BRIDGE OWNERS FORUM

MINUTES OF MEETING BOF 57: TUESDAY 15 MAY 2018 AT THE BEVES ROOM, KING'S COLLEGE, CAMBRIDGE

PRESENT:

Nick Burgess	LUL
Graham Cole	ADEPT
Rob Dean	Network Rail
Andy Featherby	Canal and River Trust
Richard Fish	Technical Secretary
Jim Hall	CSS Wales
Keith Harwood	ADEPT
Nicola Head	TfL
Daniel Healy	Transport Northern Ireland
Jason Hibbert	Welsh Government
Hazel McDonald	Transport Scotland
Campbell Middleton	Cambridge University Engineering Department (Chairman)
Hideo Takano	Highways England
Paul Thomas	Railway Paths
Paul Fidler	CUED

Guests (morning session only):

Matt DeJong	CUED
Matthew Gilbert	Sheffield University
Bill Harvey	Bill Harvey Associates
Adrienn Tomor	UWE
Haris Alexakis	CUED (Observing)
Sam Cocking	CUED (Observing)

Part 1 – Arch Bridges.

1. Welcome and Introduction to the Morning Session

The Chairman welcomed everyone to the meeting and explained the way the session was to be run following the successful format used at previous themed meetings. He especially welcomed the guests and thanked them for agreeing to attend and present their ideas on arch bridges. Richard Fish noted that Prof. Steve Garrity of Leeds University was poorly and had had to send his apologies.

2. Presentations:

a) Assessment of Masonry Arches and Asset Management – A Client View.

Graham Cole (Vice-chairman of ADEPT Bridge Committee) began by recalling the pedigree of the TRL work in the last decades of the twentieth century, their Arch Bridge Guide and the CIRIA Report C656. He also outlined ongoing work at the Universities of Sheffield, Salford and the West of England (UWE). Graham pointed out the huge dependence of the national transport infrastructure on arch bridges although only rarely had they ever been formally "designed" in the modern sense.

Graham went on to set out his views on current needs: consistency in inspection and assessment, in terms of both methods and outcomes; the management of risk, and the importance of aligning inspections and assessments. It was also important to be sure where a bridge's condition sat on the deterioration curve and the Adequacy Factor of an assessment result.

He referred to Woolfenden's paper from 25 years ago at the 1993 Surrey University Bridge Conference (published as Bridge Management 2 by Thomas Telford in the same year) which had recognised MEXE's unsuitability and sought to promote the FE program MAFEA. Graham also referred to the current DMRB masonry arch assessment advice in BA16, little changed since 1984 when it had first been published. He noted the initiatives that BOF had promoted in the last 12 years, including the BOF 17 arch bridge strengthening comparisons (by reinforcement set in chases in the intrados) and BOF 30 in 2010 which had first discussed the shortcomings of MEXE.

Graham expressed concern over the lack of progress in developing the MEXE issue, noting the considerable difference in results between MEXE and RING. He called for the Network Rail assessment guidance (NR-GN-CIV-025) to be freely available; for a review of the Highways England standards and new guidance on the effect of condition on an arch bridge assessment.

b) What the Bridges are telling us.

Bill Harvey (Bill Harvey Associates, formerly Dundee and Exeter Universities) began by quoting Richard Feynman: *"For a successful technology, engineering must take precedence over public relations, for nature cannot be fooled".* Bill went on to point out a number of shortcomings with MEXE, including assumptions about load distribution which were erroneous. He catalogued a number of arch bridges that he had visited in recent years which were exhibiting signs of considerable distress (including a case where stones were falling from the intrados) and yet had passed a MEXE assessment. Geographically, examples covered the UK from Scotland to the South West. One of Bill's concerns was that localised damage was being ignored in the MEXE analyses and yet it was essential that assessments should be able to predict where damage would occur and physical evidence of damage in such locations should in turn affect the assessment result.

