List of ICE Knowledge Networks

Knowledge Networks are set out below and categorised by the appropriate strategic theme.

Decarbonisation

Circular economy

The circular economy is a systemic approach to economic development designed to benefit businesses, society, and the environment. In contrast to the 'take-make-waste' linear model, a circular economy is regenerative by design and aims to gradually decouple growth from the consumption of finite resources. This Knowledge Network specialises in adopting a circular economy approach to the design and management of infrastructure systems and assets, ensuring that, where possible, materials can be sourced and re-used in a sustainable way.

Carbon measurement

The Infrastructure Carbon Review (2013) showed that infrastructure was associated with more than half of UK greenhouse gas (GHG) emissions. But if we do not measure, we will not know if our interventions are delivering the desired change or if we are focusing efforts in the most important areas. This knowledge network specialises in the measuring, sharing and benchmarking of carbon impacts – covering all stages of the infrastructure lifecycle – and how it is integral to facilitating carbon management as a routine aspect of infrastructure design. It will also integrate the learnings gained through the ICE Carbon Champions programme, as relevant, to support new methods of measurement to quantify carbon emissions (and emissions reduction) in practice.

Materials: Concrete

The typical UK consumption of cement per year is equivalent to the emissions of 7.2 million cars. As the infrastructure industry works towards a zero-carbon future, this Knowledge Network should look at how we can continue to use concrete, given the environmental impact of cement, its active component. Possible projects for this group will be to oversee a formation of a Low Carbon Concrete Task Force, and to look at how to achieve the Low Carbon Concrete Routemap which will be published in April 2022.

Procurement & Contracts

This Knowledge Network specializes in procurement processes and how they can include the assessment of net zero carbon targets. They will also focus on how carbon assessment is included in contracts and will engage with work already underway by the Decarbonisation CAB, the NEC4 Contract Board, the Procurement Advisory Group (PAG) and the PAS 2080 update technical author team.

Low Carbon Energy

Hydrogen

Hydrogen is a clean fuel that, when consumed in a fuel cell, produces only water, and can be produced from a variety of domestic resources, such as natural gas, nuclear power, biomass, and renewable power like solar and wind. This Knowledge Network specialises in the infrastructure required to produce, capture, store and distribute hydrogen as a viable clean alternative to fossil fuels.

Storage

Decarbonisation is changing the way we generate, distribute and use electricity, and energy storage will play an increasingly important role in supply and distribution. This Knowledge Network specialises in the storage of energy, and provides insights, knowledge and shares good practice for the development of energy storage infrastructure.

Nuclear

Nuclear power is the use of nuclear reactions to produce electricity. Nuclear power can be obtained from nuclear fission, nuclear decay and nuclear fusion reactions. Presently, the vast majority of electricity from nuclear power is produced by nuclear fission of uranium and plutonium in nuclear power plants. This Knowledge Network specialises in the whole life cycle of its infrastructure from design to decommissioning.

Floating offshore wind

Wind power is stronger in the ocean than on land, hence the development of offshore wind in recent years. Floating offshore wind, based on floating structures rather than fixed structures, offers new opportunities and alternatives. This Knowledge Network specialises in the development of floating offshore wind infrastructure, providing insight, knowledge and sharing good practice.

Tidal

Tidal power or tidal energy is harnessed by converting energy from tides into useful forms of power. This knowledge network specialises in the engineering of tidal energy infrastructure, covering Tidal stream (generating power from the energy of flow), and tidal range (utilising the difference in head between the sea and a basin).

Sustainable, Resilient and Inclusive Infrastructure

Retrofit of existing buildings

This knowledge network focuses upon the idea of 'no-build' climate solutions and consists of specialists in retrofitting and repurposing buildings, landscape, and infrastructure to be both more resilient (in terms of resilience to climate change/extreme weather - i.e., adaptation) and lower carbon (i.e., mitigation). This should incorporate a social aspect - e.g., experts researching how changing layouts of public buildings/spaces impacts upon user behaviour in terms of both social value/safety and carbon use and how they can be used as social infrastructure to support communities in disaster event situations. The network will examine the barriers to retrofitting existing buildings and assets in order to be more resilient and identify where improvements or innovations need to be made.

