UNIVERSITY OF CAMBRIDGE

CALL FOR APPLICATIONS

Deadline 28th February 2022

FUTUREROADS-COFUND Marie Skłodowska-Curie Fellowships 2021-2022

The University of Cambridge is pleased to announce that up to 10 Fellowships are available for the first cohort of the FUTUREROADS-COFUND programme. The Future Roads Fellowships Programme (FUTUREROADS) is hosted by the University of Cambridge. The scheme is funded by the European Union's Horizon 2020 Research and Innovation Programme under the Marie Skłodowska-Curie actions (grant agreement no 101034337) and cofunded by partners Costain Group Plc and National Highways.

The programme offers 27 x 36-month fellowships over 3 recruitment rounds focused primarily in digital twins, smart materials, data science, automation and robotics, and sustainability solutions for the road infrastructure industry. The programme allows applicants to have the freedom to develop their own ideas with access to excellent facilities. FUTUREROADS will enhance fellows' understanding of the methodologies and approaches of other scientific disciplines at the highest level.

The aim is also to establish a multidisciplinary training platform to strengthen researchers' capabilities such that they are capable to work anywhere in Europe and, therefore, attract researchers from around the globe to Europe and contribute to the European goals of increasing the numbers of researchers with innovation skills in Europe.

The programme supports incoming fellowships for postdoctoral researchers on a competitive basis. It aims at high-potential individuals primarily interested in following a career in the transportation infrastructure sector or academia. Awardees will be offered an employment contract with a standard postdoctoral salary and will be entitled to an individual mobility and research budget.

Why apply

The University of Cambridge (UOC) is a collegiate research university in Cambridge, United Kingdom. It was founded in 1209 and is the world's fourth-oldest surviving university. Cambridge is formed from a variety of institutions which include 31 semi-autonomous constituent colleges and over 150 academic departments, faculties and other institutions organised into six schools. UOC provides Future Roads Fellows with a thriving research environment, strong connections to industry and a strong international network. UOC is consistently ranked in the top 10 universities in the world.

The Future Roads programme is for researchers who are looking for an opportunity to pursue research as part of an innovative programme that has international and industry connections. The Future Roads Fellows will be involved in a unique cohort-oriented programme that is part of a wider initiative at the University of Cambridge researching the future of road infrastructure.

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Fellows will have access to support via local and international academic supervisors and industry partners. They will have access to career and skills development opportunities as part of the activities directly associated with the Future Roads programme and more widely at the University of Cambridge.

The Fellowship offer

FUTUREROADS offers 36-month fellowships linked to the programme’s thematic areas; digital twins, data science, smart materials, automation and robotics, and sustainability, all in the context of the road network. Fellows are offered career development support and training events to develop their non-scientific skills. They are expected to take part in teaching activities at Cambridge and are encouraged to apply for additional competitive funding. The programme is open for all applicants who meet the MSCA mobility rules for fellows.

All Future Roads Fellows will have their primary base at the Department of Engineering, University of Cambridge. However, they may have supervisors in other disciplines. Fellows also have the opportunity to pursue secondments.

Who can apply

The fellowship is designed to support post-doctoral researchers with up to 2 years of postdoctoral research experience (after completion of the PhD) at the time of applying. Applicants with 3-4 years of postdoctoral research experience will be considered in exceptional cases.

Applicants must comply with the following MSCA mobility rule:

Mobility rule: The researcher must not have resided or carried out his/her main activity (work, studies, etc.) in the host organisation's country for more than twelve months in the three years immediately prior to the call deadline. Make sure you check all specific requirements in the guide for applicants.

How to apply

Applications must be submitted online via the University of Cambridge’s job application system at https://www.jobs.cam.ac.uk/.

Applicants can search for the Future Roads Fellowship advertisement (job reference: NM29268) and apply online. The Future Roads website https://drf.eng.cam.ac.uk has a Guide for Applicants – this guide provides essential information about how to correctly supply the required supporting documents for the fellowship posts. Please note that applications that do not meet the criteria regarding mandatory documents will not be considered.

When to apply

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The deadline for cohort 1 applications: 23:59pm GMT 28th February 2022

Application timeline for cohort 1:

- Opening of call: 1st Dec 2021
- Deadline for applications: 23:59pm GMT 28th February 2022
- Evaluation period: 11 weeks
- Applicants will receive answers: mid/late May 2022
- Fellowship period begins: September 2022

For more information about the process, guidelines or application system, please get in touch with the Future Roads Programme Managers at future-roads@eng.cam.ac.uk.

