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Sustainable bridge construction through innovative advances

A. E. Long, P. A. M. Basheer, S. E. Taylor, B. G. I. Rankin and J. Kirkpatrick
Proceedings of the Institution of Civil Engineers, Bridge Engineering, **161**, No. 4, December, 183–188, **doi**: 10.1680/bren.2008.161.4.183

Sustainability is now recognised as a key issue that must be addressed in the design, construction and lifelong maintenance of civil engineering structures. This paper briefly discusses the generic aspects of sustainability, but the main focus is its application to bridges. Motorway bridges built in the 1960s and 1970s had design lives of 120 years; many, however, were showing signs of deterioration after only 20–40 years. This led to much (ongoing) debate on the issue of initial versus full life-cycle costing. In order to address the highly complex issue of the sustainability of bridges, this paper considers the following specific areas that impinge on this important subject: the impact on sustainability of different forms of bridge construction and maintenance/repair/replacement strategies; the utilisation of innovative in situ testing equipment for assessing the long-term durability of concrete; the development of innovative structural designs for bridges that inherently have greatly extended lives at minimal, if any, additional cost.

'Elred': new water for London from old assets

A. Hamilton, J. Riches, G. Realey and H. Thomas
Proceedings of the Institution of Civil Engineers, Civil Engineering, **161**, No. 1, February, 26–34, **doi**: 10.1680/cien.2008.161.1.26

The east London resource development project ('Elred') is a much-needed new urban water supply scheme created largely from redundant assets. It consists of a well field, a connecting raw water pipeline network and a treatment works; with a capacity up to 23 Ml/day, in the heart of the UK capital. Unusually, the well field re-uses boreholes originally drilled for temporary dewatering during construction of the recently completed Channel Tunnel Rail Link tunnels. Furthermore, the raw-water network reuses the dewatering discharge pipelines the treatment works is located at and re-utilises a disused pumping station. This paper describes the design and construction of this innovative scheme, including the hydrogeological and groundwater modelling studies to establish yield and sustainability of the Chalk aquifer.

Deep impact: why post-tsunami wells need a measured approach

L. Lytton
Proceedings of the Institution of Civil Engineers, Civil Engineering, **161**, No. 1, February, 42–48, **doi**: 10.1680/cien.2008.161.1.42

Following the Asian tsunami of 26 December 2004, the vital domestic fresh-water wells in the coastal zone were either scoured out of the ground entirely or filled with salt water, mud, debris and bodies. Emergency teams naturally exerted huge efforts in trying to restore intact wells, first clearing and then pumping them out. However, it soon became apparent little could be done to rehabilitate the wells in the short term due to the massive intrusion of saline groundwater as well as the fundamentally unsatisfactory nature of local water supply and drainage arrangements. Based on a study carried out on 64 wells in the Ampara district a month after the event, this paper identifies the long-standing issues that need to be solved before a reliable water supply can be established in the coastal zone.

Engineering civilisation from the shadows

P. Jowitt
Proceedings of the Institution of Civil Engineers, Civil Engineering, **161**, No. 4, November, 162–168, **doi**: 10.1680/cien.2008.161.4.162

This paper discusses the key issues, opportunities and obligations facing civil engineers to engineer civilisation from the shadows cast by world poverty and global climate change. Almost all of the 1·5billion population increase occurring by 2025 will be in urban slums in the developing world, with little in the way of civil infrastructure to protect them from disease, famine, drought and flooding. The provision of effective infrastructure, and with it the delivery of the UN millennium development goals, is vital if they are to survive. The paper is based on the author's ice Brunel international lecture, which was presented in 16 countries during 2007.