Integrated natural and built environment

This knowledge network will cover topics such as reforestation, tidal marshes, peatland, silvopastures, regenerative agriculture and others which all have the potential to mitigate carbon through absorption and sequestration, as well as improving resilience by providing co-benefits such as heat sinks, shade and coastal defence.

Climate resilience and adaptation for infrastructure

This knowledge network will focus upon risk management of, and recovery from, extreme weather events. This will involve topics such as: adaptation to improve the climate resilience of new infrastructure, 'building back better' from extreme weather events, climate equity/just transition and stakeholder engagement on resilience projects (particularly with regard to less developed areas more susceptible to the effects of climate change). The network will include specialists in climate-resilient infrastructure, and examine what is required to future-proof, retrofit and adapt infrastructure.

Flooding

Nature-based Solutions to flooding

Conventional grey infrastructure solutions have typically not met all of the challenges associated with flooding and are often highly carbon intensive. The European Environment Agency advised to 'think about green before investing in grey' (Tech. Rep. 12/2015). This network will support and promote this philosophy through: (i) treating flooding from a holistic perspective by encouraging consideration of the whole system (i.e., from catchment to coast), (ii) selecting and promoting resilient design solutions and strategies, (iii) sustaining the natural system and its services as much as possible, and (iv) promoting multi-functional designs and engaging with all key stakeholders in delivering Net-Zero solutions.

Flooding & Placemaking

This knowledge network is designed for specialists working at the interface between flooding and landscape architecture, landscape engineering, urban planning, blue-green infrastructure/SUDS and those working to optimise the multi-functional benefits of green space. It will provide expert flood risk management input from practitioners with a placemaking perspective and highlight the role those involved with placemaking have in flood risk management and the role those involved with managing flood risk have in creating great places.

Funding & financing for flood mitigation infrastructure

At a time of accelerating need for new flood resilience infrastructure, this Knowledge Network will consolidate and highlight successfully delivered and innovative international examples on how these projects are being funded and financed. The aim is to enable these models to be shared with practitioners more widely, enabling them to explore and test their application, plus connect those with experience and expertise globally. The Knowledge Network will also serve as a key point of contact for media and member enquiries on this growing challenge.

Digital advances in flooding

As Climate Change increases the risk of flooding from sea level rise, increasing rainfall intensity and convective thunderstorms, flood analysis tools need to be refined to include more extreme events using more accurate numerical algorithms and integrated informatics tools to model the full water pathway system. New data acquisition and analysis techniques also need to be integrated into improved flood modelling, impact assessment and resilience design procedures, including data from: drones, autonomous robots, mobile phone reception (e.g., rainfall intensity) and remote sensing, and complemented with improved data management standards and uncertainty. This Knowledge Network exists to share insights, knowledge and good practice for how technology can be applied to prepare, plan and mitigate for the impacts of flooding.

Climate change & flooding

This Knowledge Network specialises in all aspects of the challenge of climate change brings to the Flooding Sector. This will cover Adaptive Planning and increasing the resilience in our cities as well as the contribution this sector can make towards delivering Net Zero infrastructure. The network will be able to adapt their advice on the changing understanding of future climate projections and changes in our management approaches to respond to the updated understanding.

Water & Sanitation

Wastewater/Sewerage catchments

Sewerage infrastructure is as essential as our clean water supply, transporting vast quantities of wastewater for treatment and re-use. This knowledge network specialises in the installation, management, seepage prevention, renewal of piped wastewater networks, and management of storm overflows of existing networks.

Wastewater treatment

Wastewater treatment is a process used to remove contaminants from wastewater and convert it into an effluent that can be returned to the water cycle. This knowledge networks specialises in development of low carbon infrastructure to support this process.

Clean water distribution infrastructure

Water distribution infrastructure includes interconnected collection of sources, pipes and hydraulic control elements (e.g., pumps, valves, regulators, tanks) delivering to consumers prescribed water quantities at desired pressures and water qualities. This knowledge network specialises in the design, installation management, maintenance and renewal of our water infrastructure to effectively transport potable water supply from the source to the end user.