Core challenges to be explored by applicants:

1. DIGITAL TWINS	
1. What is an Expressway Digital Twin and how it should be structured? Understanding & digitally representing Expressway Digital Twins (DT) includes deriving (a) local and national stakeholders' user and information requirements; and generating appropriate information models, libraries, and cloud architectures consistent with CDBB's Information Management Framework (i) at micro, meso and macro scales (material-level; asset-level; network-level) and resolutions (mm-level; cm-level; m-level); (ii) for geometry, condition, and other property groups; and (iii) for product and process information. The purpose is to enable (i) productisation; (ii) interoperability with the National DT programme; (iii) information security; (iv) futureproofing; and (v) static and dynamic information curation possibly through distributed ledger concepts. This includes understanding and measuring information value at all scales to allow for optimal data preparation decisions.	Professor Ioannis Brilakis
2. How can Expressway Digital Twins be generated and kept up to date? Creating Expressway Digital Twins (DT) includes proposing and validating methods for design-stage DT generation automation, or construction/operation-stage DT (a) collection and cross-registration of spatial, visual, thermal, or other data from existing assets; (b) data preparation; (c) segmentation to object-level information clusters and formation of DT objects; and (c) object relationships detection and formation of the DT. The above applies (i) at micro, meso and macro scales (material-level; asset-level; network-level) and resolutions (mm-level; cm-level; m-level); (ii) for geometry, condition, and other property groups; (iii) for initial generation and follow up updating of the DT; and (iv) for product and process information.	Professor Ioannis Brilakis
3. How should Expressway Digital Twins interact with others?	Professor Ioannis Brilakis

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Creating effective interfaces between Expressway Digital Twins (DT) and machines (IoT, smart materials, automation systems, AI systems, etc.) or humans is a pre-requisite for any effective DT. It includes the derivation of protocols for (i) expressways IoT-DT-enterprise cloud communication, and (ii) DT to data visualisation environments communication. The purpose is to enable (i) secure data exchanges via distributed ledger concepts; (ii) multidimensional visualisation and Extended Reality (XR) environments usability; (iii) low latency; and (iv) futureproofing.	
4. What is an Expressway? Creating exemplar use cases of Expressways as a product and process, and augmented with Smart Materials, Digital Twins, Data Science and/or Automation and Robotics, is a necessary step to wider technology adoption. This includes (i) preparing ground truth datasets and/or materials, (ii) publishing datasets and associated data management plans; (iii) integrating outcomes with sponsor-provided systems; (iv) demonstrating and measuring the value of each use case with stakeholder feedback.	Professor Ioannis Brilakis
5. How can information be integrated across multiple Expressway modalities? The transportation infrastructure sector operates significantly less vertically integrated supply chains and contractual arrangements that disincentivise information and knowledge sharing. This has led to a massive information interoperability problem. Most of the information curated in isolated forms that are not easily accessible. This is exacerbated by the extreme mismatch of the very long lifecycles of Expressways versus the very short lifecycles of technologies. The challenge is to develop fundamental expressway data integration machine learning methods and understand how to fuse legacy or other data into the Digital Twin.	Professor Ioannis Brilakis
6. How can Information, Knowledge and Insight Uncertainty be Quantified? Most information, knowledge and insight used to make decisions in the transportation infrastructure sector contains a significant degree of uncertainty which is often hidden from decision makers. Quantifying this uncertainty and making it visible in the presentation of all associated information is a significant challenge for the sector. This includes uncertainty of design performance, ground conditions, planning and scheduling, material and labour prices and availability, product and process predictions, all risk-induced uncertainty at all scales, and others.	Professor Ioannis Brilakis
7. How can Information Autonomously Drive Automation and Robotics Processes? The vision of "Digital Twin Controlled Expressways" passes through addressing the challenge of coupling a Data-Driven Digital Twin (DT) to Robotic Processes. This includes learning expressways maintenance and repair processes linked to the DT product and the robotic sensing and smart materials	Professor Ioannis Brilakis