Bill also had issues with the way in which arch bridges are being managed, citing an example in Leeds where a span had been covered in a plastic lining for aesthetic reasons such that the land below could be used for commercial purposes. When the plastic was removed not only had the number of previously recorded radial cracks increased but the lining had caused the structure to sweat which in turn had softened mortar and brickwork. In passing, on the subject of radial cracking, Bill suggested that what is thought to be the current best practice of stitching was ineffective due to the huge difference in stiffness between a masonry arch barrel and small steel bars.

Turning to the assessment of viaducts, Bill acknowledged that he had for many years mistaken the structural behaviour and the influence of the mass of the masonry block above the piers. Detailed inspections have supported his thesis, again by identifying localised damage at the transition between stiff masonry blocks and more flexible arch rings. Bill also considered the effects of relieving arches in viaduct piers (citing Balcombe Railway Viaduct as an example) which also required detailed consideration.

Lastly, Bill referred to the importance of geometry and the need for accurate survey techniques. He illustrated this with examples of laser scans and photogrammetry.

c) Monitoring Degradation and Dynamic Movement of Arch Bridges under Train Loading.

Matt DeJong (CUED) presented not only on monitoring but also the interpretation of data, covering four key issues: geometry, accuracy of the image, dynamic movement and long term effects.

His first example of a bridge in Bristol examined the deflected shape as measured by a laser scan against a theoretical cylinder to determine the best fit. This also gave an automated method of defining the arch's segmentation. In terms of the accuracy of the image, Matt demonstrated a facility which graphically removed the pointing so that crack locations were easier to detect.

Matt next presented on the use of fibre optics to measure strains with high precision with possibly additional temperature sensors such that thermal movements could be discounted. This technique allowed real time visualisation of a span opening and closing under live load as well as torsional movements on piers, enabling those cracks which were active to be identified. He concurred with Bill Harvey's remarks on relieving arches in which movements had also been detected.

As his final example, Matt described a structural health monitoring system, including acoustic monitoring sensors, which was to be fitted to a bridge in Leeds and would run continuously for two years, albeit triggered by an approaching train. Although this would generate a high volume of data, the system would automatically categorise each type of train passing over the bridge.

Matt concluded by referring to the need for discrete and finite element modelling that could be calibrated by monitoring which, in turn, would improve the quality of asset management in the round by early identification of progressive damage, an ability to assess the effectiveness of future interventions and avoid the imposition of unnecessary limitations such as speed limits.

d) Fatigue Life Expectancy of Masonry Arch Bridges

Adrienn Tomor of the University of the West of England (UWE) reported on a UWE research project which aimed to consider deterioration under fatigue loading in order to better understand the need and timing for interventions. Testing had extended to over 3 million cycles at 2Hz. Acoustic emissions from test samples subject to cyclical loading were monitored and proved that crack propagation could be identified due to both increasing load and cycles of loading. The research also confirmed that there was little notice of failure during tests but confirmed that the higher the fatigue loading, the greater the risk of failure – a significant consideration for busier bridges.

Adrienn noted that there was no assessment guidance for masonry fatigue limit state and she felt that the emerging concept of Permissible Limit State (as being promoted by Matthew Gilbert) could be extended to cover this. She also acknowledged the high level of material variability in any masonry, especially with older bricks, but considered that allowance for this should be down to the judgement of the assessing engineer.

Adrienn concluded by noting that fatigue was only a relatively small part of the spectrum of potential failure mechanisms for arch bridges but all would lead to a reduction in residual life.

e) Masonry Arch Bridge Assessment – life after MEXE

Not taken due to Steve Garrity's absence because of illness.

f) Guidance arising from Recent Research on Masonry Arch Bridges

Matthew Gilbert introduced his draft assessment guidance which had been issued to all BOF members in advance of the meeting. He explained the background to the research, including the interpretation of symptoms, which also addressed the issue of understanding and distinguishing between causes and effects. The research objective was to better understand arch behaviours at ultimate and working load states and followed a process of moving from experimentation to modelling and then to guidance. He proposed to introduce the concept of Permissible Limit State (PLS) to give a more realistic appreciation of an arch under working loads.

