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Making tomorrow a better place

Q. Leiper
Proceedings of the Institution of Civil Engineers, Civil Engineering, **160**, No. 1, February, 3–11, **doi**: 10.1680/cien.2007.160.1.11

This is the inaugural address of Quentin Leiper, who became 142nd president of the Institution of Civil Engineers on 7 November 2006.

Managing the inner world of infrastructure

M. Abbott
Proceedings of the Institution of Civil Engineers, Civil Engineering, **160**, No. 1, February, 26–32, **doi**: 10.1680/cien.2007.160.1.26

Stakeholder participation in major infrastructure projects is a multi-faceted and controversial topic. This paper introduces some of the more immediate issues and attempts to show that experience in so-called first-world projects is equally relevant in the third world. It suggests that every project exists in an 'outer' physical world and an 'inner' world of the collective minds of stakeholders, and that the creation of a communications environment in which the two worlds can begin to align is essential to success. This is now increasingly possible thanks to the internet and mobile telephony and, as demonstrated by experiences on the £6 billion Denmark–Sweden fixed link, it can lead to an almost utopian working environment of complete trust and absolute integrity.

Intelligent travel: planning for the revolution

W. Stewart
Proceedings of the Institution of Civil Engineers, Civil Engineering, **160**, No. 1, February, 39–42, **doi**: 10.1680/cien.2007.160.1.39

This paper describes the 50-year view by the UK Government's Foresight programme of the future of intelligent transport infrastructure, its implications and its social context. By 2055, it is envisaged that intelligence and pervasive information will be built in to everyday life, encompassing needs to communicate and travel. People will better understand the resource implications as well as the direct costs of their lifestyles—and perhaps they will actually travel less. However, given the slow speed at which infrastructure systems adapt, the research concluded that civil engineers need to start planning now for the inevitable travel revolution. The paper is based on the author's 2006 Unwin lecture, delivered to the Institution of Civil Engineers and Institution of Mechanical Engineers on 6 April 2006, prepared with Phil Blythe of Newcastle University.

Going organic: using evolution in civils design

P. Ponterosso and D. Fox
Proceedings of the Institution of Civil Engineers, Civil Engineering, **160**, No. 1, February, 43–48, **doi**: 10.1680/cien.2007.160.1.43

Products, buildings and infrastructure are starting to look more natural thanks to recent advances in engineering design, manufacturing and construction technology. Traditional hard, rectilinear structures are being replaced by softer, more organic forms—and not just because they look more natural: millions of years of evolution mean Earth's flora and fauna are engineered to near perfection. But while the enduring design of a mosquito might not give us the blueprint for a mosque, engineers can now replicate the natural process of evolutionary design for their own purposes. This paper introduces the genetic algorithm to civil engineering designers and presents summaries of recent research areas of application, including reinforced earth embankment design, truss optimisation, masonry arch collapse loads and mechanisms, and yield-line analysis of reinforced concrete slabs. Whereas it cannot replace an engineering experience or judgement, the method appears to have great potential as an aid to more creative design.

Concrete takes the lead in sustainable construction

C. Georgopoulos
Proceedings of the Institution of Civil Engineers, Civil Engineering, **160**, No. 2, May, 53, **doi**: 10.1680/cien.2007.160.2.53

If sustainability is measured simply in terms of embodied carbon dioxide emissions, concrete is ahead on points. But if you factor in cost, durability and other unique properties of concrete, Costas Georgopoulos of The Concrete Centre says it is the clear winner for sustainable construction.

Climate stability: an inconvenient proof

D. Bellamy and J. Barrett
Proceedings of the Institution of Civil Engineers, Civil Engineering, **160**, No. 2, May, 66–72, **doi**: 10.1680/cien.2007.160.2.66

This paper demonstrates that the widely prophesied doubling of atmospheric carbon dioxide levels from natural, pre-industrial values will enhance the so-called 'greenhouse effect' but will amount to less than 1°C of global warming. It also points out that such a scenario is unlikely to arise given our limited reserves of fossil fuels—certainly not before the end of this century. Furthermore, the paper argues that general circulation models are as yet insufficiently accurate for civil engineers to rely on their predictions in any forward-planning decisions—the omission of solar wind effects being a potentially significant shortcoming. It concludes that the only certainty is that the world's fossil fuel resources are finite and should be used prudently and with proper respect to the environment.