Clean water treatment

Clean water treatment involves the removal of contaminants and/or inactivation of any potentially harmful microbes from raw water to produce water that is pure enough for human consumption without any short term or long-term risk of any

adverse health effect. This knowledge network specialises in development of low-carbon infrastructure to support this process.

Data & Digital

Digital twins

A 'digital twin' of a physical asset helps us to understand how assets operate in a wider system and how they interact with other assets. The benefits include harmonisation of operations to deliver optimal user outcomes, clash identification and automated remediation, and ultimately cost/risk reductions. This Knowledge Network specialises in the development of the technology, information, processes, Building Information Modelling, and people which facilitate the digital mapping and management of infrastructure.

Exploiting big data

Our ability to design, manage, and monitor infrastructure better will rely upon our use of technology to analyse and interpret large data sets to reveal patterns, trends and associations. This Knowledge Network specialises in the collection and analysis of infrastructure data to improve processes and make better decisions which deliver better outcomes.

5G/Connectivity

5G is widely seen as a tipping-point technology that will enable real-time and highly reliable data transmission which in turn will unlock the next generation of connectivity benefits. This knowledge network will consider all data communication networks, identify areas of best practice and how these can unlock benefits for the wider delivery and operation of civil infrastructure. It will then look at the potential impact of 5G and future generation networks to realise Industry 4.0 benefits and how the industry can adopt this. This knowledge network will operate in collaboration with all other networks, recognising the relevance of connectivity across multiple sectors.

Through-life information management and the 'Golden Thread'

Effective infrastructure asset management requires the effective management of documents and data. The golden thread is both the information about a building that allows someone to understand how to keep it safe; and the information management to ensure the information is accurate, easily understandable, can be accessed by those who need it and is up to date.

It will be the duty of the people responsible for a building to put in place and maintain a golden thread of information, meaning that those people responsible will have easily accessible, reliable, up to date and accurate information. This Knowledge Network specialises in the implementation of the golden thread and share insights and best practice for how information management supports building safety, and how this can be embedded across the sector.

Structural health monitoring

Structural health monitoring involves the observation and analysis of a system over time using periodically sampled response measurements to monitor changes to the material and geometric properties of engineering structures such as bridges and buildings. This Knowledge Network specialises in developing insights, information, technology, and processes which support improved structural monitoring.

Geospatial Engineering (Joint ICE/CICES network)

Engineers of all disciplines require geospatial data that is sufficiently accurate, contemporary and accessible. Geospatial data makes projects faster, better, and more cost effective. Whether you deal in utility networks, transportation, energy production or telecoms, your project has a location (vertical and plan coordinates), allowing you to discover, explore, analyse and interact with its context of multiple, delicate interdependencies on built and natural environmental elements both inside and external to the project elements themselves. Furthermore, dimensional control methods and procedures are of utmost criticality in the successful delivery and maintenance of physical infrastructure to realise the relative and absolute accuracies required. This Knowledge Network is a collaboration between ICE and the Chartered Institution of Civil Engineering Surveyors, specialising in how engineers can interact with geospatial data and effectively implement it in workflows.

Engineering Fundamentals

People & Communities (Community Engagement)
Community Engagement during the planning, construction and operation is an area of increasing priority, requiring a stronger evidence base to develop and share best practice. This Knowledge Network supports a community of engineers, stakeholder engagement specialists, researchers and infrastructure professionals who are committed to sharing knowledge, overcoming systemic challenges and improving how we can best engage with the public throughout the infrastructure asset lifecycle.

Implementing a Systems Approach to Project Delivery (SAID)
The sector is struggling to deal with projects that require complex systems to be planned, delivered and, most importantly, integrated to provide the mobility, energy, sanitation and other infrastructure services on which people depend. To address this. ICE created a Systems Approach to Infrastructure Delivery (SAID) - a model that can be used to help deliver better outcomes for infrastructure owners and users. This Knowledge Network acts as an ICE community of industry leaders who are implementing the SAID principles and can share progress on its development.