Matthew cited earlier arch analysis techniques, nearly all of which ignored the influence of the soil backfill which plays a significant part in determining load capacity. He recalled early research at the University of Salford which had worked on model arches built in tanks to offer lateral restraint but with no friction to influence the failures. Loading was incremental only (not cyclical) and the tests had not only, and not unexpectedly, concluded that higher loads shorten the life of the structure but also demonstrated the effect of backfill. The research also demonstrated the significant differences in Adequacy Factors using the ULS/PLS analysis and those derived by using BD21 methods with the latter generally giving an unconservative result.

Matthew invited comments on his draft guidance which could be sent to him after the meeting but his key outcomes were that MEXE should no longer be used; and that separate checks should be undertaken for ULS and PLS.

g) Discussion

The Chairman thanked all the guest speakers for their presentations and asked if the presentations could be uploaded to the BOF website. All speakers agreed but only following an opportunity for each to review and edit as appropriate.

ACTION 1: Paul Fidler

The Chairman began the discussion by commenting on the issues concerning the continued use of MEXE, although also noting the part that geometry and material variability played in arch assessments to the degree of confidence that was expected. Referring to extensive arch testing at TRL in the 1980s, which had been instrumental in determining mechanism methods of analyses, he posed the question: what had been the big change since then? Presenters were asked to comment in turn:

Graham Cole: There has been no change. With a shift to all analysis being codified and designers wary of working to a lump sum price, there was no appetite for following the Departure from Standard route that would be needed.

Matt DeJong: A positive change has been the acceptance of ULS tools and the development of programs such as RING and ARCHIE but there was no recognition of this in the DMRB. We have, however, made progress in our ability to monitor and better understand arch bridge behaviour.

Adrienn Tomor: Not much has happened in terms of the day to day application of methods for arch assessment but we have at least recognised the need for improved analyses and we are aware that there is a significant problem. On the positive side, we are benefiting from long term monitoring.

Bill Harvey: Things are worse than they were 30 years ago. The capacity and capability of bridge engineers, especially in large bridge owning organisations such as Network Rail and in consultants working to fixed prices, had greatly diminished. BA16 was almost contrary to the TRL test outcomes and should be seen as a barrier to progress. Another example of a retrograde step was the use by Network Rail of the Level 0 assessment tool which added no value whatsoever.

Matthew Gilbert: There has been little change although the availability of ARCHIE and RING software should be leading to improved outcomes and there was now a better understanding of behaviour under working loads.

The Chairman also commented that new technology such as scanning had also helped our understanding. He then opened the discussion to the meeting.

Rob Dean proposed that the definition of “failure” was difficult and we had to be wary of crying wolf. Although bridges were reportedly understrength there had been few catastrophic collapses. Failure needed to be defined by a point on the deterioration graph beyond which the capacity of the bridge could not be recovered regardless of intervention method. Matt DeJong commented that this

could also be defined as the point when the cost of maintaining was greater than the cost of replacing. Although Rob Dean agreed, he noted that the Network Rail bridge replacement programme was largely driven by other factors, such as overhead electrification, and therefore the concept of a 120 year life was meaningless. Bill Harvey noted that at the current rate of spend, it would take Network Rail 850 years to replace every bridge and 7,000 years to replace every retaining wall.

Paul Thomas asked if rail live loading was more onerous than highway live loading. Bill Harvey confirmed that this was the case by a factor of two but acknowledged that the variability in highway loading made generalisation difficult. Matthew Gilbert also commented that the arch geometry in relation to axle spacing was also a key issue in deriving capacity.