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Hong Kong – bastion of bamboo scaffolding

M. Ramanathan

Proceedings of the Institution of Civil Engineers, Civil Engineering, **161**, No. 4, November, 177–183, **doi**: 10.1680/cien.2008.161.4.177

Hong Kong's skyline is dominated by some of the world's tallest buildings. Nevertheless, the city still uses bamboo scaffolding for much of its construction work – a traditional skill passed down over 5000 years. Bamboo is sustainable, lightweight and cheap and, as long as it remains fairly dry, a good construction material with significant mechanical properties. Researchers, engineers, environmentalists and bureaucrats have taken an increasing interest in the craft, such that regulations and practice continue to be improved and refined. However, to alleviate remaining design and safety concerns a structural design code is needed.

Sustainable concrete waste recycling

Y. Dosho

Proceedings of the Institution of Civil Engineers, Construction Materials, **161**, No. 2, May, 47–62, **doi**: 10.1680/coma.2008.161.2.47

Massive volumes of construction waste will be generated by the demolition of older structures such as power stations that were built more than 30 years ago. It is essential to reuse such construction waste from a life-cycle assessment (LCA) perspective and for effective recycling of construction resources. In order to promote reuse, three concepts must be achieved: (a) assurance of safety and quality; (b) reduction in environmental impact; and (c) increase in cost-effectiveness of construction. This paper outlines a review of a system for recycled aggregate concrete produced by the aggregate replacement method, which reduces both the cost and environmental impact from an LCA perspective for concrete waste generated by the demolition of large-scale buildings, such as power stations.

Safe, high-tech and sustainable concrete construction

S. Desai

Proceedings of the Institution of Civil Engineers, Construction Materials, **161**, No. 2, May, 85–90, **doi**: 10.1680/coma.2008.161.2.85

Concrete has the status of a prime construction material in many parts of the world, owing to the number of benefits it can provide, such as economy of construction, ability to take any shape and form, inherent fire resistance, low energy demand in its production, saving of energy during the service life of the building afforded by insulation properties of concrete and so on. It may seem, however, that the making of concrete is a low-tech process and that any rapid depletion of the sources of natural constituents of concrete would jeopardise principles of continuing sustainability. Such issues are addressed through research and development in high-tech precast concrete construction and modern mix design, including alternative sources for the constituents. Furthermore, it is important to ensure that progress in these fields will not jeopardise the safety and durability of structures. This paper draws attention to some important issues associated with making concrete construction safe, high-tech and sustainable.

Recycling surfacing materials back into thin surfacing systems

J. C. Nicholls, I. Carswell, I. Widyatmoko, R. C. Elliott, J. Harris and R. Taylor

Proceedings of the Institution of Civil Engineers, Construction Materials, **161**, No. 3, August, 105–112, **doi**: 10.1680/coma.2008.161.3.105

The need to recycle thin surfacing systems is more critical than for many other generic surfacing materials because they contain a high quantity of relatively scarce aggregates with high skid-resistance properties. Laboratory investigations and site trials have been successfully undertaken to assess the feasibility of incorporating reclaimed surfacing materials in these systems. The trials were on an access road to an asphalt plant and on two heavily trafficked sites on the UK road network and included the use of polymer-modified binders and up to 30% reclaimed asphalt in the mixed asphalt. The trials demonstrate that 10% reclaimed asphalt can be easily added to new materials without processing the reclaimed asphalt. As the proportion of reclaimed asphalt increases up to 30%, greater care needs to be taken on assessing grading compatibility and how to treat the residual binder present in the reclaimed asphalt as a proportion of the 'active' binder content in the recycled surface course layer. The use of reclaimed asphalt in the surfacing has also been monitored on a major motorway contract.

Offshore wind energy—a challenge for UK civil engineering

A. H. Tricklebank

Proceedings of the Institution of Civil Engineers, Energy, **161**, No. 1, February, 3–6, **doi**: 10.1680/ener.2008.161.1.3

This article aims to provide a brief review of the current position of UK offshore wind energy development, particularly for those who are interested, but not deeply immersed, in the current scene. It is written from the perspective of a civil and structural engineer who has been engaged for some years in the development of a new approach to offshore foundation construction and is concerned that there should be a more visible involvement of the profession in the future development of large-scale offshore and marine renewable energy systems.

