network is entering a period of significant change.

From 2025, traffic is projected to grow between 8% and 54% by 2060*, placing growing pressure on a network where building significant new capacity is unlikely. Accordingly, any strategy needs to take these constraints into account whilst seeking to improve productivity, safety and value from existing roads.

We are entering a new digital era that brings significant opportunities for innovation and research that challenges many of the assumptions about how roads are designed and operated. Digital connectivity, AI and connected and autonomous vehicles are reshaping traditional approaches. On top of this, the transport system is evolving in fragmented ways, with infrastructure, vehicle technology and operations developing separately. Policy and regulatory uncertainty, alongside rapidly changing user behaviour driven by real-time information and navigation tools, adds further complexity.

A more flexible impact-based model

In response, the Roads Research Alliance (RRA) is not winding down, but deliberately evolving. The RRA will continue as a longterm, sectorcritical collaboration, repositioned to maximise impact, relevance and adoption. The RRA is moving to a new operational model that is outcomedriven and adoption focused, with National Highways (NH) and industry jointly defining challenges rooted in realworld needs.

Research will be needed not just for academic excellence, but by its ability to translate into standards, specifications, pilots and business-as-usual deployment, with clear metrics around productivity, carbon reduction, safety and cost savings. Research should be supported to build through technology readiness levels to impact with clear pathways for research to impact.

National Highways will act as the clear convenor and challenge leader, providing visible senior leadership and alignment with sector priorities. The alliance will broaden its academic and research base, moving to a multi-university, multi-institution model which may include shorter, applied projects hosted by the most appropriate partners.

Local authorities, devolved administrations, catapults and specialist organisations will be engaged closer and a supply chain community from Tier 1 to small to medium enterprises will be built. Agile and flexible governance will support project-based clusters and foundations for pathways to commercialisation will be established. Clearer communication, stronger knowledge sharing and improved IP visibility will underpin adoption.

We are now in a development phase for this future model, actively engaging with partners to shape the alliance's direction and ensure the UK's road network remains productive, safe and fit for the future.

* National Road Traffic Projections 2022

Rethinking network productivity in a digital age

Andrew Page-Dove, Director of Operational Control, National Highways

As a road operator, National Highways continues to see year-on-year growth in demand. In its latest forecasts, the Department for Transport (DfT) National Road Traffic Projections 2022* suggest that road traffic in England and Wales will grow by between 8% and 54% from 2025 to 2060.

Providing increased physical capacity to our road network is simply not possible. So, if we want to avoid a future where all our roads are gridlocked, we need to explore ways of getting more from what we already have – increased productivity.

I've worked in the highway sector for more than 35 years and whilst there have been advancements in construction and materials, the fundamentals of traffic flow are still steeped in research from nearly a century ago. In a rapidly changing world, where the increased presence of digital and AI are changing the way we think, act and behave, are these still true and relevant today?

I agreed to join the RRA, because I believe we need to dramatically rethink how we operate our road networks to increase their productivity. Our roads provide a service for the movement of people and goods. So, rather than simply focus on the engineering that supports the product (our roads), we need to focus more on the operation of the service if we are going to avoid recurrent widespread congestion.

With the acceleration of the digital world, connected and autonomous vehicles are no longer a vision of the future, they are a reality of today. When you look at the progress being made in the construction and maintenance sectors, versus that of the vehicle manufacturers, they appear to be evolving in separate worlds. But until we are all in flying cars, we need to reunite the thinking between vehicle manufacturers and highway designers and operators so that our highway infrastructure becomes the enabler that helps realise the full potential of future vehicle fleets.

If we cannot rapidly build physical capacity on our road network, what can we do to increase the productivity of our existing road network? Does historic research into traffic flow dynamics still hold true today or is the increased move to connected and autonomous vehicles changing how we look at the age-old parameters of speed, flow and headway? Do we have the right legislative framework to realise the full potential of connected and autonomous vehicles and to enable the strategic network to fully realise its purposes of connecting centres of population.