Climate change: ICE aims for authority and balance

S. Heffernan
Proceedings of the Institution of Civil Engineers, Civil Engineering, **160**, No. 3, August, 100, **doi**: 10.1680/cien.2007.160.3.100

Climate change is a vast, complicated and controversial topic. Seamus Heffernan explains how ICE is expending considerable effort in attempting to devise an authoritative and balanced policy to help members, stakeholders and society decide what can and should be done.

Earth systems engineering: turning vision into action

J. Hall and E. O'Connell
Proceedings of the Institution of Civil Engineers, Civil Engineering, **160**, No. 3, August, 114–122, **doi**: 10.1680/cien.2007.160.3.114

The potential of technology to help solve many of the world's most pressing problems, ranging from climate change to resource scarcity and poverty, is widely recognised. However, rationally managing and engineering the Earth's systems is a hugely complex task, which extends engineering from its traditional technical domain to dealing with coupled human and natural systems and unprecedented levels of uncertainty. It requires new understanding of how the effects of engineering accumulate and propagate across scales, up to the planetary scale. This paper surveys the challenges and principles of 'Earth systems engineering', as a counterpart to the already fast-developing field of Earth systems science. Examples illustrate how engineers are already applying their skills to manage complex systems such as cities, coastlines and climate.

New rules demand more care of protected species and habitats

J. Abbatt
Proceedings of the Institution of Civil Engineers, Civil Engineering, **160**, No. 4, November, 148, **doi**: 10.1680/cien.2007.160.4.148

New rules have recently come into force in the UK which oblige civil engineers to take even more care of protected species and habitats during construction works. Jon Abbatt of environmental consultancy ADAS explains the ever-tightening legislation and what it means for the profession.

Climate change and civil engineering challenges

J. Hunt
Proceedings of the Institution of Civil Engineers, Civil Engineering, **160**, No. 4, November, 170, **doi**: 10.1680/cien.2007.160.4.170

The greatest challenge facing civil engineers today is how mitigate and adapt to climate change. However, as discussed in this paper, there are still considerable uncertainties about the trends of some critical aspects of climate change and thus doubts about the mechanisms controlling them. In developing future strategies, a major contribution of civil engineers will be through providing practical and financial evidence about projects and systems which work and do not work. Engineers also know about risk, which is intimately related to system design. The paper concludes that the UK engineering profession needs to be more closely involved in developing effective integrated policies, working with scientists, business and government agencies.

GGBS and sustainability

D. Higgins
Proceedings of the Institution of Civil Engineers, Construction Materials, **160**, No. 3, August, 99–101, **doi**: 10.1680/coma.2007.160.3.99

Concerns about climate change have heightened interest in sustainable construction materials. Ground granulated blast-furnace slag offers civil engineers a high-quality, environmentally-friendly material, which can replace much of the Portland cement used in concrete. This article looks at its manufacture and environmental impact and gives examples of its use.

Life-cycle assessment and embodied energy: a review

G. F. Menzies, S. Turan and P. F. G. Banfill
Proceedings of the Institution of Civil Engineers, Construction Materials, **160**, No. 4, November, 135–143, **doi**: 10.1680/coma.2007.160.4.135

In this paper life-cycle assessment (LCA) is studied and a brief review and classification of databases and inventories is given. The factors affecting the dissimilar results in various databases are examined and discussed. The main obstacles to LCA and life-cycle energy studies, and their sources, are discussed, together with the role of data in inventory analysis. Embodied energy results are reviewed and compared, and the causes of dissimilarities and variations in these studies are presented. This paper focuses on methodologies developed and adopted for data processing, and inventory analysis for building materials. The data–LCA relationship is investigated, and the importance and role of data in LCA is reviewed. A case study of steel as a building material is introduced and a number of life cycle energy assessment studies are evaluated. The paper concludes by outlining a number of issues which need to be handled with care when performing a life-cycle study, and which warrant further qualitative and quantitative analysis.