Performance of two photovoltaic arrays in the UK

K. Tovey and C. Turner

Proceedings of the Institution of Civil Engineers, Energy, **161**, No. 1, February, 11–21, **doi**: 10.1680/ener.2008.161.1.11

There are numerous conflicting reports into the economic and embodied energy return of photovoltaic (PV) arrays installed in the UK. Using actual performance data measured on two PV arrays installed on the Zicer building at the University of East Anglia, this paper attempts to resolve some of the issues arising from earlier predictions made using theoretical test bed performance data. A PV model using the monitored data, in combination with solar radiation and geometry data from across the UK, was used to predict the average annual electricity output from the installations over a range of tilt angles, orientations and geographical locations. Six separate capital cost scenarios are considered and the predictions of the unit cost for electricity range from £0·10 (€0·14) perkWh under the most favourable

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conditions to £2·68 (€3·83) per kWh. At a mean solar radiation of 1000 kWh/ m^2 per year, typical of many locations in the UK, the energy yield ratio (EYR) ranges from 4·3 to 5·1 depending on whether the cells are monocrystalline or polycrystalline and the assumptions made in the scenarios. Even on a vertical west-facing face, an EYR of over 2·5 is achieved.

Financing new low-carbon electricity generation in Britain

K. Palmer

Proceedings of the Institution of Civil Engineers, Energy, **161**, No. 1, February, 23–30, **doi**: 10.1680/ener.2008.161.1.23

This paper considers the challenges involved in financing new electricity generating capacity in Great Britain in the light of government-backed carbon reduction initiatives. Impacts of carbon costs on electricity prices, the economics of various types of generation and the implications of the renewables obligations are discussed. The paper considers whether new nuclear generating capacity will be economically viable in the UK and its cost effectiveness in terms of reducing carbon emissions relative to wind power.

Low-cost biomass electricity: more wires or more traffic?

R. Everett and I. Billington

Proceedings of the Institution of Civil Engineers, Energy, **161**, No. 1, February, 31–36, **doi**: 10.1680/ener.2008.161.1.31

Given the construction of a new wood-fired power station in Scotland and the recent refusal of planning permission for one in Devon, the impacts of such plants need consideration. This paper attempts to answer a simple question: 'if least-cost options are to be pursued, will an expansion of UK electricity generation from energy crops require strengthening of the electricity grids or will it involve more physical transport of fuel?'. The economies of scale of biomass electricity generation plant and transport costs for biomass fuel are examined. This has been part of a wider ranging study of the effects of an increase in renewable electricity generation on the electricity grid, focusing on the far west of Cornwall. It concludes that the economies of scale in generation are important. The physical transport of fuel to large plants is likely to be cheaper than extending the grid to a large number of smaller ones. Over longer distances the relatively low costs of transport by train and coastal shipping may provide some options for the future.

Energy saving through building insulation and airtightness

N. Prescott

Proceedings of the Institution of Civil Engineers, Energy, **161**, No. 2, May, 49–50, **doi**: 10.1680/ener.2008.161.2.49

Carbon emissions attributable to the operation of new and existing buildings have never been more prominent in construction, and great strides have been made in developing more energy-efficient designs and building products. In the context of the building envelope, this commonly sees better insulating properties of plain elements, as well as more effective solar treatment/shading of glazing systems. Thermal bridging is also now being taken more seriously. The 2006 Building Regulations brought in simplified building energy model (SBEM) calculations, which set targets for carbon emission relative to a 2002 baseline. The building energy rating must be around 27% lower than a similar 'notional' building (designed to 2002 elemental standards) to see compliance with part L2A for new nondomestic buildings. Similar targets exist for dwellings (in part L1A) by way of standard assessment procedure calculations. 'Backstops' are in place to dictate minimum standards for all aspects of the building design affecting energy efficiency, but designers must decide which aspects may need to be enhanced to achieve compliance.