Is driver behaviour changing? If so, how do we need to change our approach to the design and operation of our roads? Today, drivers have access to a wealth of data and information, but is this helping or hindering road safety and the need for increased productivity?

There are definitely more questions than answers, and that's why I believe research undertaken with the mindset to challenge the status quo will make a fundamental difference for future generations.

* National Road Traffic Projections 2022

6. Communications

Connecting research to reality: the essential role of communications in the RRA

Sharon Creary, Strategic Communications Lead, National Highways

Effective communication is essential to maximising the impact of the Roads Research Alliance (RRA). With a partnership that spans National Highways, academia and 22 industry organisations, communications play a critical role in translating complex research into accessible insight, strengthening engagement across the sector and ensuring knowledge is shared widely and consistently.

Clear, compelling communication also helps demonstrate the value of the alliance's work, connects research outputs to real-world challenges, and supports adoption by those best placed to drive change. It also enhances the alliance's visibility, reinforces its credibility as a sector-leading collaboration, and enables partners, practitioners and decision makers to understand how emerging research can improve resilience, productivity, sustainability and safety across the road network. Through purposeful, well-coordinated dissemination, effective communications ensure that the alliance's innovations do not remain within project boundaries, but become catalysts for sector-wide learning, alignment and impact.

The RRA discuss the lessons, achievements and future of the alliance at Highways UK 2025

Discover button *Dr Jinying Xu, talks about her secondment with National Highways, to refine a standardised carbon data collection methodology*.

Discover button Innovation in action*. In partnership with AtkinsRéalis, Laing O'Rourke, Connect Plus Services, Balfour Beatty and Expanded, we've installed cutting-edge sensor technology on the M25 Junction 10 and A3 Wisley Interchange West overbridge to monitor its condition and performance in real-time.*

RRA showcase

The RRA hosted a showcase event on 29th April 2025 at the National Highways Development Centre (NHDC) in Moreton-in-Marsh to highlight emerging research, widen engagement, and demonstrate how research and innovation can deliver practical benefits for the road network.

The event showcased early outputs from the Future Roads Fellowship Programme, with research fellows presenting progress. These presentations were complemented by guest speakers, exhibitions and live demonstrations that illustrated how research can transition into applied solutions.

Senior National Highways leaders joined discussions and presented their visions for innovation and research – Mike Wilson, Head of Safety Engineering and Standards, and Richard Pedley, Head of Digital Services from the NHDC. Andy Cooke, from Costain and the University of Warwick, talked about his research on "Escaping the Valley of Death – A Perspective from Industry", based on his experience at Airbus.

A key feature was a mini-exhibition of organisations that have used the NHDC to test and develop technologies at higher Technology Research Levels (TRL), including Levistor (flywheel energy storage), Roadside Technologies (hazardous object detection software), HRS (incursion warning systems), and Leica Geo (LiDAR and ground-penetrating radar). This demonstrated the NHDC's capability to support innovation from early research through to testing and trials.

The showcase significantly widened engagement with the RRA, attracting 17 industry partners, representatives from 6 universities (in addition to the University of Cambridge), and key sector bodies including the Department for Transport, Local Council Roads Innovation Group (LCRIG), and the Department for Business, Energy and Industrial Strategy. For the 10 research fellows, the event provided valuable networking opportunities and routes to industry support, including access to digital data.

The venue choice reinforced National Highways' strategic pathway for research and innovation, bringing together lower-TRL research and higher-TRL demonstrations to illustrate the scaling and sustaining journey supported by National Highways, the RRA and the NHDC.