Responding to a comment from Bill Harvey that risk from masonry falling from a distressed arch would soon lead to serious injury or even fatalities, Rob Dean cited a recent example where a spandrel wall pattress plate (anchoring a tensioned cable) had failed and had been projected from the bridge. Although adjacent to a children's playground, this had luckily occurred during the night. As a consequence, however, he had been asked to compile a database of all such details across the network – an almost impossible task. He also reported on an incident in which a lump of brickwork had fallen from a bridge while a train was passing below. Landing on the train, the masonry was carried along with it. Nick Burgess noted a similar incident on London Underground when a piece of fallen concrete had had a similar ride.

Rob Dean also questioned whether our inspection resources could be put to better use; what benefit was gained from tactile inspections (Detailed Examinations (DE)) and was there any value in Visual examinations (VE)? What was needed was a move away from reliance on VE and a trial to explore other ways of information gathering. Nicola Head noted that TfL had made a decision to defer some of this year's General Inspections as a first step towards a risk based inspection programme, as permitted in the revised Code of Practice.

Responding to comments on BD21 and the DMRB, Hideo Takano noted that both BD21 and BA16 were being rewritten under the principle that they would not be over reliant on process and therefore the revision should be an improvement. The Chairman expressed concern that the DMRB rewrite was being undertaken by consultants and suggested that bridge owners should be involved. Hazel McDonald noted that Transport Scotland would be able to comment and, although similar arrangements appeared to be in hand for Wales and Northern Ireland, Hideo agreed to issue details of the Technical Project Board (TPB).

ACTION 2: Hideo Takano/Neil Loudon

Graham Cole recalled that original DMRB documents such as BD21 and BA16 had been effectively drafted by a panel of nationally recognised experts and it

seemed that the drive to complete the DMRB rewrite by 2020 could dilute its quality and value. Jason Hibbert suggested that, once drafted, all critical elements of the DMRB should be subject to regular review. Rob Dean accepted that the 2020 deadline was fixed but agreed that any new assessment guidance should be considered to be a live document. The Chairman suggested that the proven ineffectiveness of MEXE and the importance of the BD21 rewrite should be discussed at the next UKBB in June. Jason Hibbert expressed concern over the cost implications to smaller local authorities who relied totally on MEXE but agreed that a change in assessment guidance was essential.

ACTION 3: UKBB Members

Returning to the subject of rail live loads, Rob Dean noted the recent announcement from Network Rail on the forthcoming "digital railway" which would see enhanced signalling and hence the potential for more trains running on the network. He also noted that a change in the RA loading was proposed based on European standards which would be an equivalent RA10. It had been estimated that a programme of work to assess and strengthen bridges to accommodate this would cost £1.5bn.

The Chairman suggested that current improvements in digital mapping and monitoring of structures might help prioritisation and improve understanding. He referred to work being undertaken at Cambridge on the digital twin concept. Rob Dean agreed that this was a long-term aspiration and noted that Network Rail were part of a European project on digital twins. There were problems, however, with Network Rail's limitations on IT capacity and with the sheer scale of the number of bridges in the bridge stock.

Concluding the discussion, the Chairman invited final comments and/or advice to owners from guest speakers:

Adrienn Tomor: Consider enhanced remote monitoring as part of the inspection regime using newer technology such as acoustic emission data collection.

Matt DeJong: Consider methods of overcoming IT data limitations and monitor the effectiveness of maintenance interventions.

Bill Harvey: Continually question historic assumptions. As an example, the assumptions he made in developing ARCHIE for multi-spans in the 1980s he now knows were wrong.

Matthew Gilbert: There was a major opportunity to move from MEXE to more reliable assessment methods. He repeated his request for comments on the sheet which Richard Fish agreed to issue.

ACTION 4: Richard Fish

The Chairman thanked our guests for contributing to an excellent morning's work and hoped discussions might continue, not only over lunch but also within the wider network of bridge owners.

Part 2 – BOF Business Meeting.

3. Introductions and Apologies

The Chairman welcomed Hazel McDonald to her first BOF meeting in her new role as Chief Bridge Engineer for Transport Scotland (TS), having been appointed after Wayne Hindshaw's retirement, and asked her to summarise her career to date and the challenges she faced in the new role.