Shallow ground energy systems

O. Boënnec

Proceedings of the Institution of Civil Engineers, Energy, **161**, No. 2, May, 57–61, **doi**: 10.1680/ener.2008.161.2.57

In a move to reduce the effects of climate change and energy dependency, planners, regulators and local authorities have encouraged or requested a number of technologies for saving carbon to be integrated into new buildings. Ground-source energy is among these technologies and one that has been applied to many parts of the construction industry including buildings, green houses, roads and bridges. Of particular interest is the integration of ground energy systems into the structural piles of the building. Energy piles have been installed in many buildings in the last 10–15 years in the USA, Europe and Britain. What does it mean to structural engineers? Will these energy piles require a redesign of the building? Will they lead to the loss of load-carrying capacity of the piled foundations? This article will look at the progress of the ground-source heat pump industry to date and will consider an opinion on the future. It will define some of the challenges facing structural, civil and services engineers and the opportunities for developing a new range of solutions to the construction industry.

Development of the Kirklees renewable energy toolkit, UK

K. Deacon

Proceedings of the Institution of Civil Engineers, Energy, **161**, No. 2, May, 63–72, **doi**: 10.1680/ener.2008.161.2.63

In today's modern built environment, the introduction of renewable energy technologies as part of new builds or refurbishments is increasing. Although national building regulations are starting to drive this through legislation, some local authorities are pushing boundaries further and championing renewable energy projects within their districts. Kirklees Council in Huddersfield, UK, is one such authority. Its policy for sustainable buildings encourages renewable energy technologies to be incorporated in nondomestic new builds and refurbishment projects once energy efficiency and energy conservation measures have been incorporated into the design. The key for successful implementation of such policies relating to renewables lies with the building designers. Therefore, a user-friendly renewable energy toolkit has been created to assist engineers and architects in the successful implementation of renewable energy technologies and, in turn, Kirklees policy within nondomestic building projects. The renewable energy toolkit consists of seven elements including a whole-life costing and carbon dioxide saving calculation tool, guidance checklists and

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a case study library to encourage the sharing of experience and best practice. An overview of the results of the testing phase of the toolkit provides an insight into the development process of the resource; brief examples utilising actual project data indicate the potential success of such a tool.

Integrated appraisal of micro-generators: methods and applications

S. R. Allen, G. P. Hammond, H. A. Harajli, C. I. Jones, M. C. McManus and A. B. Winnett
Proceedings of the Institution of Civil Engineers, Energy, **161**, No. 2, May, 73–86, **doi**: 10.1680/ener.2008.161.2.73

A range of integrated appraisal techniques have been utilised to study the comparative performance of various domestic micro-generators that have been proposed as possible decentralised energy resources for 'low carbon' buildings. Energy, environmental impact and cost–benefit analysis methods, employed on a 'whole systems' basis, are described. The application of this 'toolkit' is illustrated by way of the evaluation of three microgenerators: a micro-wind turbine; a (generic) solar photovoltaic array; and a solar hot water system. It is estimated that all three generators, in appropriately sited installations, have energy and carbon paybacks well within their lifetimes. Significant life-cycle environmental impacts are associated with the use of aluminium to fabricate both the solar hot water unit and the microwind turbine. All three domestic micro-generators were found to be economically unattractive in the present liberalised British energy markets from a societal perspective. Increased production volumes and technical innovations in the next generation of devices, such as improvements in their manufacturing processes and operational efficiencies, are necessary in order to render micro-generators economic propositions. However, there are likely to be many external and unpredictable changes to the global energy market during the years to 2050. These could dramatically alter the prospects for distributed generation.