Fellow presenting their research at the RRA showcase

Publications

Discover button RRA 2024 annual report

Discover button The Future Roads programme at the University of Cambridge

Discover button Research publications

7. APPENDIX

Appendix 1:
Future Roads Research Programme Overview

Since its inception, the programme has supported 26 research fellows across 3 cohorts, engaging 22 industry partners alongside National Highways and the Department for Transport. The programme has addressed 23 industry challenges, selected from a total of 84 identified challenges. Industry secondments are now actively contributing to impact, with placements completed and ongoing across cohorts, and additional secondments planned for 2026.

Theme 1: sustainability

Research topic	Fellow	Cohort	Industry challenge addressed
Assessing road infrastructure resilience against extreme weather events and fostering climate change adaptation	Dr. Zizhen Xu	3	What strategies could be used to achieve biodiversity (or more broadly ecosystem services) net-gain in managing a national highway network?
Measuring and enhancing the resilience of urban transport infrastructure networks to climate change	Dr. Jie Liu	3	What strategies could be used to achieve biodiversity (or more broadly ecosystem services) net gain in managing a national highway network?

Theme 2: smart materials

Research topic	Fellow	Cohort	Industry challenge addressed
Zero-waste geopolymer pavement Discover button, Link TBA – Find out more as Abbas talks about and demonstrates his research	Dr. Abbas Solouki	2	Carbon zero roads: decarbonisation of road materials And Zero waste roads: capitalising on existing pavements and eliminating the mining of natural resources
An innovative zonation-based machine-learning methodology for studying the interactive impacts of traffic, microclimate and natural hazards on pavement deterioration	Dr. Ze Zhou Wang	2	Maximising road life: smart materials and sensors to extend the life of existing assets

Theme 3: automation and robotics

Research topic	Fellow	Cohort	Industry challenge addressed
Control and implications of mixed autonomous vehicle-infrastructure in a heterogeneous multi-agent system framework	Dr. Kai-Fung Chu	2	Control of multi-agent systems for traffic management
Robotics for safe human–machine interaction	Dr. Chapa Hewa Sirithunge Pelendage	2	Safety feedback for autonomous and semi-autonomous heavy machinery usage
AI-assisted unconventional road surface monitoring	Dr. Xiang Wang	3	Road surface monitoring with non-conventional sensors

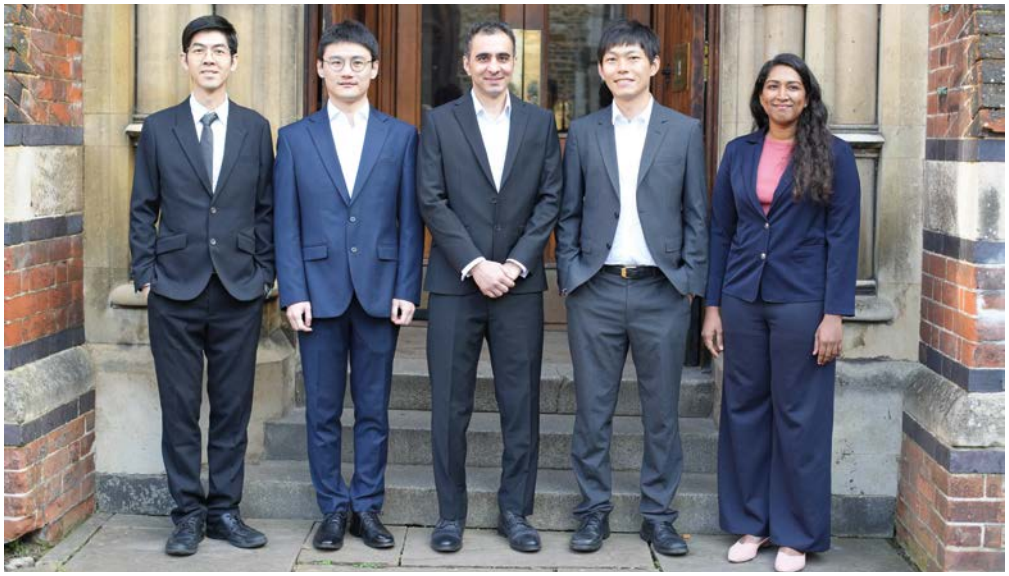
Theme 4: data science

Research topic	Fellow	Cohort	Industry challenge addressed
Digital twin-driven structural health monitoring of roads by using physics-based model and machine learning	Dr. Zhaojie Sun	3	Synthetic data generation for improving automated classification of highway assets and defects

