BOF
Bridge Owners Forum

Grand Challenges 2020

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1. Preventing bridge failures
2. Extending the life of existing structures
3. Building bridges that will perform better
4. Embracing innovation and embedding technology
5. Securing a competent and diverse workforce

The Bridge Owners Forum was established 20 years ago to promote mutual understanding between all bridge owners in the UK and Ireland and to act as a focal point for bridge related research.

From an early stage, we recognised that there were considerable challenges facing bridge engineers and produced our first Grand Challenges document in 2006. Although that work was very useful at the time, BOF decided that a refresh was needed. It is interesting to note that whilst most challenges are unchanged there are many that are new: high profile collapses, resilience from the effects of climate change and the need to decarbonise to name but a few.

The other difference is that the new Grand Challenges are not only for bridge owners but are also outward facing, to engage with the public and with governments to ensure that our aging bridge infrastructure receives the investment it deserves and that newly built bridges perform as required for the whole of their design lives and beyond.

Cam Middleton
CHAIR OF BRIDGE OWNER'S FORUM, LAING O'ROURKE PROFESSOR OF CONSTRUCTION ENGINEERING, UNIVERSITY OF CAMBRIDGE

As part of the UK Roads Liaison Group, the UK Bridges Board is the body charged with establishing the strategy for the safe management of the UK's bridges. That task presents many challenges in the contexts of increased highway and rail traffic volumes, an aging bridge stock and competing budget pressures.

UKBB has been working closely with BOF in the development of the Grand Challenges concept and it is one that the Board is happy not only to endorse but also to promulgate within other high-level organisations, including the UKRLG itself.

The Grand Challenges are intended to be used to influence bridge stakeholders, to present an accurate picture of the current pressures we face and to lobby for increased funding so that we can all be confident that the travelling public are not exposed to unnecessary risk.

Liz Kirkham
CHAIR OF UK BRIDGES BOARD

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1. Preventing Bridge Failures

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Polcevera Viaduct, Genoa collapsed on 14th August 2018 making headlines around the world. 43 people lost their lives and the disruption is estimated to have cost the economy around €600 million. Since 2000 there have been 125 bridge collapses worldwide that have claimed at least one life, resulting in 982 fatalities and significant economic loss. Catastrophic bridge collapses occur too frequently even though, with hindsight and timely investment, most could have been predicted and prevented.

The human, financial and reputational costs of such incidents, which frequently make international news, are unacceptable by any reasonable measure. Can we be more successful in preventing them?

Responsible bridge owners have robust regimes in place to inspect and manage their bridges in line with prevailing good practice and yet catastrophes are seldom anticipated or, when they are, the risks are underestimated or ignored.

As bridge stocks continue to age, the likelihood and frequency of bridge collapse can only increase, along with the financial and reputational damage. It is therefore crucial that we find better ways of meeting the challenge.

KEY FACTS

Polcevera Viaduct, Genoa, collapsed 14 Aug 2018. 43 deaths. Cost of disruption €600m, cost of rebuilding €200m. After Polcevera, media reports stated the following:

- Italy: 300 more bridges could be unsound
- France: 840 bridges at risk of collapse
- Germany: Only 12.5% of bridges in good condition

Over 65,000 structurally deficient bridges in USA (National Bridge Inventory 2018). Equivalent UK data is not collected.

UK bridge collapses since 2015:

- Tadcaster Bridge, N Yorks (Dec 15)
- Bell Bridge, Cumbria (Jan 16)
- Pooley Bridge, Cumbria (Dec 15)
- Keswick Path Bridge, Cumbria (Jan 16)
- Eastham Bridge, Worcs (May 16)
- M20 Footbridge (Aug 16)
- Barrow-upon-Soar (Aug 16)
- Laxey Shore, Isle of Man (Dec 15)
- Skipton Bridge (Feb 18)
- Grinton Moor (Jul 19)

PRIORITY AREAS FOR DEVELOPMENT

- Cradle to grave Bridge Management
- International collaboration
- Sensor technology to understand structural behaviour, performance and condition
- Bridge and environmental monitoring and warning systems
- Inspection techniques and training
- New materials for repair and protection
- NDT and forensic engineering techniques
- Knowledge of previous bridge collapses, sharing of knowledge
- Assessment techniques, understanding of collapse mechanisms and redundancy
- Risk analysis and prioritisation
- Understanding and prevention of scour damage
- Data, statistics and analysis of UK bridge condition and performance

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2. Extending the Life of Existing Structures

Our transport infrastructure has been built and expanded over centuries, from the 18th century canal network to railways in the 19th and the highway network in the last century. Our changing world - climate change, technological change, and increasing transport needs – places demands on our structures that were never envisaged and which stretch their capacity to the limit.

Our existing infrastructure is the foundation for economic development of the country. The challenge is to maintain this aging infrastructure as fit for purpose in the 21st Century, adapting to the changing world.