Implementing NIC Design Principles
The ICE/NIC report 'What Makes Good Design?' set forth a series of principles for designers to implement: climate, people, place, and design. This Knowledge Network specialises in the implementation of those principles and identifies best practice examples of good design for infrastructure.

Construction (Design & Management)
To improve health and safety in the industry projects must sensibly plan and implement the work so that health and safety risks, throughout the lifecycle of the project, are managed from start to finish. The Construction (Design and Management) Regulations aim to help projects do this, however integrated safety management in design, construction, maintenance and operation can also require (for example) strong multi-disciplinary engineering integration, application of soft management skills, and application of systems thinking. This Knowledge Network specialises in the identification and promotion of good practice to manage health & safety risks in construction, maintenance and operation at the design stages of a project. Whilst this Knowledge Network has a particular focus on the Construction (Design and Management) Regulations, it also specialises in the broader topic of integrated safety risk management.

Safety, Health & Wellbeing
There have been significant safety and risk assessment improvements in modern times, including a reduction in fatalities and injury to construction workers. However, there remains a number of serious ill-health issues which continue to affect construction workers, and the public. This Knowledge Network specialises in the development and promotion of a body of safety, health and wellbeing resources that supports members to enhance their competence and capability to deliver ethically aligned civil engineering projects.

Productivity

Collaborative outcomes-led project delivery
People need to lead the way in promoting and optimising multi-party collaboration on infrastructure projects to achieve the best outcomes for all stakeholders. This Knowledge Network specialises in sharing insights and examples of where this is being achieved both on infrastructure projects and in other industries, with a focus on topics which bring about transformational change including: leadership, systems-thinking, decision-making, project team collaboration & communication including high performance team approaches.

Procuring for success
Achieving the outcomes of infrastructure projects is totally dependent on setting them up for success and procuring projects in a way that people can deliver. This Knowledge Network will encompass procuring and contracting to deliver outcomes, promote efficiency and high productivity, provide the collaborative environment essential for high performing

teamwork, and the sustainable commercial frameworks that allow all parts of the project team to be successful. This Knowledge Network will be connected with both Project 13 and the Engineering and Construction Contract.

Consenting for major projects

The development consent order (DCO) process for nationally significant infrastructure projects (NSIPs) in England has four main stages: pre-application; submission and examination; decision-making; and implementation. This Knowledge Network specialises in developing the people, processes, information, tools and technology to enable a more collaborative, transparent approach to consenting on major infrastructure projects that protects the environment and communities but enables efficient delivery of infrastructure.

Efficiency in Design and Design for Manufacture and Assembly (DfMA)

An engineers approach to design is crucial to increased efficiency. Making best use of the resources and tools available, improved design procurement and organisation, smarter use of materials, the adoption of modern methods of construction will all ultimately lead to better outcomes for our infrastructure assets. This Knowledge Network specialises in how engineers can optimise efficiency in infrastructure design.

DfMA is a design approach that focuses on ease of manufacture and efficiency of assembly. By simplifying the design of a product, it is possible to manufacture and assemble it more efficiently, in the minimum time and at a lower cost. This Knowledge Network specialises in identifying where and how DfMA is being successfully applied and identify solutions which may challenge wider use for infrastructure.

Operational efficiency and continuous improvement

Operational efficiency enables efficient workflows that save time and money, allowing reductions in wasted time and effort. Within this way of working, continuous improvement is a technique that helps to streamline workflows. This Knowledge Network specialises in sharing insights which demonstrate how the construction industry is effectively applying the approach to construction and shares lessons learnt in doing so.

Robotics and automated systems in construction

Robotics and automated systems have been identified as having the potential to address inefficiencies and improve productivity in construction, while eliminating health and safety risks. However, there is not currently significant adoption in the construction industry. This Knowledge Network specialises in identifying where automation and robotics have or can be implemented effectively and considers solutions to challenges that may be inhibit adoption.

Structures & Geotechnical

Fire safety of structures

Structural fire protection refers to fire protection methods incorporated into a structure's design and construction (whether building, tunnel or other engineering structure). It helps to ensure that the structural integrity is maintained and protected for as long as necessary to assure life safety or operational requirements, should a fire materialise. This Knowledge Network specialises in the protecting building and civil engineering structures from fire, sharing insights, expertise and good practice. is maintained and protected for as long as possible should a fire materialise. This Knowledge Network specialises in the protecting buildings and civil engineering structures from fire, sharing insights, expertise and good practice.