Theme 5: digital twins

Research topic	Fellow	Cohort	Industry challenge addressed
Large language model-driven multi-agent framework for enhancing human–digital twin interaction in built infrastructure management	Dr. Linjun Lu	2	How can we build a trustworthy digital twin?
Exploring the minimum viable products of a digital twin for roads inspection and maintenance	Dr. Mengtian Yin	2	What are the minimum data requirements for a valuable digital twin?
A graph-based approach for road digital twinning	Dr. Junxiang Zhu	3	How can we design a road digital twin?
An uncertainty aware road geometric digital twin using multi-modal data	Dr. Shirin Malihi	3	How can we construct and maintain a road digital twin?

Discover button more on the current Future Roads fellows and their work



The cohort 2 Future Roads researchers (LtoR); Dr. Kai Fung Chu, Dr. Linjun Lu, Dr. Abbas Solouki, Dr. Mengtian Yin, Dr. Chapa Hewa Pelendage

The cohort 3 Future Roads researchers (LtoR); Dr. Xiang Wang, Dr. Junxiang Zhu, Dr. Shirin Malihi, Dr. Zizhen Xu, Dr. Zhaojie Su

Secondments

Research Fellow: Dr Jinying Xu, FR Cohort 1
Host: Saroj Bhatoa, National Highways
25 November 2024 – 31 May 2025

Research Fellow: Dr Mengtian Yin, FR Cohort 2
Host: Kieran Mulvey, Trimble
10 November – 20 December 2025

Research Fellow: Dr Jie Liu, FR Cohort 3
Host: Prof Matt Peck, AtkinsRéalis
January – February 2025

Research Fellow: Zizhen Xu, FR Cohort 3
Host: Prof Matt Peck, AtkinsRéalis
January – February 2025

Future Roads programme alumni

Recruited by the University of Cambridge, several Future Roads research fellows have since progressed to new roles, with many continuing their work in the roads sector across industry and academia. This alumni cohort demonstrates the developing academic network which paves the way for future development of the RRA.

Fellow	Research topic	New position beyond the Future Roads programme
Dr. Jinying Xu	Data science and digital technologies for intelligent carbon management in the whole life of highway assets	Assistant Professor at National University of Singapore – integrating digital technologies and AI for sustainable built environment
Dr. Arsen Abdulali	Human–robot cooperation for maintenance and construction of future roads	Lecturer, School of Engineering and Materials Science, Queen Mary University of London
Dr. Khashayar Kazemzadeh	Enhancing equity, diversity, and inclusion in active mobility: a study on underrepresented groups' perspectives in road infrastructure planning in Cambridge	Lecturer in Transport Planning, the University of Manchester
Dr. Fengqiao Zhang	An integrated road asset monitoring system supported by probabilistic models and artificial intelligence	Assistant Professor in Concrete Structures at Delft University of Technology
Dr. Yue Xie	Highway intelligent traffic control system based on vehicle-road coordination and multi-agent technology	Lecturer (Assistant Professor), Department of Computer Science, Loughborough University
Dr. Yuandong Pan	Construct and maintain a highway digital twin from multi-modal data	Postdoctoral researcher, Stanford University
Dr. Varun Kumar Reja	Establishing asset information requirements for road digital twins	Assistant Professor in the Department of Civil Engineering at the Indian Institute of Technology Bombay (IIT Bombay), specialising in digital construction and smart infrastructure management

