

BRIDGE OWNERS' FORUM

CHALLENGES 2007/8

What preoccupies bridge owners/managers and what researchers can do for them?

INVITATION TO SUBMIT RESEARCH PROPOSALS

This paper identifies challenges facing bridge owners in the UK. The challenges are given to assist researchers to formulate proposals for research that address aspects of the identified challenges. It is hoped that the paper will result in submissions of relevant research proposals to the Bridge Owners' Forum (BOF) for support.

Researchers are invited to take into account the aspects and topics given in section 5 in formulating and submitting research proposals to BOF for funding in 2008 as indicated in section 6.

1. Introduction

- 1.1 A well-managed transport infrastructure is vital to the economic stability, growth and social well-being of the UK. Bridges are fundamental to the transport infrastructure forming essential links in infrastructure networks.
- 1.2 The management of bridges in the UK is undertaken by a variety of authorities and other owners, e.g. local authorities, trunk road agencies, Network Rail, BRB (Residuary), London Underground Limited, British Waterways, Environment Agency, Transport for London and many private owners.
- 1.3 Up-to-date guidance and standards for the management of highway bridges may be found in *Management of Highway Structures: A Code of Practice*, September 2005, published by The Stationery Office [ISBN 0 11 552642 0] and also freely available on the web at <http://www.ukroadsliaisongroup.org/liaison/practice.htm>. Some owners of other infrastructure bridges, e.g. rail underbridges, adopt their own standards.

2. Requirements and objectives of bridge owners

- 2.1 Bridges are significant assets and their management is a major task for owners. The task is complex. The main requirements and objectives of the management of bridges by owners are:
 - 2.1.1 Providing the agreed/required/expected levels of service in terms of traffic load-carrying capacity and reliability.
 - 2.1.2 Meeting statutory obligations. For example, there is a statutory obligation on highway authorities to maintain the public highway (Highways Act 1980). The obligation embraces the two essential functions of 'Safe for use' and 'Fit for purpose'.
 - 2.1.3 Keeping maintenance, upgrading and replacement costs at a prudent and affordable level, aligning with government transport policy and local transport plans. Maintaining a 'steady state' or improved condition through sustainable work programmes. For local authorities there is a 'best value' duty to improve the economy, effectiveness and efficiency of service provision. Other bridge owners generally have similar aspirations.
 - 2.1.4 Reducing environmental impact and improving sustainability through bridge management.
- 2.2 The bridge owner's overall objective is to provide a better service, more efficiently and at less cost. Research needs spring from this challenge.

3. Bridge management

- 3.1 Bridge owners cannot meet their requirements and objectives through management without information and processes related to:
 - 3.1.1 The bridges they own, their function in the transport infrastructure, and their history, including construction and repair.
 - 3.1.2 Bridge condition/performance, historical and current, relating to the traffic carried, including diagnosis and prognosis.
 - 3.1.3 Assessment of performance of the original bridge design and in its current condition for capability to carry the required traffic and prognosis of capability taking account of likely/expected changes in traffic, structural condition and repair/upgrading.
 - 3.1.4 The efficacy of maintenance, repair and strengthening techniques including costs and long-term performance.
 - 3.1.5 Processes of asset management planning, financial planning and maintenance planning and management.
 - 3.1.6 The management and technical capabilities of managers, engineers and the construction industry workforce.

4. Challenges for bridge owners that may be informed by research

4.1 The above discussion indicates that particular challenges for bridge owners are embraced in the following questions:

- 4.1.1 **Condition information:** To improve asset management, what and how should information be collected on bridges and their structural performance/condition?
- 4.1.2 **Inspection, testing and monitoring:** What inspection, testing and monitoring systems can be used better to capture performance/condition information?
- 4.1.3 **Future performance:** What is the prognosis for condition and performance?
- 4.1.4 **Acceptable limits of performance/condition:** What limits on bridge performance and condition are required in bridge assessment to maintain safe, serviceable and economic bridges?
- 4.1.5 **Advantages/limitations of materials/structural systems:** What are the advantages and limitations of traditional and newer materials and structural systems in terms of safety, durability/service life and economy?
- 4.1.6 **Extending service life:** How can the service life of bridges be extended through better techniques and strategies for maintenance, repair and rehabilitation?
- 4.1.7 **Efficiency of maintenance and construction:** What are the most efficient and quickest maintenance and construction strategies, planning processes and methods for repair/rehabilitation and new build to achieve safe, durable and economic bridges?
- 4.1.8 **Managing knowledge:** What new and more effective approaches are available to manage bridge engineering knowledge and develop more knowledgeable bridge managers, engineers and workforce to deliver more effective and economic bridge management?
- 4.1.9 **Transport policy and legislation:** How can the context and requirements of transport policy and legislation be influenced and interpreted best to enable the most efficient and cost effective bridge asset management?