Hazel confirmed that she had only started on 1st May and was still doing her old job as well as the new one. She had over 20 years' experience in bridges having worked for Mott MacDonald and Cumbria County Council before joining TS where she had held a number of jobs. Hazel has a PhD in monitoring and predicting temperature effects on Glasgow's Kingston Bridge and listed her current concerns/interests as scour, maintenance prioritisation, structural health monitoring and concrete specification/deterioration. She is responsible for 4,970 structures in Scotland, of which 2,029 are bridges, and an annual budget of £64m.

The Chairman also welcomed Hideo Takano from Highways England who was substituting for Neil Loudon.

Richard Fish noted the following apologies for this meeting:

Henry Dempsey	SCOTS
Liam Duffy	Transport Infrastructure Ireland
David List	Big Bridge Group
Neil Loudon	Highways England

4. BOF 55 Minutes

a) Accuracy

The minutes were agreed as an accurate record and could be uploaded to the BOF website.

ACTION 5: Paul Fidler

b) Matters Arising

Action 2: BOF LinkedIn Page
Richard Fish had not yet actioned this but reported that the BOF Twitter account was proving to be popular.

ACTION 6: Richard Fish

Action 3: BOF Website
Paul Fidler questioned the efficacy of uploading photographs of BOF members to the BOF website especially in the context of the new GDPR; he agreed to check the approval process.

ACTION 7: Paul Fidler

There was a short discussion on the BOF website format and it was agreed that it was somewhat dated. The Chairman agreed to investigate options for upgrading it.

ACTION 8: Chairman

Action 4: CIRIA
Rob Dean advised that he had recently taken up a role as a non-executive director with CIRIA and therefore would have to declare that interest in any relevant discussions. The Chairman welcomed this move, suggesting that it would improve the BOF/CIRIA working relationship.

Action 5: Sheffield University Masonry Arch Assessment Guidance
Graham Cole agreed to issue the names on this steering group via Richard Fish.

ACTION 9: Graham Cole/Richard Fish

Action 12: The State of Bridge Infrastructure
Richard Fish now has the IStructE contact for their work on the need for as-built records.

Action 16: Safety Alerts to SCOSS and CROSS
Richard Fish noted that one of the likely outcomes from the various reviews of the Grenfell Tower tragedy was a demand for professionals to be able to *prove* their competence in the field in which they were working.

Action 18: Annual Bridges Conference: Innovations in Bridge Management
The Chairman congratulated Keith Harwood for the successful PechaKucha initiative as used at the conference in March.

Action 22: Future Manufacturing Research Hub
The Chairman agreed to check the Cambridge University position regarding input into various ongoing research initiatives.

ACTION 10: Chairman

Action 23: QUB Research Project
Daniel Healy agreed to try to locate this report that John McRobert had mentioned.

ACTION 11: Daniel Healy

Action 24: Chloride Study
In Liam Duffy's absence this item will be deferred to BOF 58.

ACTION 12: Liam Duffy

Action 25: BICS
Graham Cole reported on the latest position following a recent BICS committee meeting with LANTRA. It was clear that Highways England's deadline for all inspectors to be BICS accredited – 1st June 2018 – would not be met and that a revised date would be announced shortly. Although to date only 19 inspectors had achieved the BICS standard, there were over 500 signed up to the process and preparing e-portfolios. Some 50 applicants had been interviewed but more than half had not passed.