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outputs and being able to use the learned processes to generate viable new processes when a new DT is presented.	
8. How can Knowledge and Insights be generated from Information in an Expressway Digital Twin? This challenge encapsulates the broader area of converting low level information in a Digital Twin (DT) to knowledge patterns extracted via interpolation and insight projections extracted via extrapolation. This includes developing a machine learning framework of methods for process knowledge and insight discovery from the DT.	Professor Ioannis Brilakis
2. AUTOMATION & ROBOTICS	
1. Innovative robotic road maintenance device development There exist many automation challenges in road maintenance, such as tunnel cleaning, grass cutting, litter picking, traffic controlling. This project area covers the challenges associated with robotic physical enablers, by investigating robotics technologies including manipulation, material/soil processing, and various locomotion (climbing, flying, mobile and walking). This investigation includes preliminary lab testing of technological components, prototyping of experimental platforms, and on-site user testing.	Professor Fumiya Iida
2. Modelling and simulation of robotic road monitoring and maintenance Road monitoring and maintenance make use of a large variety of machinery for automated operations, such as road monitoring vehicles, crack/pothole repair rigs. This project area investigates the modelling of these machinery for process optimisation with respect to time, cost, and manpower requirements. This investigation includes development of robotic manipulation models of smart functional materials, under various conditions (e.g. cracks, symptoms, potholes in expressways); Development of simulated robots interacting with and manipulation of these materials; Investigation of robot control architectures to physically maintain and repair faulty surfaces in simulation.	Professor Fumiya Iida
3. Robotic sensing and perception for road monitoring and sustainability This project area investigates the use of robotics technologies for sensing, monitoring, and perception of road and surrounding environmental conditions. Holistic, synchronised, and high-granularity of sensory data play crucial roles to systematic improvement of cost, efficiency, and environmental load, for which robotics engineers can develop tangible sensor-motor coordinated devices. The outcome of this device development will be used for data processing, digital twin integration, and resource analysis for sustainability improvement. This investigation includes: sensory devices for higher TRL experiments; prototyping of sensor systems for the testing in various conditions including in the COS testing facilities; establishment of benchmarking processes.	Professor Fumiya Iida

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4. Smart materials for robotic road sensing, monitoring, and maintenance Sensing, monitoring, and maintenance processes of roads can be significantly simplified by deploying functionalized asphalt, concrete, and other materials. This project area investigates the use of functional materials for road construction, monitoring, and maintenance, together with associated necessary sensor technologies. This investigation includes: Development of basic sensing principles of new smart materials for expressway monitoring and fault detection; Development of lab experimental platform for in-vitro sensor testing and data generation; Modelling of sensing processes and develop simulator for reproducing a feasible expressway and its faulty conditions; Investigation of algorithms for optimal sensing.	Professor Fumiya Iida
5. Tele-presence and tele-operation of road construction, monitoring, and maintenance Reduction of human labourers in construction/maintenance sites is one of the most important challenges in order to improve health/safety as well as environmental impact. Robotic technologies for tele-presence and tele-operation are investigated in this project area. The investigation includes communication strategies of remote robotic hardware; control theories and technologies for human-in-the-loop system with significant latency; development of novel human interfaces for tele-presence, tele-operation robots.	Professor Fumiya Iida
3. SUSTAINABILITY Potential applicants may contact the sustainability theme lead, Dr Kristen MacAskill (kam71@cam.ac.uk), for any queries regarding these sustainability challenges.	
1. How to effectively achieve net zero-carbon road operation and/or construction? Asphalt, steel, on-site plant, material transport, cement and concrete are currently the main sources of emissions in maintenance and construction of roads. New net zero strategies are shaping planning and operation decisions made by infrastructure asset owners (and their supply chain) towards supporting a lower carbon future. While these plans already specify staged targets, developing transparent and consistently applied protocols for collecting and analysing data to measure progress do not always exist. There are limitations in how the data is collected across projects and how information can be communicated to wider stakeholders in the supply chain. Possible Future Roads projects could seek to (A) improve and standardise protocols for carbon assessment or (B) improve data and information availability to increase the robustness of claims to net-zero carbon. A Future Roads project might, for example, start with a focus on a particular issue such as improving understanding of material waste throughout construction. We encourage applicants to consider the wider supply chain or lifecycle impacts beyond the construction site in their proposals.	Dr. Kristen MacAskill