VIP and their applications in buildings: a review

X. Wang, N. Walliman, R. Ogden and C. Kendrick
Proceedings of the Institution of Civil Engineers, Construction Materials, **160**, No. 4, November, 145–153, **doi**: 10.1680/coma.2007.160.4.145

The properties of insulation materials used in the building envelope have a strong influence on thermal performance of buildings, in particular the U-value of their walls/roofs. This paper summarises current research and developments of vacuum insulation panels (VIP), which provide a quantum leap forward in thermal insulation, offering exciting opportunities for both new and retrofitted buildings. Use of VIP not only provides excellent thermal performance to meet the requirements of building regulations, as well as offering a great potential to reduce energy consumption in buildings, but also increases the available internal area of buildings. However, a real indication of overall thermal performance in use must take into account the thermal bridging that occurs around the edges of the panel caused by the construction details. The performance is also dependent on the maintenance of a vacuum against the influences of envelope permeability, outgassing, moisture and physical damage. More research and development is needed in the practical application of VIP in building solutions.

Recycled waste glass as aggregate for lightweight concretes

A. Petrella, M. Petrella, G. Boghetich, D. Petruzzelli, D. Calabrese, P. Stefanizzi, D. De Napoli and M. Guastamacchia
Proceedings of the Institution of Civil Engineers, Construction Materials, **160**, No. 4, November, 165–170, **doi**: 10.1680/coma.2007.160.4.165

A granulated porous recycled waste glass (RWG), namely Poraver, derived from the differential separation of municipal solid waste, was used as aggregate in concrete formulations. On account of the intrinsically highly porous cellular structure of the reference materials, the concrete structures appeared particularly light and refractory to thermal effects. The use of this type of glass has been focused on the production of lightweight concrete that is able to improve thermal insulation in addition to demonstrating good mechanical properties. In this context, the thermal insulating properties of RWG-based cement conglomerates were analysed and compared with equivalent conglomerates produced by the use of expanded clays. Very promising results were obtained from the concrete prepared from a mixture of the recycled waste glass and expanded clays, in terms of the high mechanical resistance attributed to the clays coupled with lower thermal conductivity of expanded glass.

Mechanical properties of cement-bound recycled pavements

M. Katsakou and S. Kolias
Proceedings of the Institution of Civil Engineers, Construction Materials, **160**, No. 4, November, 171–179, **doi**: 10.1680/coma.2007.160.4.171

Tensile (uniaxial and flexural) and compressive (uniaxial cube and equivalent cube) tests were carried out on mixtures of crushed aggregates and milled bituminous materials with proportions by mass 100/0, 75/25, 50/50, 25/75, 0/100, respectively. All mixtures were bound with 3 or 5% by mass (b.m.) cement and 5·2% b.m. water. Strength and modulus of elasticity were determined for one-day- and 60-day-old specimens. It was found that this type of recycled materials forms a generation of new materials with different and enhanced properties in comparison with ordinary cement-bound granular materials. Both strength and modulus of elasticity decreased as the proportion of milled bituminous material in the mix increased. However, the rate of decrease of the tensile strength was lower than that of the corresponding compressive strength and similarly the rate of decrease of the modulus of elasticity was lower than that of the corresponding strength. For each mix proportion a different relationship existed between compressive strength and tensile strength and between tensile strength and the corresponding modulus of elasticity.

Energy efficiency with natural ventilation: a case study

S. D. Fitzgerald and A. W. Woods
Proceedings of the Institution of Civil Engineers, Energy, **160**, No. 1, February, 9–14, **doi**: 10.1680/ener.2007.160.1.14

Application of laboratory analogue modelling of air flow in a naturally ventilated shopping mall is reviewed in this paper. A detailed study of the ventilation was undertaken to establish the principles and to explore how natural ventilation might interact with a localised mechanical ventilation system designed to enhance the cooling of a high density food court area. The case study is used to show how the combination of laboratory modelling and simplified mathematical modelling enables one to rapidly identify the various flow regimes which can occur, to quantify the resultant flows and mean temperatures and to thereby develop appropriate ventilation strategies for the different external conditions which occur through the year.