It was agreed that more pressure needed to be applied to enforce the BICS requirement and the Chairman asked BOF attendees to comment:

Hazel McDonald stated that **Transport Scotland** were fully committed to BICS and had also insisted that all inspectors should be qualified by 6th June. Jim Hall suggested that the financial pressures facing **CSS Wales** members meant that political support would not be given. He understood that elected members were generally aware of the need to comply with the Code of Practice but every authority's budgets (except Education and Social Care) were being cut by 20% per annum. There was a real problem in technical capacity irrespective of BICS. Jason Hibbert said that the **Welsh Government** was planning to impose a BICS requirement on Trunk Road inspections by the end of the financial year. He also suggested that there was a fault in the scheme itself with a disproportionate amount of time being needed to prepare a submission and gather evidence. For **Railway Paths**, Paul Thomas agreed that the scheme was seen as too onerous and he was adopting a wait-and-see approach. Daniel Healy reported that **Transport Northern Ireland** were not using BICS for in-house inspectors but were planning to require maintenance contractors to adopt it. Daniel suggested that a modular approach should be considered; the syllabus was too complicated to expect inspectors who had started work on the tools to commit to a single submission. Graham Cole reported that guidelines were being reviewed following the recent committee meeting and that material modules were being considered. Nicola Head advised that **TfL** were unable to impose BICS until a contract was coming up for rebid as costs would be passed back to the client which was also under considerable budget pressures.

Responding to a question from the Chairman on funding, Hazel McDonald noted that Transport Scotland had covered the costs of the Assessors' Standardisation

day in November 2017. Other than that, LANTRA were bearing all costs and their business model would only show a return when a significant number of Inspectors had been certified. Graham Cole noted that the original 2005 Code of Practice had a requirement that inspectors should be able to demonstrate competency.

The Chairman requested that the BICS situation should be discussed at the next UKBB meeting in June.

ACTION 13: UKBB Members

The Chairman also committed to raising the matter at a higher level with DfT and the ORR as and when opportunities arose.

ACTION 14: Chairman

5. BOF 56 Minutes

a) Accuracy

The minutes were agreed as an accurate record and could be uploaded to the BOF website.

ACTION 5: Paul Fidler

b) Matters Arising

The Chairman remarked on the success of this year's Annual Bridge Conference but questioned whether speakers were going to receive any feedback from delegates as had been the case in past years. Richard Fish agreed to ask the Conference organisers.

ACTION 15: Richard Fish

6. BOF Grand Challenges – Update

Keith Harwood set out the current position on the Grand Challenges project with a short presentation. He suggested that we should remain committed to the six previously agreed themes as below:

What:

- Preventing structural failures (Chairman)
- Extending the life of existing structures (Jim Hall)
- Building bridges that will perform better (Jason Hibbert)

How:

- Embracing innovation and embedding technology (Nicola Head)
- Securing a competent, diverse workforce (Neil Loudon)
- Sharing knowledge and best practice (Rob Dean)

He proposed to issue a template to those who had originally volunteered their time (names in brackets above) which should be completed with some key facts on each theme and suggested priority areas for development.

The following programme was agreed:

- Finalise template: end of May
- First draft each challenge: end of June
- Final drafts each challenge: end of July
- Sign off: end of August

ACTION 16: Keith Harwood, Chairman, Jim Hall, Jason Hibbert, Nicola Head, Rob Dean

The question of publicising and promulgation was raised, especially in context of the existing clunky BOF website as raised earlier in the meeting (Action 8 above). The Chairman reaffirmed his commitment to identify a resource to do this under Paul Fidler's direction. Discussion about the BOF website extended to questioning the policy of a members' only area; Graham Cole proposed that, as ADEPT was a membership organisation, should not all ADEPT members be able to access all content. After discussion it was agreed that the policy should remain unchanged for the time being.

7. UKRLG Call for Research Projects

Richard Fish reported that the UKRLG secretariat had recently issued a call for research projects against a £0.5m DfT budget that had recently been announced. The timing was good in that this meeting could decide on a priority list to be approved by the Chair of UKBB before consideration at UKRLG.

Reference was made to the last prioritisation exercise in 2016 which had led to nothing as funding had been withdrawn. After discussion, it was agreed that the previous two BOF promoted projects should remain, although the background submissions would require a review and refresh:

2016-11 Provision of Parapet Systems on Local Roads
2016-12 Bridge Deterioration Rates

Richard Fish suggested that this opportunity would fit neatly with the proposed guidance on masonry arch assessment as discussed in the morning session and the fact that the DMRB rewrite should be informed by it. This was agreed.

