Grand Challenges

Bridge Owner's Forum – 5 November 19

- From Wikipedia:

- *Grand Challenges are lists of important problems developed to energise and encourage the community (research, commercial organisations, professional bodies) to understand the issues and accelerate solutions. They are beyond ordinary research questions, may be global in scale, difficult but possible to solve, but involving numerous projects. They must capture the popular imagination to gain support.*

BOF
Bridge Owners' Forum

Grand Challenges

- Five grand challenges:

  What

  - Preventing bridge failures
  - Extending the life of existing structures
  - Building bridges that will perform better

  How

  - Embracing innovation and embedding technology
  - Securing a competent, diverse workforce

BOF
Bridge Owners' Forum

BRIDGE OWNERS FORUM GRAND CHALLENGES

BOF
Bridge Owners' Forum

❶ EXTENDING THE LIFE OF EXISTING ASSETS

Ponte Morandi Bridge, 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. Catastrophic bridge collapses occur too frequently even though, with hindsight, most could have been predicted and prevented.

The human, financial and reputational costs of these incidents, which frequently make international news, are unacceptable by any reasonable measure so why are we not 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 catastrophies 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

Ponte Morandi Bridge, Genoa, collapsed 14 Aug 2018. 43 deaths. Cost of disruption €600m, cost of rebuilding €200m.

Over 54,000 structurally deficient bridges in USA (National Bridge Inventory 2018)

3,177 sub-standard bridges across England, Scotland and Wales. RAC Foundation January 2019

UK bridge collapses since 2016:

- 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 (Aug 16)
- M20 Footbridge (Aug 16)
- Barrow-upon-Soar (Aug 16)
- Skipton Bridge (Feb 18)

PRIORITY AREAS FOR DEVELOPMENT

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

Capture the imagination

Intro
Not too technical

What is the challenge?

Why is it a Grand Challenge?

Consequences?

Relevant facts, understood by non-engineers

Opportunities – broad range of ideas from earlier work

BOF
Bridge Owners' Forum

The way forward – discussion

- Finalise the text and key facts
  - Combine ‘Extending life’ and ‘Bridges that perform better’ into ‘Bridges Fit for the Future’?
- Introduction (Cam M for BOF, Liz for UKBB)
- Format – improve graphics and style
  - BOF November discussion
- Dissemination and publicity
  - UKRLG support
  - CIHT website
  - Bridges 2020

BOF
Bridge Owners’ Forum

BRIDGE OWNERS FORUM
GRAND CHALLENGES

BOF
Bridge Owners' Forum

1 PREVENTING BRIDGE FAILURES

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 119 bridge collapses worldwide resulting in 967 fatalities and significant economic loss. Catastrophic bridge collapses occur too frequently even though, with hindsight, most could have been predicted and prevented.

The human, financial and reputational costs of these incidents, which frequently make international news, are unacceptable by any reasonable measure so why are we not 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 Viduct, Genoa, collapsed 14 Aug 2018. 43 deaths. Cost of disruption €600m, cost of rebuilding €200m.

Over 54,000 structurally deficient bridges in USA (National Bridge Inventory 2018). Equivalent UK data is not collected.

3,177 sub-standard bridges across England, Scotland and Wales. RAC Foundation January 2019

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 (Aug 16)
- M20 Footbridge (Aug 16)
- Barrow-upon-Soar (Aug 16)
- Skipton Bridge (Feb 18)

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

BOF
Bridge Owners' Forum

BRIDGE OWNERS FORUM GRAND CHALLENGES

BOF
Bridge Owners' Forum

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.

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

BRIDGE OWNERS FORUM GRAND CHALLENGES

BOF
Bridge Owners' Forum

3 BUILDING BRIDGES THAT WILL PERFORM BETTER

Bridge infrastructure in the UK has been developed over centuries. Performance has varied – 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.

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

BOF
Bridge Owners' Forum

BRIDGE OWNERS FORUM GRAND CHALLENGES

BOF
Bridge Owners' Forum

4 EMBRACE INNOVATION & 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.

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.

BRIDGE OWNERS FORUM GRAND CHALLENGES

BOF
Bridge Owners' Forum

5 SECURING A COMPETENT AND DIVERSE WORKFORCE

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 to other seemingly more attractive industries. 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. There is still improvement to be made in gender and ethnic diversity.

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.

PRIORITY AREAS FOR DEVELOPMENT

Bridge engineering in schools (sg STEM ambassadors)

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

Courses to support skills needs

Publicity campaign for bridge engineering – to appeal to diverse backgrounds

Promoting career paths eg. for bridge inspectors

Specialised training and certification schemes

Workshops to share knowledge between experienced practitioners and younger engineers

Industry support to training establishments

BOF
Bridge Owners' Forum