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2. What is the optimal road service provision for society? Roads have historically been built to support the economy to provide improved capacity to facilitate the movement of goods and services across a country. However, negative environmental and social impact considerations (e.g. congestion, inequality) are fuelling radical new policies, for example in 2021 the Welsh government put a temporary freeze on all new road-building projects as part of its climate change policies. In accepting that there is a limit to building new roads as an effective basis for developing and sustaining a prosperous economy – when do we stop? A Future Roads project could explore this problem through adoption of urban system modelling techniques to analyse infrastructure provision at a national and regional level, testing various combinations of needs and levels of service, and how a focus on different indicators could lead to alternative network priorities. It may require collecting data from international cases studies for comparative purposes. A related consideration lies in what services a road provides. A Future Roads project might be oriented on the analysis of and development of new technologies and services that could fundamentally change the allocation of road space and wider augmentation of the physical asset to provide other services.	Dr. Kristen MacAskill
3. How can roads be a net contributor to ecosystem services? Environmental assessment of roads is a process that is traditionally focused on minimising or off-setting negative environmental impact. However, with advances in technology and changes in use of road space, there is an opportunity to think radically about the services that could be incorporated into the road corridor. A Future Roads project in this area would be aimed at reconciling the current gap in cost-benefit analysis processes for road infrastructure development to better capture wider system considerations. This project may involve (A) developing new quantification and analysis techniques and/or (B) improvement of the availability of data to monitor and understand impact. An alternative, related, angle lies in determining to what extent a road network can be managed following circular economy principles. Any proposed assessment framework needs to bear in mind scalability, where there is less scope in smaller schemes to meet broad criteria that might be applied to large, complex road building programmes. It also needs to consider safety considerations alongside the protection of neighbouring habitats.	Dr. Kristen MacAskill
4. How should decision making criteria be revised to reflect better whole life balance of natural, economic and societal outcomes? Business case assessments are evolving in recognition of the need to incorporate wider social and environmental considerations into the assessment. But there are not yet well-established, robust techniques for developing business cases that value sustainability over the whole life. A related question here is how do we track data in the long term? In the UK, the London 2012 Olympic development project continues to be presented as a leading example of legacy planning, but change across planning for the built environment has been slow. There continues to be a need to “price” societal benefits and non-financial goals for these considerations to be materially incorporated into	Dr. Kristen MacAskill

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decision-making. We encourage projects that will help to advance the ability to assess societal value, well-being and/or long-term environmental impact of roadbuilding.	
5. Cross-cutting idea: How can data science and analytics contribute to sustainability-orientated decision making? Data and information may already exist that has the potential to provide the basis for better decision making by wider stakeholders, but there is no viable mechanism by which the data can be readily accessed in a suitable format. Future Roads projects in this area may address how existing data sources could be better harnessed, or new data sources established to help more effective asset management decisions. An alternative, related angle is to explore how the development of digital twin models, and integration of sustainability data into these models, will help to reduce uncertainty in assessment of environmental impact. We expect that projects are likely to incorporate governance, organisational and legal considerations.	Dr. Kristen MacAskill
4. DATA SCIENCE	
1. How do we optimally automate using the Digital Twin? The prevailing paradigm for data-driven automation is Reinforcement Learning (RL). RL has the potential to learn optimal maintenance schedules; continuously refine these schedules in light of new data; incorporate expert demonstration; optimise the deployment of robotic sensing. However, there are many challenges towards an effective RL implementation for FRs, e.g. RL is known to be data, computation and memory intensive; RL architectures (e.g. neural network based) are difficult to tune and can be slow to converge; it is challenging to optimally incorporate uncertainty in the sensed data. These are some of the practical challenges inherent in exploiting the Digital Twin and its data rich environment for optimal automation and decision making via a single integrated framework.	Professor Sumeetpal S. Singh
2. How can uncertainty quantification be done effectively at scale? Statistical reasoning about physical engineering systems is essential in this FR endeavour however, even simple uncertainty quantification problems can be very computationally costly. Cloud computing (e.g. Amazon EC2) is an immense resource for Data Science and is potentially an ideally suitable platform for the Machine learning/Bayesian inference algorithms that will be employed to quantify the uncertainty of insights drawn from the noisy and disparate sources of data within the Digital Twin. The pertinent questions are thus how can these algorithms be run effectively at scale, say on the cloud, avoid idling computing resources and deliver timely results via real-time computing budgets? How can these algorithms be designed to be elastic, i.e. seamlessly utilise new computing resources as they come available and be robust to unexpected drop-outs of existing computing resources?	Professor Sumeetpal S. Singh