Keith Harwood suggested that now would be a good time to invest in a revamp of the Structures Toolkit. Jason Hibbert referred to an Investment Toolkit for structures that Atkins had produced but Keith suggested that this still had a

number of flaws. The Chairman pointed out that starting afresh with the toolkit concept was the right thing to do, allowing the full use of emerging technology. This was also agreed, leaving the four bids (and those who volunteered to prepare the paper-work) as follows:

Provision of Parapet Systems on Local Roads	Graham Cole
Bridge Deterioration Rates	Keith Harwood
Assessment Guidance for masonry arches	Graham Cole
Revamped Structures Toolkit	Keith Harwood

ACTION 17: Graham Cole, Keith Harwood

Richard Fish agreed to advise Liz Kirkham of the outcome of today's meeting.

ACTION 18: Richard Fish

The Chairman recalled that there had been a MOU for the research process from BOF to UKBB to DfT and agreed to try to locate it.

ACTION 19: Chairman

8. Bridge Research Updates

a. Transport Scotland
Hazel McDonald referred to a NERC project on scour probability being conducted at Strathclyde University where TS were providing a site for trials.

b. **LUL**
Over-height vehicle detection
Nick Burgess mentioned the ongoing project on this topic.

c. DfI Northern Ireland
Daniel Healy noted that he was shortly to meet with Queens University, Belfast, and would report on any developments at the next meeting.

d. **Welsh Government**
Jason Hibbert reported on another NERC project – the development of a scour risk map which involved CADW (the Welsh equivalent of Historic England). He agreed to check on its status and report back at the next meeting. Jason also noted that there was to be a Materials for Life (M4L) conference in Cambridge on 17th October.

e. **Highways England**
Hideo Takano reported on the following:

Driving Stability in High Winds: Trials were being undertaken on the QE2 bridge in conjunction with City University. It was hoped that the outcome

could see an increase in the threshold for wind speeds that required restrictions to be imposed.

Scour: Meetings were being held with Exeter, Newcastle and Leeds Universities to discuss HE input into scour research. Rob dean suggested that Hideo should speak to Steve Roffe at Network Rail.

Orwell Bridge: A study was underway to consider the effects of higher parapets on structural behaviour.

f. **Railway Paths**

Paul Thomas referred to a contact he had made with David Gent, a wrought iron specialist, who has proposed linseed oil as an option for protective treatment of wrought iron, with little need for surface preparation. This was especially attractive to Railway Paths who relied heavily on a volunteer workforce for such work. He agreed to issue a paper which included the results of some accelerated testing. There was also an option for a presentation at a future meeting. Andy Featherby supported this concept as C&RT also use volunteers.

ACTION 20: Paul Thomas

g. **TfL**

As had been mentioned earlier, Nicola Head confirmed that TfL were reviewing intervals between inspections but still in compliance with the Code of Practice. Rob Dean offered to help with this as work on inspection frequencies was also going on within Network Rail. Similarly, Jim Hall reported that CSS Wales had also been considering this but, as yet, had little evidence to prove that the bridge stock was not suffering as a result. The Chairman suggested that all should liaise on this and share any ideas at the next meeting.

ACTION 21: Nicola Head, Rob Dean, Jim Hall

h. **ADEPT**

Keith Harwood noted upcoming CIRIA reports with guidance on the following:

- Deterioration Modelling
- Structural Health Monitoring
- Safety Critical Fixings
- FRP Design

With respect to FRP, Keith noted this was due to be published in the late summer and would also include advice on the management of FRP bridges. Hazel McDonald agreed that guidance would be welcome as it appeared that consultants were reluctant to use the material as design was not codified.

i. **Network Rail**

Rob Dean reported on the following projects in which Network Rail were engaged:

Over-height Lorries: Entitled "What the Truck? Lorries can't Limbo!", this was a campaign aimed at improving awareness with hauliers and working through Satnavs and advanced warning signs.