Clean coal technologies for power generation

J. M. Farley
Proceedings of the Institution of Civil Engineers, Energy, **160**, No. 1, February, 15–20, **doi**: 10.1680/ener.2007.160.1.15

In the course of a little less than a year from the end of 2005 to late 2006, there was a significant change in the perception of the future for coal-fired power generation in Britain, Europe and worldwide. There has been widespread recognition that coal will continue to be used in increasing, not diminishing, quantities for power generation. In parallel, it has become increasingly urgent to reduce emissions of carbon dioxide because of its impact as a greenhouse gas on climate change and it is now widely recognised, for example in the Stern Review, that coal-fired generation needs to be cleaned up by the use of clean-coal technology and carbon dioxide capture and storage (CCS), rather than substituted. This paper elaborates further on these changes and describes the available clean coal technologies (including CO_2 capture) and their economics. Scenarios for investment in coal-fired generation in the UK are described and some of the actions needed by government and supporting bodies are defined.

North Hoyle offshore wind farm: design and build

J. M. F. Carter

Proceedings of the Institution of Civil Engineers, Energy, **160**, No. 1, February, 21–29, **doi**: 10.1680/ener.2007.160.1.21

North Hoyle is the UK's first major offshore wind farm. It comprises 30 wind turbine generators each capable of generating up to 2MW. The total installed capacity is therefore 60MW and enough electricity is generated each year for some 40 000 homes. The wind farm offsets an annual release of about 160 000 tonnes of carbon dioxide. Initial site investigations began in the summer of 1999 and by April 2001 a Development Licence was awarded by Crown Estate and the Department for Trade and Industry (DTI). Public consultation commenced in July 2001 and the Consent Application was submitted in February 2002. All the required consents were granted by October 2002. Following a competitive bidding process, a design and build contract was awarded to the North Hoyle Consortium (comprising Vestas Celtic Wind Turbines and Mayflower Energy) in the autumn of 2002. Onshore construction commenced in November 2002 with offshore construction commencing in April 2003. First official generation from the site was in mid November 2003 and the wind farm was fully operational in April 2004. Total project costs were around £80 million.

Renewables and the grid: understanding intermittency

R. Gross, P. Heptonstall, M. Leach, D. Anderson, T. Green and J. Skea

Proceedings of the Institution of Civil Engineers, Energy, **160**, No. 1, February, 31–41, **doi**: 10.1680/ener.2007.160.1.31

This paper reviews the key issues and findings of the UK Energy Research Centre report on the costs and impacts of intermittent or variable renewable electricity-generating technologies. The relevant principles of managing electricity networks are examined and aspects that change when significant intermittent generation is added are analysed. The impacts and costs of intermittent generators can be quantified only in the context of the characteristics of the system of which they form part. The principal reasons why these impacts differ from one system to another are examined and explained. The evidence for likely impacts and costs in the UK, at intermittent penetration levels up to 20% of total electricity supplied, is analysed. The two main categories of impact are on system balancing and system reliability, and costs are quantified for these factors. Estimates are in the range of an additional £2–3/MWh for system balancing and £3–;5/MWh for system reliability.

European Marine Energy Centre: facilities and resources

J. Norris and I. Bryden

Proceedings of the Institution of Civil Engineers, Energy, **160**, No. 2, May, 51–58, **doi**: 10.1680/ener.2007.160.2.51

This paper describes the European Marine Energy Centre (EMEC) wave and tidal test facility, which was established on Orkney Islands, UK, to assist and hasten the development of the wave and tidal stream energy conversion industries. The facilities include infrastructure and a number of soft provisions, or services. After a brief overview of the theory of wave and tidal energy assessment and extraction, the wave and tidal resources available at the EMEC test sites are summarised. The paper also gives an update on the uptake of facilities by developers.