Civil engineering structures

Civil engineering structures are those structures required to support civil infrastructure, whether bridges, embankments, water retaining structures, tunnels, pumping stations, flood barriers or slope stabilisation and foundation solutions. Civil engineering structures are often exposed to intense or unusual environmental and operational loadings and come in all shapes and sizes, from drainage sump structures through to multi-kilometre long bridges. They may be historic structures, modified existing structures or new-build structures. They are required to safely and efficiently support the provision of civil infrastructure to meet society's needs, in a sustainable and responsible manner. This Knowledge Network specialises in the planning, design, construction, management and maintenance of civil engineering structures and contributes to the development of good practice, insights, and the development of structural codes and standards with industry partners.

Building structures design

The structure of a building – whether framed or non-framed – concerns those parts that are fundamental to its strength, stability and rigidity and which transfer the various loadings down to the foundations. Building structures are usually designed and constructed as part of a multi-disciplinary team and are required to integrate and co-ordinate closely with, for example, architecture and building services. They may be historic, modified existing or new buildings. This Knowledge Network specialises in building structures design (as distinguished from civil engineering structures), and the process of creating a safe, efficient structure in which loads are conveyed safely and efficiently to the foundations and which can withstand prevailing natural forces, in a multi-disciplinary context.

Materials and emerging technologies

The skills, materials, technology, and innovation associated with civil engineering & building structures is continually evolving. Driven by the need to source more sustainable products, which retain resilience and safety, civil and structural engineers must keep pace with emerging technologies and materials. This knowledge network specialises in the exchange of knowledge, insights and innovations for structural materials and technologies.

Coastal & Maritime

Coastal & Maritime engineers identify, plan and deliver innovative engineering solutions for challenges such as coastal erosion, flooding and sea level rise, as well as designing infrastructure such as ports and harbors which all require skilled civil engineering input. This Knowledge Network supports ICE in its development of projects focusing on key areas in the sector including coastal engineering and management, dredging, flood risk management, offshore engineering, ports, harbors, and docks.

Transport & Mobility

Walking & Cycling

Getting more people cycling and walking plays a critical role in reducing emissions, decreasing congestion on roads and improving air quality and health for all.

We need better cycling and walking infrastructure networks and a more holistic approach that embeds active travel across other areas, such as net zero and planning policies. This Knowledge Network specialises in the construction, design and management of infrastructure which facilitates human-scale transportation including walking, cycling, scooters, e-scooters, and emerging active and personal transportation.

Inclusive urban planning & development

More than half the world's population lives in cities, and this proportion will reach 70% by 2050. Engineers have a critical role to play in creating a safe and inclusive urban built environment. This Knowledge Network specialises in development of the urban environment, including municipal engineering, masterplanning, regeneration, inclusive cities, Stakeholder engagement, and consultation.

Highways infrastructure asset management

The UK's Strategic Road Network is the backbone of the road network in England, supporting almost 40 million vehicles annually. Entire sectors and communities depend on it for continued prosperity, meaning that upgrading and maintaining the network is essential. Similarly, our local road networks are equally as important to effectively move people and goods. Although the vast majority of travel happens using the nation's road network, recent years have seen a steady decline in maintenance and increase in the number of roads in urgent need of attention. This Knowledge Network specialises in the management, maintenance and development of our local and strategic road networks.

Aviation

Our air transport hubs exist as vital infrastructure to maintain and open our economies to tourism and global markets. This Knowledge Network specialises in the development of airports infrastructure, with a strong emphasis on how we achieve this sustainably and zero carbon.

Passenger transport (moving people)

This Knowledge Network specialises in the design and planning of infrastructure required to move people in and between towns and cities. This includes innovations in engineering and technology, increased user demands for connected services, Automation of transportation; issues of inadequate or aging infrastructures, pollution, congestion; and tackle the challenge of aging or obsolete vehicle fleets, and systems that lack interoperability with emerging technologies.