In2rail Horizon 2020: Working on digital twins via sensor technologies.

Artificial Intelligence: Working with Innovate UK, Huddersfield University and Waldeck Consulting, aimed at predicting and identifying defects through machine learning. (As an aside, Rob had been very impressed with Waldeck for their structural technology innovations. The Chairman thought he would like to meet them).

Train Mounted Sensors: Currently used for detection of defects in rails, work was being undertaken by Nottingham University and Aecom as a trial for identifying bridge defects.

Micro-wave Technology: Also being carried out at Nottingham University and could be used to identify hidden defects. This work was not yet fully funded and further investment was being sought.

Environmental Deterioration: This was some work being undertaken by a Network Rail sponsored PhD student which had identified salt based deterioration up to 30km from the coast as well as additional impact from industrial pollution. Rob agreed to issue a paper.

ACTION 22: Rob Dean

Inspection Reliability: Rob also agreed to issue a paper on Network Rail work on this topic.

ACTION 23: Rob Dean

j. CUED

Referring to one of the projects discussed at the BOF scour special, the Chairman reported that a bridge had been identified in Bradford with scour issues and this was to be monitored as a trial to predict overall performance. He also noted that the work by Sakthy Selvakumaran on satellite technology had just been published.

9. Bridge Collapses

Following an action from BOF 56, the meeting considered the following bridge collapses that had occurred since March 2018:

- FIU, USA
- Chirajara, Colombia
- Myaungmya, Myanmar
- Footbridge, Pakistan – occurred 13th May 2018 so not noted on agenda

Richard Fish also reported that the NTSB report had been published on the I-85 bridge that collapsed following a serious fire below the deck.

10. Future BOF Topics and/or Presentations

Richard Fish had prepared a paper which summarised all actions since BOF 53 in which a presentation had been proposed. Although no firm decisions were taken on what topics should be given priority, Rob Dean explained that the Cyber Hawk presentation would cover a case study on the use of UAVs for inspections. Discussion then extended to question whether any feedback had been forthcoming on the DfT sponsored UAV trial. It was agreed that this should be raised at the next UKBB meeting in June.

ACTION 24: UKBB Members

11. BOF Subscriptions 2018/19

The Chairman reported that invoices had been issued with subscription rates fixed at 2017/18 prices. Nick Burgess was not sure that his had been received and the Chairman agreed to ask his PA to track it.

ACTION 25: Chairman

12. GDPR

It was agreed that Paul Fidler should establish the CUED policy with respect to email lists in the context of the new regulations.

ACTION 26: Paul Fidler

It was also agreed that those names still on Richard Fish's BOF email list but had not attended a meeting in the last year should be removed.

ACTION 27: Richard Fish

13. Any Other Business

a. ICE Bridge Engineering Journal

The Chairman noted that there had been a call for papers for a special edition which would focus on bridge maintenance and encouraged participation.

ACTION 28: All

b. Parapet Heights

The Chairman drew the meeting's attention to an email from David List which had been circulated prior to the meeting.

c. Questionnaire on the Value of Data

The Chairman reported that, as part of a research project on the Queensferry Crossing SHM system, CUED had prepared a questionnaire on how bridge owners use and/or manage data and this will be sent to all BOF members.

ACTION 29: Chairman/All

14. Next Meetings

The Chairman confirmed the following dates for the next three meetings, all to be held in Cambridge.

BOF 58	6th November 2018
BOF 59	29th January 2019
BOF 60	14th May 2019

All to note.

ACTION 30: All

There was a short discussion on whether there should be an additional meeting next year immediately prior to the 2019 Annual Bridge Conference. In part due to the relatively poor attendance, on balance the meeting agreed that we should decline if invited by the organisers.

15. Close

The Chairman thanked everyone for attending and closed the meeting.

Richard Fish,
BOF Technical Secretary,
24th June 2018