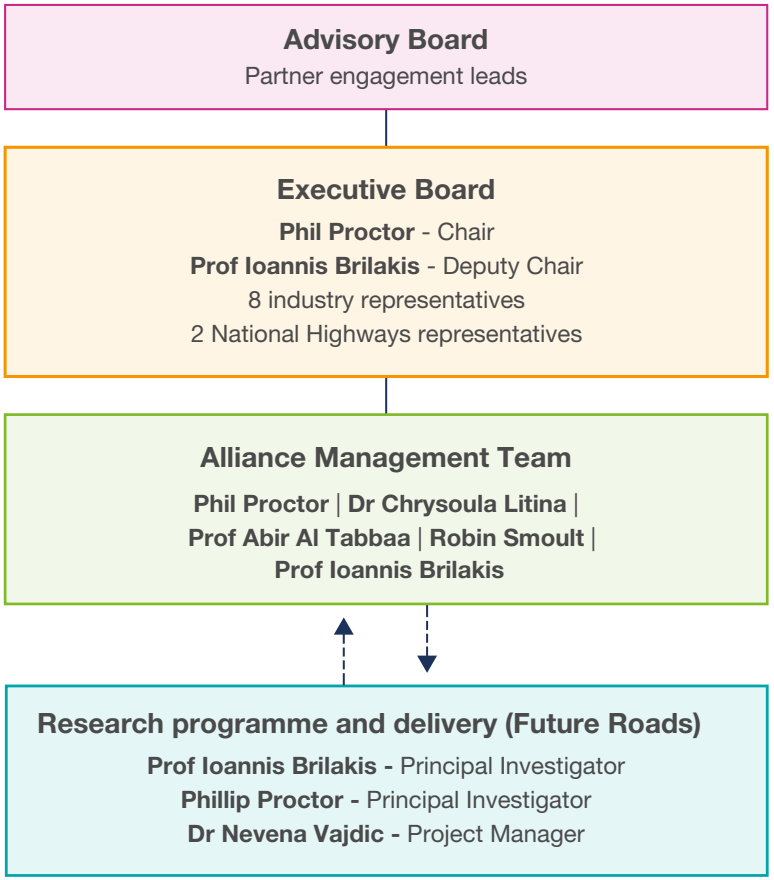
Fellow	Research topic	New position beyond the Future Roads programme
Dr. Judith Fauth	Advanced planning and building permits through road digital twins	Researcher, digital building permitting, Technical University of Munich
Dr. Vahid Afroughsabet	Low-carbon, self-healing concrete pavements	Concrete and Materials Advisor at National Highways, UK
Dr. Daniel Grossegger	Material flow analysis of roads: a review	Department of Engineering Sciences, Empa, Swiss Federal Laboratories for Materials Science and Technology, Switzerland
Dr. Anand Sreeram	Maximising recycled materials for sustainable pavement construction	Assistant Professor in Transportation Engineering at the University of Nottingham and the NTEC – Nottingham Transportation Engineering Centre, UK
Dr. Yiming Zhang	Digital twin-driven probabilistic machine learning for predictive maintenance of pavements	Young Chair Professor, School of Civil Engineering, Southeast University, Nanjing, China
Dr. Quentin Adam Felix	Thermal performance optimisation of ribbons-based electrically heated pavements	Postdoctoral Research Associate at Institute of Highway Engineering Aachen (ISAC), Germany
Dr. Munkhbaatar Buuveibaatar	Digital twins for road infrastructure networks	Postdoctoral Research Fellow, Kyungpook National University, South Korea

Appendix 2: Governance

Leadership and Board

This research alliance brings together senior leaders from industry, National Highways and the University of Cambridge, whose collective experience and perspectives shape and guide the alliances direction.