Photovoltaics: added value of architectural integration

A. S. Bahaj, P. A. B. James and M. F. Jentsch

Proceedings of the Institution of Civil Engineers, Energy, **160**, No. 2, May, 59–69, **doi**: 10.1680/ener.2007.160.2.59

The majority of people live and work in urban environments. If the common targets of substantially reducing greenhouse gas emissions within the next few decades are going to be met, it is in the urban environment where change must happen. Building integrated photovoltaics (BIPV) are commonly seen as one appropriate measure to reduce urban carbon emissions through power generation and as an aid to promote behaviour change of occupiers to contribute to the goal of more sustainable cities. Solar photovoltaics (PV) are often applied as an add-on solution to existing building structures in an aesthetically less than pleasing manner, representing a technological and environmental statement but not always a testament to good design. A more sensitive integration of PV into buildings (glazing, cladding, roofing or shading systems) can offer additional benefits by offsetting the costs of expensive materials (e.g. high-value cladding) or by providing additional functions such as solar shading. There is no doubt that the uptake of solar technology by architects and designers can be facilitated by well-designed solutions in which PV arrays form a unity with a building and add to its identity. The study presented here assesses basic forms of architectural integration of PV arrays into buildings and discusses the implications with regard to embodied energy, economics (excluding capital subsidies) and the impacts on a building's carbon footprint.

Integrating environmental issues in estuary flood plans

T. Matthewson

Proceedings of the Institution of Civil Engineers, Maritime Engineering, **160**, No. 3, September, 105-111, **doi**: 10.1680/maen.2007.160.3.105

The Humber Estuary is designated at national and international levels on account of its importance for the conservation, among other things, of estuarine habitats and the wildlife these support. The estuary and its floodplain also contain major industry and ports, and important historic buildings, settlements, landscapes and archaeological sites. Since the mid-1990s the Environment Agency has been developing a strategy for managing the Humber Estuary's flood defences for the next 100 years, culminating in the publication in August 2005 of works proposed for the first five years of this period. Environmental considerations have been integrated into the decision making throughout this development process, from high-level strategy planning through to detailed selection of options at specific locations. This has been achieved by a series of 'tiered' environmental appraisals, with the type and level of analysis reflecting the stage of flood risk management. The flood risk management planning has been especially effective at integrating wildlife conservation within its development; indeed the impact on important natural habitats has been a major driver for the selection of the preferred approach. In future projects of this scale, a similar focus may be required on other aspects of the environment to ensure all aspects of sustainability are addressed.

Implementation and implications of Water Framework Directive

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Proceedings of the Institution of Civil Engineers, Maritime Engineering, **160**, No. 4, December, 139-141, **doi**: 10.1680/maen.2007.160.4.139

The European Union (EU) Water Framework Directive (WFD), which was transposed into law in most member states in 2003, introduces a new, integrated regime of protection, improvement and management to all water bodies. These include rivers and canals, coastal and estuarine waters and, in some countries, large marine areas. The WFD also aims to prevent further deterioration in water status and to reduce or phase out pollution from certain named 'priority and priority hazardous substances' (these are being identified as part of the process of agreeing a separate 'daughter Directive' to the WFD). Another key objective of the WFD is to ensure that water bodies reach 'good status' by the end of 2015. Reaching good status requires not only chemical but also new ecological targets to be met. Implementation of this ambitious Directive is continuing apace in both the UK and at EU level. Stakeholder participation is a key element of the provisions of the Directive and the navigation sector is ensuring that it gets involved in this process at all levels. This briefing note provides a short overview of these activities.