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These are some of the challenges inherent to practical uncertainty quantification in the FRs initiative: effective algorithms for high-dimensional statistical inference problems with large volumes of disparate data types.	
3. How do we assimilate traffic congestion data with pavement condition data for pavement maintenance and longevity? Roads are usually designed for 40 years while traffic data predictions are usually for 20 years. The aim is to move from this static approach towards a more dynamic approach that assimilates traffic data - along with laboratory generated data, modelling data, sensor data and pavement and environmental data - to inform the design and maintenance of roads. This data-driven approach might include data mining from multiple sources, location mapping, and the use of statistics and machine learning techniques to train the predictive models that will inform the design and maintenance schedules. Optimal design considerations and maintenance schedules are also to be found.	Professor Sumeetpal S. Singh
5. SMART MATERIALS	
1. Digitally-enabled Roads: Enabling proactive asset management How can smart materials digitally-enable proactive asset interventions and maintenance strategies? Can we design pavement materials that can look after their own state of health and access and provide live reporting and communication of this to enable timely and proactive asset management? How can pavement materials play a much more proactive role here? What are suitable and realistic mechanisms for digitising pavements and pavement materials? How can sensors, and other digital tools, and the integrated use of sensors in pavements and road assets, be used to predict when maintenance is needed? Could those sensors act as pavement materials heath monitoring indicators? Could the use of sensors enable proactive management of pavement drainage and run-off? Could we design or deploy low cost multifunctional sensors e.g. for combined asset management, traffic flow analysis and temperature measurements? Could pavement sensor technology be designed for the future network e.g. compatible with electrification of the network? Could we make sense of the significant body of data already available on pavement conditions and capitalise on its value when digitising pavements? What is the role of nanotechnology in digitising pavements? How can we digitise pavement materials for compatibility with the Digital Twin of the asset?	Professor Abir Al-Tabbaa
2. Carbon Zero Roads: Decarbonisation of road materials The UK Net Zero Highways document has set a target of net zero for maintenance and construction by 2040. Current road construction and maintenance projects are far from being carbon neutral and pavement materials are a major contributor to carbon emissions. Half of infrastructure carbon is associated with the maintenance of repair of assets. Can suitable low carbon or ultra low carbon pavement materials be designed, validated and rolled out to contribute to carbon reductions in both construction and maintenance? Where within the different pavement materials and components	Professor Abir Al-Tabbaa

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can we make the quickest and largest impact and how? Can we rethink the design and performance of our pavement materials and structures to reduce material need and use and design more efficiently with less material consumption? Can we, and by how much, capitalise on the generation and implementation of recycled materials, waste-based materials and locally sourced materials? What and where are the most relevant and compatible national waste streams and where can we simultaneously help solve certain pressing waste and pollution problems? This challenge could also address the reuse and recycling of wastes on site. What are the opportunities for carbon capture and storage/sequestration within the pavement materials and the wider road infrastructure and network materials and assets. Where are the low hanging fruit in the decarbonisation of road materials and is it in addressing capital carbon or operational carbon? Can we continue to reduce the carbon footprint of pavements throughout their service life? How do we quantify those benefits in whole life carbon calculations and life cycle analyses? Can we develop sufficiently accurate carbon analysis tools? Can lessons be learnt from existing or past projects? What is the best way to balance cost, carbon and longevity	
3. Zero and positive impact roads: Zero waste and environmentally responsible pavements While road schemes can have a significant impact on their surrounding environment and ecosystem, they also have a significant potential to positively impact on the environment and can be delivered in an environmentally responsible fashion. How can materials enable low environmental impact schemes? How can materials enable added environmental value to a road scheme? This challenge can address how the different generated wastes and waste streams on a road construction project can be processed, reused or recycled within the same project to enable zero export, and result in a significantly reduced import, of raw materials on site? How can we innovate in the reuse of existing materials and material components and elements on site? What reprocesses are there for particularly challenging construction, demolition and excavation wastes to enable their reuse on site? What changes to specifications and QA procedures and what incentives are needed to drive such innovation and reuse. For example, asphalt is 100% recyclable, but usually only ~50% is recycled. As road schemes are site and locality specific, this challenge can be addressed at project level and draw lessons from previous road projects. Designing for decommissioning is another relevant element. This challenge could also be expanded to take a systemic view of materials to deliver environmentally responsible and zero waste roads. How can we incorporate added functionalities to deliver a positive environmental impact. This could include depolluting road materials to enhance air quality, designing road surface materials to minimise noise or minimise water run-off or designing materials for smooth pavement surfacing to minimise petrol usage.	Professor Abir Al-Tabbaa
4. Data-driven Roads: Enabling connectivity and autonomy We know that data plays a fundamental role in enhancing our understanding of material and structural behaviour providing knowledge, insights and predictions that were not possible before. At the same time, the design requirements are	Professor Abir Al-Tabbaa

