Civil Engineering
Volume 168 Issue CE2 May 2015

http://dx.doi.org/10.1680/cien.2015.168.2.57

Monitor: Discussion

Discussion

Presidential address: Civil Engineering: fit for the future

by David Balmforth (February 2015)

Contribution by David Gardner

Balmforth (2015) explores the fascinating topic of infrastructure fragility, noting 'the vulnerability of society to the extremes of nature'. He cites several examples of recent failures due to natural events, but how many of them were foretold by the civil engineering profession and how well prepared were the countries involved? Certainly I believe the UK is not as well prepared as it might be to cope with a prolonged adverse winter. This journal and others are full of the tremendous actions taken after events, such as the 2013 UK floods, but some of these could have been foreseen and action taken in advance. Some authorities will be better prepared than others, however a similar scenario to the recent flooding chaos is likely to play out when, not if, the UK gets another really severe winter.

Britain's vulnerability to severe weather is obvious to civil engineers, so why is the country not better prepared?

Author's reply

In drafting its *State of the nation: infrastructure* report in 2014 (ICE, 2014a), the Institution of Civil Engineers (ICE) made the important point that in the future the UK would be unlikely to be able to afford infrastructure that remained fully operational during extreme events – that is, 24/7 operation could not be guaranteed. This of course relates to any extreme event, not just to extended cold weather. This was quite a radical departure from our traditional view of appropriate infrastructure operational performance but we believed that we needed to make this important statement at this time so as to manage future expectancy. Therefore the issues the contributor raises are very much in our mind.

The resilience of future infrastructure to extreme events remains a cause of concern, and not just in the UK. ICE has published three international resilience case studies (ICE, 2014b) and an analysis paper which highlight challenges that other cities face and lessons we can learn from them. These have also been published in the *Guardian* public leaders network (Hall, 2015). We raise this with governments at every opportunity. We have endeavoured to persuade Infrastructure UK to include resilience to climate change in its criteria of major programmes and projects in the top 40 list. However, to date this has been unsuccessful.

Evidence from catastrophic events around the world shows that there is typically insufficient understanding about the cascading collapse of infrastructure during extreme weather. In other words, responsible bodies are failing to deal adequately with the 'what if' question. This is hindering our ability to plan for such events. Good planning should of course include an effective communications strategy, as the contributor suggests. However this must be integrated into the wider planning and be led by government.

There are several important initiatives currently ongoing that will help us to deal better with this important issue. The Infrastructure Transition Research Consortium led by Jim Hall at Oxford University is delivering a collaborative research programme which addresses various areas (Tran *et al.*, 2014). Defra's *Climate Change Risk Assessment* (CCRA) was published by the government in January 2012 (Defra, 2012). It sets out the main priorities for adaptation in the UK under key themes identified in the CCRA 2012 evidence report. The Department for Transport's Brown review on the resilience of the UK transport network to extreme weather events followed the winter 2013/14 extreme weather events (DfT, 2014). It was published in July 2014 and made a number of recommendations to transport operators.

The adaptation sub-committee within the UK Committee on Climate Change published *Managing Climate Risks to Well-being and the Economy* in July 2014 (CCC ASC, 2014). The report assessed preparedness for extreme weather across nationally significant infrastructure. In addition, major new UK infrastructure projects, such as High Speed 2 and nuclear power stations, are accounting for relevant climate hazards including increases in flood risk.

ICE established its 'Shaping the world' campaign to help address the challenges that the world faces from the future mega-trends: climate change, population growth, resource depletion and economic instability. The campaign is built on the principle of future infrastructure that is resilient, adaptable and available to all. One area that we are currently fundraising for is to develop tools to help prepare city administrations to meet those future challenges. An important element of this will be the extent to which we need to engage the public. An effective communication strategy must therefore be at the centre of any future action plan, but it is something that is perhaps best led by governments rather than by professional bodies.

References

Balmforth D (2015) Civil Engineering: fit for the future. *Proceedings of the Institution of Civil Engineers – Civil Engineering* **168(1)**: 3–7, http://dx.doi.org/10.1680/cien.2015.168.1.3.

CCC ASC (Committee on Climate Change Adaptation Sub-Committee) (2014) *Managing Climate Risks to Well-being and the Economy*. Committee on Climate Change, London, UK. See http://www.theccc.org.uk/wp-content/uploads/2014/07/Final_ASC-2014_web-version-4.pdf (accessed 18/03/2015).