Governance structure:



The Executive Board

Name	Role and organisation	Board Role
Phil Proctor	Head of Research, National Highways	Chair
Prof. Ioannis Brilakis	Laing O'Rourke Professor of Civil and Information Engineering, University of Cambridge	Deputy Chair
Paul Campion	CEO, TRL	Research landscape
Greg Weingarten	Head of Intelligent Infrastructure, Jacobs	Alliance membership
Mohammed Dakri	National Highways Market Director, Amey	National Highways and other client stakeholder engagement
Prof. Matt Peck	Director of Innovation – Transportation AtkinsRéalis	Digital twins champion, alliance development into future model

Name	Role and organisation	Board Role
John Armitage	Technical Director, Ramboll	Technical leadership and industry engagement
Edward Wells	Infrastructure Head of Digital Construction, Galliford Try	Progress, risks and opportunities
Dr. Oliver Thomas	Innovation Manager, Colas	Developing international insights and impact
Will Waller	Senior Director, Arcadis	Maximising commercial opportunities from the research
Andrew Page-Dove	Director of Operational Control, National Highways	Safety, Operations and Network Control
Jason Glasson	Head of Asset Management Development, National Highways	Data-Driven Asset Management and Infrastructure

Executive Board Invited Members

Name	Role and organisation	Board Role
Robin Smoult	Roads Research Alliance Manager, National Highways	Secretary
Dr. Chrysoula Litina	Principal Research Engineer, National Highways	Management Contract Sponsor
Sharon Creary	Strategic Communications Lead, National Highways	Communications

Advisory Board

Organisation	Name	Role
AECOM	Dr. Ramesh Perera	Technical Director
AECOM	Joanne Edwards	Technical Director
Amey	Emily See	Highways Market Director
Amey	Mohammed Dakri	Head of Technology, Lighting and Energy Solutions | SPaTS3 Framework Market Director
Arcadis	Paviter Singh Phull	Technical Director – Design and Construction Health, Safety and Environment
Arcadis	Will Waller	Senior Director – National Highways Account Leader
AtkinsRéalis	Professor Matthew Peck	Director of Innovation – Transportation
Balfour Beatty	Michael Schenk	Head of Demand, Operations and Innovation Planning
BAM Nuttall	David Robson	Innovation Manager
Bentley Solutions	Joe Rice-Jones	Strategic Account Director
COLAS	Mark Saunders	Client Director
COLAS	Dr. Oliver Thomas	Innovation Manager
Costain	Rob Cairns	Strategic Innovation Lead
Ferrovial Construction	Grant Mobbs	Strategy and Preconstruction Director
Galliford Try	Philip Farrar	Innovation Lead
Galliford Try	Edward Wells	Head of Digital Construction
Jacobs	Greg Weingarten	Head of Intelligent Infrastructure
Aureos	Tim Barber	Operations Director
Aureos	Simon Hayton	Head of Engineering and Performance
Kier	Jordan Flint	Director Kier Highways Design Solutions
National Highways	Dr. Chrysoula Litina	Principal Research Engineer
National Highways	Phil Proctor	Head of Research
Ordnance Survey	Dr. Stefano Cavazzi	Principal Innovation and Research Scientist

Organisation	Name	Role
Ramboll	John Armitage	Technical Director
SAP	Francesco de Toma	Transportation Industry Advisor
Telent	Martin Herbert	Head of Contract Services
Telent	Andy Gifford	Director of Highways
Telent	David Taylor	Head of Strategic Planning
Trimble	Marianna Kopsida	Market Development Manager
TRL	Paul Campion	Chief Executive Officer
TRL	Dr. David Hynd	Chief Scientist
University of Cambridge	Prof. Ioannis Brilakis	Laing O'Rourke Professor of Civil and Information Engineering
University of Cambridge	Prof. Abir Al-Tabbaa	Professor of Civil and Environmental Engineering
Versarien	Dr. Daniele Annicchiarico	Senior Application Scientist
Versarien	Dr. Stephen Hodge	Chief Executive Officer
Vinci Construction	Yogesh Patel	Quality, Improvement & Innovation Director

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Roads Research Alliance – National Highways

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