It is essential that we understand the impact of climate change, of rising water levels, increased flooding and consequent scour and changing environmental conditions. Scour is the greatest cause of bridge collapse.

With pressure on funding, increasing maintenance requirements necessitate innovation in understanding deterioration, and in strengthening and repairing structures. Emerging technologies offer opportunities for better value and performance of maintenance.

To avoid a future of failing and non-performing structures we need to grasp the challenge of extending their useful life into the 21st century and beyond.

KEY FACTS

- The estimated value of Scotland's Trunk Road structures maintenance backlog in 2018 was 12.5% of the asset value.
- Closure of the Forth Crossing in December 2015 is estimated to have cost the economy over £1m per day.
- Where practical, economic and environmentally desirable the largest abnormal loads should be moved by inland and/or coastal waters to reduce the impact caused by moving these loads by road
- Network Rail own over 29,000 bridges of over 1000 different construction types. The majority are older than the design life of a modern bridge.

PRIORITY AREAS FOR DEVELOPMENT

- Intelligent bridges – sensor monitoring of condition, deterioration and maintenance needs
- Smart repair materials – self healing, long life
- Prioritised assessment and repair
- Improved data collection and analysis
- Predictive models of deterioration, risk and performance
- Adapting bridges for transport technology – autonomous vehicles, alternative fuels, embedded sensor technology
- Impact of climate change – flooding, scour
- Advanced analysis for structural assessment
- Understanding and learning from performance of existing materials

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3. Building Bridges That Will Perform Better

Copyright: Transport Scotland

Bridge infrastructure in the UK has been developed over centuries. Performance has varied – many canal structures built 300 years ago for horse and cart perform well under modern loading, whereas concrete structures built in the 1960s have been closed due to safety concerns stemming from degradation of materials.

In the great road building age of the 1960's and 70's designs were pushed to the limits of engineering without sufficient understanding of the processes of deterioration that could affect the service life. 21st century innovations in materials and technology must address this legacy as bridge managers deal with increasing risk with limited budgets.

The world is changing, and structures must be designed to perform under increasing demand. Climate change brings flood and scour risk. The digital age brings autonomous vehicles and the Internet of Things. Consumer demand increases freight and vehicle loading.

Landmark new bridges are celebrated as connections open up and journeys are made easier. Bridges of the future will need to be efficient structures, adaptable to change of use and resilient to environmental factors.

KEY FACTS

- Since 1949 motor vehicle traffic has increased more than ten-fold from 28.9 to 327.1 billion vehicle miles, largely driven by steady growth in car traffic
- Traffic of lorries with four or more axles was 44% higher in 2017 than in 1997
- Flood damage in Europe is predicted to increase four-fold by 2050, due to socio-economic development alongside climate change
- Analysis by Network Rail shows that structures currently experience a potentially high consequence failure every 5.2 weeks. A structure's failure impacts on customers every 1.2 weeks through the implementation of a temporary speed restriction

PRIORITY AREAS FOR DEVELOPMENT

- Climate change research and impact analysis
- Understanding bridge behaviour and deterioration through data analytics and sensor technology
- Improved standards for design and assessment
- Off-site manufacture
- New materials – self-healing, high strength, low maintenance
- Adaptable bridges that facilitate change of use
- Cradle to grave bridge management
- Guidance on new techniques and technologies
- Use of BIM in management of structures

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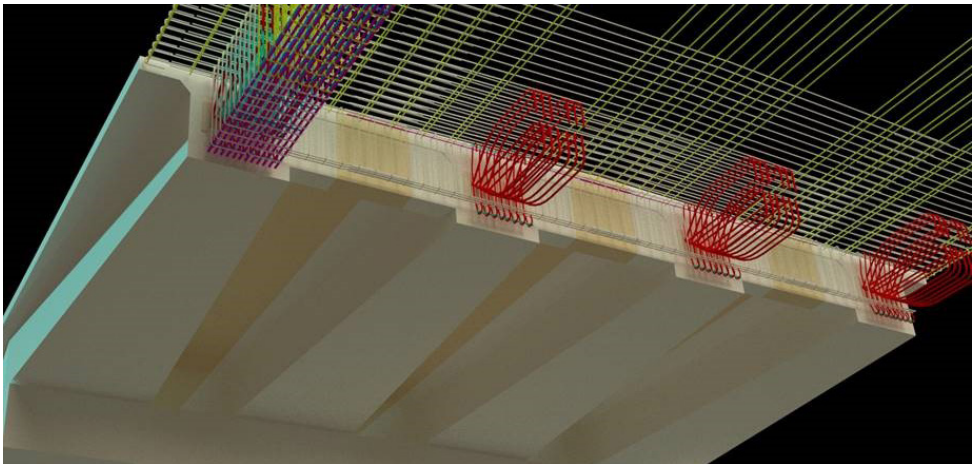
4. Embrace Innovation and Embed Technology



The construction industry lags other sectors in adoption of technology and innovation and the bridge industry is no exception to this. To meet future demands, it is essential that we make our bridges more reliable, affordable, sustainable and accessible for future generations. By embracing innovation and embedding technology we will be able to fully exploit opportunities to better manage our aging infrastructure and to build better and more resilient bridges fit for the future.