5. Aspects of challenges where research may benefit bridge owners

- 5.1 Aspects relating to the challenges given above are listed as items (1) to (17) below. For each item, specific topics on which research may be useful to bridge owners are shown in italics.
- 5.2 The lists of topics are not exhaustive. The lists indicate those topics where BOF members or others have suggested that research may be helpful. They are given to assist focus by researchers in the definition of relevant research. The topics require background review (including identifying relevant R&D already completed or in progress) and focusing in order to define research projects that BOF may wish to support.

(1) Bridge stock and information on performance and condition

- *Make up of the bridges stock*
- *Implementation of performance indicators*
- *Data on material/structure performance failures*
- *Pedestrian loading on footbridges*
- *Time-dependent performance of concrete*
- *Use of bolts in tension*
- *Soil pressures behind integral bridge abutments*

(2) Inspection, testing and monitoring processes and techniques

- *Measurement of extent and significance of corrosion*
- *Improvement of NDT techniques particularly non-intrusive test methods*
- *Reliable test to distinguish between wrought iron and steel*
- *Inspection of cable-supported bridges*
- *Real time and remote monitoring/hand held instruments*
- *Automation of bridge inspection*
- *Optimised inspection regimes*
- *Detection of voids in concrete structures*
- *Real-time scour measurement*
- *Monitoring systems for masonry walls*

(3) Modelling of condition and durability over time

- *Progressive deterioration and deterioration rates*
- *Models and analysis methods*
- *Fatigue requirements for cable-supported bridges*
- *Life expectancy models*

(4) Assessment techniques

- *Assessment standards for deteriorated structures*
- *Assessment of residual life*
- *Structural forms where no analysis method is available*

- (5) **Safety, performance, durability and costs of materials and structural systems, including repairs**
 - *Use of 'new' materials for strengthening/repair, eg composites*
 - *Use of stainless steel*
 - *Design of structures for long-term performance*
 - *Tolerance to vibrations of lightweight bridges*
 - *Increase in reliability of existing concrete technology*
 - *Improving quality of concrete repairs*
 - *Sacrificial steel thickness on support piles*
 - *Non-standard parapets for local roads*

- (6) **Strategies for maintenance, repair and rehabilitation**
 - *Back-of-abutment maintenance strategies for integral bridges*

- (7) **Extending service life**
 - *Management and conservation of older bridge types*
 - *Bridge strengthening techniques for wrought iron, steel and masonry bridges*
 - *Carbon fibre plate bonded strengthening of pre-1972 concrete box girders*

- (8) **Methods of construction, repair and rehabilitation**
 - *Performance in use of FRP strengthening of existing structures – cast iron, steel, early PSC, shear strengthening*
 - *Easy to replace yet durable bridge expansion joints*
 - *Field testing and monitoring of repairs*

- (9) **Costs and benefits of maintenance , repair and rehabilitation**
 - *Whole life costing and models*

- (10) **Asset management planning and financial planning**
 - *Whole life cost management*
 - *Use of condition indices to achieve 'steady state'*

- (11) **Maintenance planning and management**
 - *Guidance on procurement processes*
 - *Maintenance strategies*

- (12) Management processes/strategies**
 - *Bridge management systems with continuous updating facility*
 - *Management of network safety and risks*
 - *Control of risks of service loss*
 - *Auditing of bridge management – design, construction, inspections, testing*

- (13) Competencies**
 - *Bridge inspectors*

- (14) Continuing professional development**
 - *Maintenance strategies*
 - *Asset management planning*

- (15) Training**
 - *Training of bridge inspectors*
 - *National training scheme for bridge inspectors*

- (16) Implications and application of current or proposed transport policies and legislation**
 - *Environmental burdens of bridge maintenance*

- (17) Other aspects**
 - *Mitigation measures for railway noise and vibration*
 - *Specification of cables of cable-supported bridges*

6. Research proposals

- 6.1 Researchers are invited to prepare research project proposals relating to the aspects and topics identified above or on any other topic that they believe BOF may wish to support.
- 6.2 It is recognized that the aspects and topics identified above do not define potential project scope or objectives. Rather they provide indications of the areas where bridge owners face challenges and where research may assist them better to manage their bridges stock.
- 6.3 BOF therefore seeks research proposals that are relevant to the existing bridges stock. Proposals that involve investigations, trials and demonstrations on existing bridges, including redundant structures, in co-operation with bridge owners would be of particular interest. BOF gives priority to supporting research related to current challenges but may also consider proposals that are of a more forward looking 'blue skies' character.

Submission of research proposals

- 6.4 Research proposals should be submitted using the BOF Research Project Proposal form that may be obtained from the BOF website – www.bridgeforum.org
- 6.5 Completed proposals should be sent

by email to: research@bridgeforum.org

or posted to: Dr C R Middleton
Department of Engineering
University of Cambridge
Trumpington Street
Cambridge
CB2 1PZ

Tel: 01223-332814

Fax:01223-332813

Email: crm11@cam.ac.uk