Sustainability for bridge engineers – Part 1

1 **The Green Bridge, Mile End Road, London, designed by Mott MacDonald. It was constructed to reconnect public open spaces previously dissected by roads and railways. The bridge carries park landscaping across a four-lane highway, providing a safe and uninterrupted pedestrian route as part of a 3km linear park**

Introduction

Information on sustainability has largely been focussed on environmental issues and reduction in carbon which has rightly targeted transport and building operation. Currently sustainability does not appear to form a major part of the day to day work of a bridge engineer in the UK. This briefing note aims to illustrate what engineers are already doing and how they might improve. Knowledge of the subject is essential in order to provide good advice to clients and provide a full professional service.

Bridge engineers are currently applying sustainability principles within efforts to comply with CDM, design efficient structures and minimise costs and disruption. They may not recognise all the sustainable impacts or benefits of various options or understand the issues that are particularly important and relevant to bridge schemes. Applying sustainability principles will not change the way work is carried out but will better inform decision making. For bridge engineers the challenge is to learn a new language and principles and to modify current practice rather than significantly change it.

This briefing note is split into two parts. Part 1 gives a general discussion and includes a list of issues to consider at project inception. Part 2 gives lists of issues to consider at all other stages of a project lifecycle. Reference to other briefing notes in this series[1] is recommended to understand the general principles.

What we are already doing

A significant majority of projects will already be subject to environmental assessment, particularly if they are for Highways Agency work. The environment is just one of the three pillars of sustainability and environmental specialists cannot be expected to address social and economic issues. The following points show how current practice in bridge engineering already addresses sustainability:

- Application of CDM covers some social aspects
- A design that minimises disruption to traffic results in savings in fuel costs as well as social benefits
- Minimising costs can also drive significant sustainable benefits if it results in use of fewer raw materials. Minimising interventions by strengthening or accepting load restrictions rather than rebuilding a structure is also beneficial
- Civil engineering applications already account for the majority of recycled aggregates
- Highways Agency area agents are already measuring carbon on schemes and some are completing sustainability registers
- Most major projects are subject to full sustainability assessment which is tracked throughout the life of the scheme through to construction and should be followed up during operation and use

Measurement of environmental impact

Decision making in relation to sustainable choices will always rely on judgement to balance social, economic and environmental effects of any scheme. A number of measurement tools are available. The relative merits of different measurements will vary by location (the ratio of use of water : use of carbon will have a different balance where water is scarce). Carbon and sustainability measurement tools can be used to compare options to inform decision making but should not be taken as absolute measurements and results using different tools cannot be compared. Some research is recommended before selecting a calculation tool because each will have limitations. Tools currently available are:

– Life cycle assessment[2]
– ASPIRE, ICE (A Sustainability Poverty and Infrastructure Routine for Evaluation)
– CEEQUAL (Civil Engineering Environmental Quality Assessment and Award Scheme)
– Embodied energy and lifecycle tools (environment agency calculator, Highways Agency)
– CapIT & CESMM3 carbon price book

Engineering approach

The form of construction chosen has a significant impact on how well a structure meets sustainability aims. The priorities for a bridge engineer must always be to ensure that the structure is safe to carry loads, serviceable for the intended use, durable for the design life, and robust enough to accommodate damage and the effects of maintenance and strengthening operations.

Engineers are ideally placed to manage the decision making process for construction schemes. They must understand all the issues within the sustainability agenda and the impacts and benefits of alternative options, in order to provide comprehensive advice to their clients and make reasoned decisions.

The increasingly litigious nature of society is leading to conservatism and avoidance of risk which is working against the aims for improving sustainability. The application of some principles (e.g. arching action for bridge slabs) will involve more design effort so the implications of this must be clearly explained to the client.

It is often not appropriate to carry out a sustainability assessment for minor bridge schemes but engineers should be recording design decisions as they affect sustainable benefits and impacts, possibly in a similar way to that used to record design decisions for CDM.

Sustainability should be considered at every phase of a development: planning, design, construction, maintenance, change of use and demolition. The first and arguably the most influential stage, planning or 'project inception' is expanded below. Part 2 of this briefing note covers the remaining phases.

Project inception

Many key decisions are taken at an early stage and, since bridges are generally very strategic structures with a long life, a good understanding of sustainable issues is desirable. The whole scheme lifecycle including modification and end of life or replacement strategies should receive full consideration, both in the brief and initial response.

At project inception consideration of sustainability should include:

– the strategic contribution of the bridge to the locality
– design and construction strategies

For significant schemes an overall contract strategy including sustainability should be defined including reference to performance specifications derived from an initial strategy and needs assessment[3]. This stage is where much of the social and economic impacts and benefits are determined.

The following list includes references which illustrate examples of good practice to address the two key points above. It is given as a set of examples and should not be taken to be a comprehensive checklist of all aspects of sustainability:

– Guided public involvement in decisions[4], public consultations and presentations enhance local support
– Provisions to inform travellers may reduce congestion and objections
– Provision for safety and operation of major bridges in extreme wind, fog and ice particularly for users going underneath (e.g. closures due to falling ice)
– Resilience against severe damage and progressive collapse of long crossings against accidental, natural and vandalism damage
– Resilience for climate change extreme weather events
– The form of structure and method of construction should be selected to minimise construction disturbance noise and dust.
– Combining operations on a stretch of highway and avoiding public events will minimise disruption
– Combined use will enhance benefits e.g. utilisation of space under a structure[3]; use of railway arches; green bridges (Fig 1); tunnels and cuttings may reduce noise and pollution
– Selection of location to minimise environmental impact, disruption and to maximise benefits. A good location will minimise foundation size, span lengths and embankment heights and will avoid sensitive sites and minimise land take
– Improved transport links and the provision of integrated foot and cycle provision are a benefit; foot and cycle bridges encourage non-motorised use and new links can reduce journey lengths
– Plan the solution for the whole serviceable life including future change or increase in use to suit need but avoid over design
– Build in maintenance provision including access and upgrading facility[2]
– Detailed geotechnical investigations will facilitate efficient design of foundations. Design can provide for some foundation movements to minimise their size[5]
– Early contractor involvement (ECI) can result in significant benefits: buildability; waste management and reuse of materials; minimisation of disruption
– Building in a reduction in severance for wildlife by providing green links, otter ledges etc

Part 2 of this briefing note provides detailed guidance for consideration at the remaining stages of a project lifecycle.

References

1 IStructE Sustainable Construction Panel (2010) Sustainability Briefing Notes 1-12. Available at http://www.istructe.org/knowledge/topic_areas /Pages/Sustainability.aspx (Accessed: 13 January 2011) [Reprinted from *The Structural Engineer* 2008-2010]

2 Steele, Kristian: (2004) 'Environmental sustainability in bridge management'. *BRE Information Paper IP14/04.* Watford: BRE Bookshop

3 IABSE. (1999) *IABSE Symposium Rio De Janeiro 1999. Structures for the future - the search for quality. IABSE reports v.83*. Zurich: IABSE. [Keynote lecture & various papers on sustainability]

4 Martin, A. J.: (2004) 'Concrete bridges in sustainable development', *Proc. Institution of Civil Engineers: Engineering Sustainability,* **157**/4, p 219-230

5 Rowson, J.: (2009) 'Thread lightly', *New Concrete Engineering* (Supplement to New Civil Engineer, October 22) October, p 22-23. [David Kreitzer Bridge, Lake Hodges, San Diego, USA]

Further Information

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