A Child in the City

Special issue
Proceedings of the Institution of Civil Engineers, Municipal Engineer, **160**, No. 2, June, 69–113

How infrastructure procurement can enhance social development

J. Hawkins and J. Wells
Proceedings of the Institution of Civil Engineers, Management, Procurement and Law, **160**, No. 1, February, 33–38, **doi**: 10.1680/mpal.2007.160.1.33

This paper reports the findings of a study by Engineers Against Poverty and the Institution of Civil Engineers into the factors in infrastructure procurement that are currently inhibiting the achievement of social development objectives. The paper explores the impact/performance of the asset and the service it delivers (the product), and the opportunities during the project's construction and operation (the process). The study adopted a very broad definition of 'procurement' to embrace all stages from project identification to the final monitoring, enforcement and evaluation. Methods included reviews of procurement documentation and practice in four case-study countries (India, Indonesia, Kenya and Nigeria), round-table discussions and in-depth interviews with stakeholders. This yielded a long list of inhibiting factors but also some encouraging efforts at reform. The paper concludes that procurement procedures and contract agreement have the potential to promote social objectives. However, the objectives should be clearly identified in the project design; the budget and procurement strategy have to be appropriate; and implementation must be monitored and enforced.

A changing climate for claims?

A. Hamer and C. Peters
Proceedings of the Institution of Civil Engineers, Management, Procurement and Law, **160**, No. 3, August, 91–96, **doi**: 10.1680/mpal.2007.160.3.91

As the effects of climate change are already beginning to be felt, the impact it will have on structures could expose the civil engineer to claims of liability for failure to consider the changing climate in the design process. A project on the drawing board now might not suit the climate of the future. The civil engineering fraternity must be aware of the legal consequences of designing for the future and ensure their insurance can cover any claims that subsequently arise.

Testing and analysis of a traditional oak frame

T. Hill, J. Shanks, J. Stott and P. Walker
Proceedings of the Institution of Civil Engineers, Structures and Buildings, **160**, No. 1, February, 23–29, **doi**: 10.1680/stbu.2007.160.1.23

Despite the widespread historical use of green oak framing, using all-timber connections, their engineering performance is poorly understood. Restoration of existing structures and design of new buildings are both often reliant on the skills of the carpenter and historical precedents. Structural engineers frequently struggle to validate green oak frame designs using modern codes of practice. The present paper presents findings from a study undertaken to investigate the structural performance of arched-braced green oak sub-frames. The sub-frames were part of a traditional roof structure in a barn that had fallen into disrepair and was to be replaced. To inform the design process and improve engineering understanding, five identical arched-braced sub-frames were commissioned for load testing under laboratory conditions to failure. The experimental results from the sub-frame tests, including deformation and load capacity, are presented. Experimental load capacities are compared with a novel collapse load analysis.

Defra's New Technologies Demonstrator Programme

Special issue
Proceedings of the Institution of Civil Engineers, Waste and Resource Management, **160**, No. 1, February, 1–41

The EU Landfill Directive sets targets that the UK must meet in respect of the diversion of biodegradable municipal waste away from landfill. This issue describes a programme established by the UK Department for Environment, Food and Rural Affairs (Defra) to encourage the development and implementation of new technologies to help achieve these targets. The core of this programme is a series of demonstrator projects; supporting research, education and awareness activities are also summarised.

England's waste strategy: waste or resource management?

I. Avery
Proceedings of the Institution of Civil Engineers, Waste and Resource Management, **160**, No. 2, May, 45–48, **doi**: 10.1680/warm.2007.160.2.45

In January 2006 the Institution of Civil Engineers (ICE), in conjunction with the Institution of Mechanical Engineers

(IMechE), published *The Case for a Resource Management Strategy*, proposing that the national waste management strategy be repositioned as a resource management strategy, making up one element of a wider sustainable consumption and production agenda. The ensuing debate and stakeholder interest established support for England to adopt a material resource economy and a follow-up report *How to Deliver a Resource Management Strategy* was published in March 2007. This briefing outlines the blueprint set out in that document, summarises the government's response and assesses the extent to which the government's response reflects the resource management approach.