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changing to support the long-term vision of full digitisation, connectivity and autonomy as well as delivery of net zero. How can data that is currently available or which can be generated on-demand be used to deliver the data-driven smart pavements of the future? There are many data-driven approaches that can be capitalised on and utilised in the design and manipulation of new materials and components. Exploring the applicability of different data-driven approaches and solutions is one area. The generation of data banks for new materials could enable smart pavement materials to act as the IoT and facilitate dynamic communication with a 'live' digital twin or to automation processes. How can we facilitate the integration and seamless interaction between different data sources (evidence-based laboratory generated data, modelling data, sensor data and pavement and environmental data) be used to deliver data-driven solutions. How can be capture data, sufficient data, from pavement materials to enable us to fully understand, communicate and connect the road asset to the road system around it? How could materials support digitally enabled workers/road users and operations such as readable roads for automated vehicles, dynamic data acquisition and sharing. How can pavement materials be designed to be autonomous and connected using data-driven approaches? Data-drive approaches include data mining from multiple sources, database management and mapping, the use of applied statistics and machine learning techniques to design predictive models, the extraction, interrogation and integration of data from sensor devices and other digital tools, life cycle inventory databases and environmental impact assessments, including carbon footprint calculations. How can data integration and data-driven solutions deliver the smart pavement of the future that is digitised, decarbonised and environmentally responsible?	
5. Automated Roads: Robotics-enabled pavement materials The National Highways Digital Strategy aims to deliver significant automation to the road network within the next five years. Currently, automation in pavement practices is extremely limited. There is hence a huge potential for automation in the design, construction, inspection, maintenance and replacement of pavements. This challenge could consider the potential for the use of pre-casting, prefabrication and 3D printing in the design and delivery of pavement components. Is it feasible to design and construct a fully automated pavement? Can we design and deliver automated pavement maintenance? What is the potential for zero carbon and zero waste in automated pavement materials? What is the potential for automated pavement to contribute to traffic control, pavement condition, weather and pollution monitoring and vehicle to pavement communication. The role of sensors within an automated pavement is an important area and facilitation of pavement health monitoring at high speed is a particularly relevant aspect. Other potential relevant areas include: how can we enable 'first time right' installations? What is the potential for automation in hostile pavement environments/conditions, robotics-based sprayed self-reporting materials, automated quality assurance, removal of manual inspection, minimising variability/maximise repeatability/maximise productivity and net zero carbon pavement materials.	Professor Abir Al-Tabbaa
6. Future-proof roads: Materials for durable and climate resilient pavements	Professor Abir Al-Tabbaa

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Roads are usually damaged well within their design life – is it a design issue or a construction issue? This challenge area covers understanding material performance and ensuring resilience against future climate- and loading-related actions. How can we design roads with materials that enhance their life span, longevity and durability? Can we design future pavement materials that are adaptive to their evolving performance requirements? How should design specifications be updated for resilience? In a changing climate what will be the most relevant failure criteria to design for? Can we design roads without the need for de-icing? How can we ensure drainage effects on pavement structure are controlled and mitigated? In a changing fleet and increased demand, what are the failure mechanisms for pavements? What assets will be more prone to failure under future traffic composition? We need to understand the modes of failure and the failure mechanisms in different types of assets to help us arrive at the mitigation measures and inform maintenance approach.	
7. **New Materials Roads: Designing with the end in mind, using the right material in the right place** How can we ensure we are still using the right pavement materials, in the right place, in the right way, for the right duration and to their full capacity? Looking towards the future of road design, it is important to predict, identify and map needs for alternative materials or novel materials and trends outside the sector. How are pavement materials supporting the network of the future? Could for example conductive pavements be used for power generation and charging or support for example digitally enabled workers/road users and operations? What are the selection criteria for materials that balance cost, longevity/performance and low carbon? What are the unintended consequences of new materials and hence what are the challenges associated with enablers for uptake of these materials. How will these new materials be incorporated in design and delivery considering aspects of specifications? This requires building confidence in material performance but also thinking outside the current toolbox. What is the role of non-conventional methods, accelerated testing but also customer experience input in standards? Are there commercial or policy incentives that should be provided for use of new materials?	Professor Abir Al-Tabbaa

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