Defra (Department for Environment, Food and Rural

Affairs) (2012) *UK Climate Change Risk Assessment: Government Report*. The Stationery Office, London, UK. See https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69487/pb13698-climate-risk-assessment.pdf (accessed 18/03/2015).
DfT (Department for Transport) (2014) *Transport Resilience Review: A Review of the Resilience of the Transport Network to Extreme Weather Events*. Department for Transport, London, UK. See https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/335115/transport-resilience-review-web.pdf (accessed 18/03/2015).
ICE (Institution of Civil Engineers) (2014a) *State of the Nation: Infrastructure 2014*. ICE, London, UK. See http://www.ice.org.uk/getattachment/8185ef54-ca0d-457d-8a1f-d0e2212e1fb3/State-of-the-Nation–Infrastructure-2014.aspx (accessed 18/03/2015).
ICE (2014b) *Availability of Infrastructure: Resilient Cities*. ICE, London, UK. See http://www.ice.org.uk/topics/community/Case-studies/Availability-of-Infrastructure-Resilient-Cities (accessed 18/03/2015).
Hall J (2015) Storm-weary New York City needs to adapt faster to climate change. *The Guardian*, 2 March. See http://www.theguardian.com/public-leaders-network/2015/mar/02/storm-new-york-city-adapt-climate-change (accessed 18/03/2015).
Tran M, Hall J, Hickford A *et al.* (2014) *National Infrastructure Assessment: Analysis of Options for Infrastructure Provision in Great Britain, Interim Results*. Environmental Change Institute, University of Oxford, UK. See http://www.itrc.org.uk/wordpress/wp-content/results/ITRC-First-results-WEB.pdf (accessed 18/03/2015).

1400033: High-resolution sonars set to revolutionise bridge scour inspections

by Simon Clubley, Costantino Manes and David Richards (February 2015)

Contribution by Brian Maddison

As a chartered civil engineer and a diver who has carried out many hundreds of underwater inspections, I welcome the use of modern sonar techniques proposed by Clubley *et al.* (2015). However, there are several assertions in the paper I take issue with. It is true that divers often cannot see scour forming – but it is the soundings that are carried out at the time of the inspection that are designed to find scour, not the divers. Their main role is to carry out the physical examination of the structure. However, they can look for features on the structure that may indicate scour. Most structures at risk from scour are the smaller bridges with strip foundations crossing fast-flowing rivers. These cannot be examined with boat-mounted equipment as described in the paper.

Authors' reply

The current Network Rail standard (NR/L3/CIV/006/2A) stipulates depth sounding requirements in an attempt to identify localised scour features or more generalised erosion. Unfortunately, single-pulse depth altimeter readings do not readily provide the fidelity or volume of data successfully to underwrite any determination of issues existing or forming. Detection of critical areas is more by chance than design, as demonstrated in the current research programme. This issue is further worsened by the lack of consistency in subsequent survey control points, preventing an easy-to-understand picture when overlaying time-evolving string lines. The authors have noted this problem on many bridge surveys, not just the River Hamble viaduct.

The authors do not advocate the removal of diver-based inspections at all and believe the case for inclusion is further strengthened when used in combination with these sonar technologies. The paper illustrates methods of monitoring and assessment that can help guide divers to specific areas of concern in real time for visual inspection wherever possible. High-resolution sonars can further serve to increase safety by actively tracking diver progress around dangerous obstacles towards the target zone. The paper demonstrates a new transformational approach in which diver-based inspections still remain a component part of the methodology.

All of the sonars featured in the paper do not ultimately need to be mounted on a boat. High-resolution multi-beam sonar can be installed on a protruding pole system or remote-control miniature craft. The only requirements are a power supply, telemetry and control. They are typically mounted on boats through convenience because, as asserted in the paper introduction, they have been initially developed for deep-water surveying.

The paper details a field study in which telemetry was tested by connecting directly to vessel navigation systems. This represented the most difficult deployment challenge worthy of reporting, taking into account a constantly varying spatial signal source and return position. As with any sonar, the only general restriction is a minimum depth of water. This is, however, still shallow at approximately 0·5 m. Arguably any less than this and a bridge inspector could manually wade across and visually scrutinise areas for concern.

Smaller bridges over fast-flowing rivers cannot be examined with boat-mounted sonar equipment

Reference

Clubley S, Manes C and Richards D (2015) High-resolution sonars set to revolutionise bridge scour inspections. *Proceedings of the Institution of Civil Engineers – Civil Engineering* **168(1)**: 35–42, http://dx.doi.org/10.1680/cien.14.00033.