Hydraulic conductivity of tyres in landfill drainage systems

A. P. Hudson, R. P. Beaven, W. Powrie and D. Parkes
Proceedings of the Institution of Civil Engineers, Waste and Resource Management, **160**, No. 2, May, 63–70, **doi**: 10.1680/warm.2007.160.2.63

Whole or shredded scrap tyres are sometimes proposed as an alternative to conventional aggregates in landfill drainage systems. Landfill basal drainage systems are, however, subjected to large overburden stresses from the overlying waste, which may compress a tyre drainage layer, thereby reducing its porosity and hence its effectiveness. Previous work has indicated that tyre drainage layers will remain effective under high stresses, but tests have in the main been restricted to small (< 100 mm) shred sizes. The use of coarser shreds or even whole tyres for landfill drainage systems may be advantageous as they are more economical to produce and may be less prone to clogging than smaller shreds.

Ways to facilitate the use of recycled aggregate concrete

V. W. Y. Tam, K. Wang and C. M. Tam
Proceedings of the Institution of Civil Engineers, Waste and Resource Management, **160**, No. 3, August, 125–129, **doi**: 10.1680/warm.2007.160.3.125

A huge amount of solid waste is generated annually from construction and demolition activities. This has led to the promotion of waste recycling as a major measure to reduce waste and to mitigate the harmful effects of construction activities on the environment. Among these wastes, concrete apportions more than half of the total. While recycled concrete waste has been used in low-grade utilisations, high-grade applications are rarely discussed. Although the Hong Kong Special Administrative Region Government has actively been promoting recycling of construction solid waste by issuing technical circulars, specifications and practice notes and setting up a recycling plant to encourage the adoption of recycled aggregate (RA), these measures have not facilitated wide adoption of recycled aggregate concrete (RAC). In fact, the quality of RA and RAC is less than that of virgin material or ordinary concrete and concrete suppliers are thus reluctant to use these materials. Utilising a series of laboratory tests, this paper aims to set out some guidelines to facilitate the use of RAC in the construction industry.

Influence of El Niño on rainfall in Guyana and Uganda

R. Wardlaw, D. Jaigopaul and Z. Rahaman
Proceedings of the Institution of Civil Engineers, Water Management, **160**, No. 3, September, 135–143, **doi**: 10.1680/wama.2007.160.3.135

El Niño/southern oscillation (ENSO) activity is known to affect weather patterns in many parts of the world. This paper develops an approach to identifying signals and incorporating associated impacts on hydrological risk into water resources planning and management. The paper builds on earlier research reported in the climatology literature, and brings this to the engineering domain. An evaluation of seasonal rainfall in Guyana clearly demonstrates that distinct rainfall distributions are associated with La Niña and El Niño events. Forecasts of these events are made by a number of organisations at lead times of up to eight months. If these are coupled with the precipitation analysis presented in this paper, an objective hydrological risk assessment can be made. The methodology applied in Guyana has been repeated with data on net basin supply to Lake Victoria. There is a clear indication of a link between ENSO activity and net basin supply to Lake Victoria.

Retrofit SuDS—cost estimates and decision-support tools

V. R. Stovin and A. D. Swan
Proceedings of the Institution of Civil Engineers, Water Management, **160**, No. 4, December, 207–214, **doi**: 10.1680/wama.2007.160.4.207

Many urban water quality and flooding problems may potentially be addressed by disconnecting stormwater from the formal drainage system and installing source control sustainable drainage systems (SuDS) instead. This approach is referred to as SuDS retrofit. This paper focuses on the construction costs associated with a range of SuDS devices likely to be implemented in a retrofit context. Three distinct types of costs have been prepared. The costs of construction per device are provided as unit costs. This approach does not, however, enable devices to be compared in terms of an area served. For this reason, schemes have been designed and costed according to representative contributory areas, such as a residential roof or a small car park. These contributory area-based cost comparisons are embodied within a decision-making framework for retrofit SuDS. A case study highlights how secondary costs need to be combined with device unit costs accurately to cost the construction of a whole scheme. The evaluation indicates that infiltration basins represent the cheapest form of SuDS to construct, followed by soakaways, ponds, infiltration trenches and porous pavements. This ranking does not, however, take account of land purchase or sterilisation costs, potential conflicts with requirements for high-density developments or other life-cycle costs—these could alter this preference ranking significantly.