We live in a fast-changing world of new and competing technologies. Opportunities abound, but the challenge is to choose wisely those ideas which best build on existing resources and best support asset management. We must recognise the potential value of technology which may not be fully 'tried and tested' whilst maintaining safety and value.

The diverse nature of bridge owners makes a consistent approach difficult, but through planned innovation involving collaboration and partnership we can realise the benefits of smarter, more cost effective, asset management supported by better informed decision making.

Our existing infrastructure is the foundation for economic development. Innovation and technology are the essential enablers that will ensure we can manage and adapt our structures to face the demands of the 21st century and beyond.

KEY FACTS

- The profession must embrace digital technology, and Civil Engineers should develop these rapidly evolving skills. ICE Professional Skills Review, July 2019
- Queensferry Crossing incorporates around 200 digital sensors measuring temperature, movement, corrosion, etc (ICE Proceedings, Bridge Engineering, May 2019)
- According to a report by PwC detailing for the first time the possible financial benefits of BIM, the implementation of BIM Level 2 could save the government £400m a year
- We won't experience 100 years of progress in the 21st century – it will be more like 20,000 years of progress at today's rate, (Kurzweil 2001)
- The UK Government Industrial Strategy sets out four Grand Challenges: Artificial Intelligence and data, Ageing Society, Clean Growth and Future of Mobility (UK Government, Sept 2019)

PRIORITY AREAS FOR DEVELOPMENT

- Effective use of data in understanding and managing bridge performance
- Use of BIM in management of structures
- Application of new technologies to bridges – survey, sensors, new/smart materials,
- Technology transfer between industries
- Sensor technology and application of Internet of Things
- Demonstration projects
- Collaboration between industry and academia
- Common processes and standards that facilitate innovation and continuous improvement
- Specification of needs to allow partners to develop innovative solutions
- Guidance on new techniques and technologies

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5. Securing A Competent and Diverse Workforce

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The construction sector has experienced a skills shortage since the 2008 recession, struggling to attract young people into the industry whilst losing staff to retirement and not adequately addressing the challenges and benefits of gender and ethnic diversity. Exacerbating the shortage, the digital world requires enhanced skill-sets and the industry has been slow to take up the challenges.

Existing skills and knowledge must be retained and transferred whilst embracing new digital skills in data, automation and analysis. Focus will be around safety, delivery and customers, and values of ownership, integrity, teamwork and passion.

Across the industry, from designers to academics, from schools to professional institutions we must address career paths and succession planning, training, skills and knowledge transfer. We must encourage multiple entry routes to the industry – graduates, apprentices, and transfers from other disciplines.

A safe, efficient and sustainable transport network and bridge industry require a competent and diverse workforce. We must face the challenge as we embrace the innovations and technologies that are changing our industry.

KEY FACTS

- The construction industry employs nearly 3 million people – close to 10% of the UK workforce
- The profession must embrace digital technology, and Civil Engineers should develop these rapidly evolving skills. (ICE Professional Skills Review, July 2019)
- For the engineering sector to gain enough candidates to reduce the skills shortage, they would need around 186,000 skilled recruits each year until 2024 (Randstad January 2019)
- The UK Government Industrial Strategy sets out four Grand Challenges. Embedding AI across the UK will create thousands of good quality jobs and drive economic growth (UK Government, Sept 2019)

PRIORITY AREAS FOR DEVELOPMENT

- Bridge engineering in schools (sg STEM ambassadors)
- Encouraging diversity and recognising the benefits of a diverse workforce
- Publicity campaigns for bridge engineering
- Teaching bridge engineering including operation and maintenance at University
- Training for bridge related digital skills
- Supporting practitioners at work through specialised bridge engineering development packages
- Promoting career paths e.g. for bridge inspectors
- Specialised training and certification schemes
- Workshops to share knowledge between experienced practitioners and younger engineers
- Industry support to training establishments

Bridge Owner's Forum
Member Organisations

Highways England

Welsh Government

Department for Infrastructure: Roads (Northern Ireland)

Transport Scotland

Transport Infrastructure Ireland

Network Rail

CSS Wales – County Surveyors Society Wales

SCOTS – Society of Chief Officers of Transportation in Scotland

ADEPT – Association of Directors of Environment, Economy, Planning & Transport

Department for Transport

Canal and River Trust

HS2 – High Speed Two Ltd

Transport for London

London Underground Limited

Railway Paths Ltd

Rochester Bridge Trust

UK Big Bridges/Cable Supported Bridges Group

SSE plc

Forestry England

Environment Agency

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