Civil Engineering
Volume 168 Issue CE2 May 2015

1400014: On track: the future for rail infrastructure systems

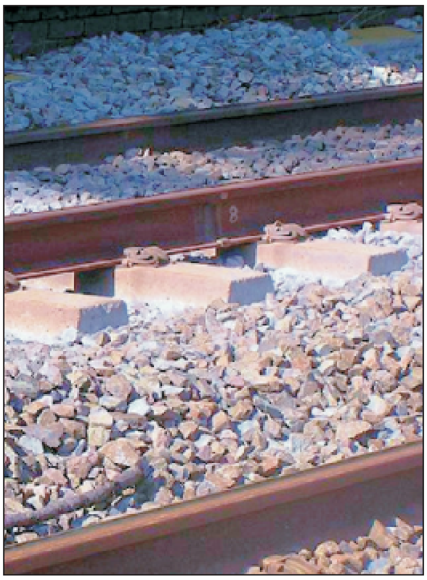
by William Powrie (November 2014)

Contribution by Michael Baxter

The trend on new railway projects in the Far East, where most of my experience is based, is to utilise concrete slab track rather than ballasted track despite its higher initial cost. This is primarily because the life-cycle cost for concrete slab track is significantly lower, from as little as 8 years after installation. Most if not all of the disadvantages Powrie (2014) listed for ballasted track are eliminated by using slab track. In view of this, would the author like to comment on whether the funding for ballasted track should be diverted to research into non-ballasted track forms for use in the UK and the feasibility of converting existing ballasted tracks to non-ballasted tracks?

Author's reply

A ballasted track system generally has a lower initial cost but higher maintenance costs than a slab-track system. In a life-cycle analysis, the time at which the cumulative initial and maintenance costs of a ballasted track and slab track cross is critically dependent on the assumptions made about trafficking, performance and maintenance requirements. Thus in the literature, where life-cycle analyses have been attempted and reported, there is considerable variation of this figure.



Slab track would avoid problems such as ballast migration on canted curves

The 2013 James Forrest lecture, on which the paper was based, showed a graph (Powrie, 2013: slide 47) taken from a presentation by Vossloh (2009) dating from 2009, in which the cumulative cost in net present value terms of a slab-track system crosses that of ballasted track, becoming lower after about 18 years. Schilder and Diederich (2007) show the crossover occurring after 20 years. Neither of these sources explains or cites the origin of the data used.

The lecture also showed the results of a calculation based on embodied energy (Powrie, 2013: slide 48); here, the cumulative embodied energies become equal after about 30 years, but re-cross several times so that the cumulative embodied energy of the slab-track system is obviously less than that for ballasted track for three periods totalling about 30 years over the next 90. Other versions of this analysis, with different assumptions regarding trafficking and maintenance intervention requirements, give different answers. Meaningful comparison with real data is almost impossible, hence rare; thus the models and calculations remain generally untested.

Some of the issues with ballasted track identified in the paper arise from inadequate preparation of the subsoil or the foundations, which would likely cause equivalent problems for slab track. Others have become apparent as the demands placed on traditional ballasted track have exceeded those anticipated in design, and could yet occur with other track forms. Anecdotal reports of the unexpected development of long-wavelength rail corrugations on slab track in parts of Europe suggests that this may be beginning to happen.

The contributor invites comment on diverting research funding for ballasted track into researching non-ballasted track forms and the feasibility of converting existing ballasted track to non-ballasted. The research described in the paper was aimed primarily at improving the performance of existing ballasted track,

Over the past 4 years our research has developed techniques that could extend the maintenance interval for ballasted track by a factor of 3 or more. Any whole-life-cost analysis shows this to be an absolute game changer

rather than (necessarily) new build. Whatever happens with new build, replacing the current UK network with a different track form would be immensely disruptive as well as costly, and realistically is simply not going to happen. Over the past 4 years, our research has developed techniques that could extend the maintenance interval for ballasted track by a factor of 3 or more. Any whole-life-cost analysis shows this to be an absolute game changer. At a cost equivalent to that of converting less than 1 km of twin-line track from slab to ballast, the research represents exceptional value for money.

References

Powrie W (2013) *The James Forrest Lecture: On Track: The Future for Rail Infrastructure*. See http://www.track21.org.uk/files/2014/11/James-Forrest-lecture-2013.pdf (accessed 18/03/2015).

Powrie W (2014) On track: the future for rail infrastructure. *Proceedings of the Institution of Civil Engineers – Civil Engineering* **167(4)**: 177–185, http://dx.doi.org/10.1680/cien.14.00014.

Schilder R and Diederich D (2007) Installation quality of slab track – a decisive factor for maintenance. In *RTR Special: Maintenance and Renewal*. Eurailpress, Hamburg, Germany, pp. 76–78. See http://www.rhombergrail.com/fileadmin/user_upload/Bahntechnik/Bilder/Downloads/RTR_Special_2007_Installation_Quality_of_Slab_Track.pdf (accessed 18/03/2015).

Vossloh (2009) http://railtec.illinois.edu/CEE/pdf/PPT%27s/Spring09/Steidl%202-27-09.pdf (accessed 18/03/2015).