Embodied energy and carbon in construction materials

G. P. Hammond and C. I. Jones
Proceedings of the Institution of Civil Engineers, Energy, **161**, No. 2, May, 87–98, **doi**: 10.1680/ener.2008.161.2.87

The development of an open-access, reliable database for embodied energy and carbon (dioxide) emissions associated with the construction industry is described. The University of Bath's inventory of carbon and energy database lists almost 200 different materials. The data were extracted from peer-reviewed literature on the basis of a defined methodology and a set of five criteria. The database was made publicly available via an online website and has attracted significant interest from industry, academia, government departments and agencies, among others. Feedback from such professional users has played an important part in the choice of 'best values' for 'cradle-to-site' embodied energy and carbon from the range found in the literature. The variation in published data stems from differences in boundary definitions (including geographic origin), age of the data sources and rigour of the original life-cycle assessments. Although principally directed towards UK construction, the material set included in the database is of quite wide application across the industrial sector. The use of the inventory is illustrated with the aid of 14 case studies of real-world new-build dwellings. It was observed that there was little difference between embodied energy and carbon for houses and apartments until external works were taken into account (energy inputs for roads, connecting pathways, etc.).

Sustainability of land remediation. Part 1: overall analysis

M. J. Harbottle, A. Al-Tabbaa and C. W. Evans
Proceedings of the Institution of Civil Engineers, Geotechnical Engineering, **161**, No. 2, April, 75–92, **doi**: 10.1680/geng.2008.161.2.75

A comparative assessment was carried out of the technical and environmental sustainability of five different contaminated land remediation projects completed in the UK between 1997 and 2002. The remediation technologies employed were in situ stabilisation/solidification, soil washing, ex situ bioremediation, cover system and excavation, and disposal to landfill. A further objective of the assessment was to highlight areas of sustainability concerns for the individual technologies and projects. The assessment is based around four principal criteria defined by the authors. Each project was assessed using both an overall multi-criteria analysis, detailed in this paper (Part 1), and a study of the detailed impacts on an individual project basis, detailed in Part 2.

Sustainability of land remediation. Part 2: impact assessment

M. J. Harbottle, A. Al-Tabbaa and C. W. Evans
Proceedings of the Institution of Civil Engineers, Geotechnical Engineering, **161**, No. 3, June, 117–127, **doi**: 10.1680/geng.2008.161.3.117

A comparative assessment was carried out of the technical/environmental sustainability of five different contaminated land remediation projects completed in the UK between 1997 and 2002. The remediation technologies employed in those projects were in situ stabilisation/solidification, soil washing, ex situ bioremediation, cover system, and excavation and disposal to landfill. A further objective of the assessment was to highlight areas of sustainability concerns for the individual technologies and projects. The assessment is based around four principal criteria defined by the authors. Each project was assessed using both an overall multi-criteria analysis, detailed in Part 1 of this paper, and a detailed impact assessment, detailed here in Part 2.

Breach design for managed realignment sites

I. H. Townend
Proceedings of the Institution of Civil Engineers, Maritime Engineering, **161**, No. 1, March, 9–21, **doi**: 10.1680/maen.2008.161.1.9

In low-lying areas of the coast and particularly around estuaries, the option to realign some of the seawalls is becoming increasingly attractive. Although the wholesale removal of existing walls is possible in some cases, frequently this is not possible for a variety of reasons and it is necessary to consider simply breaching the existing wall over a limited length. In

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order to undertake this in a controlled manner the size of the breach needs to be determined in advance. Current guidance on breach design was derived from a regression analysis of data from sites on the east coast that have breached during storms. This provides a simple relationship between the tidal prism of the site and the breach width. The basis of this approach is re-examined and shown to have limited explanatory power. An alternative method is presented, which uses the basic flow conditions, a limiting threshold of erosion and a description of the site hypsometry (variation in area with level) to estimate the breach profile. The proposed method is tested using the east coast data for seawalls that have breached and shown to provide better estimates. As the basis of the method is quite general, it can be used in widely varying situations, allowing rough estimates to be made with the minimum of data, or more refined estimates when more site-specific information is available.

Managed realignment – lessons from Wallasea, UK
M. Dixon, R. K. A. Morris, C. R. Scott, A. Birchenough and S. Colclough
Proceedings of the Institution of Civil Engineers, Maritime Engineering, **161**, No. 2, June, 61–71, **doi**: 10.1680/maen.2008.161.2.61

Managed realignment often involves the construction of new sea walls at a location behind existing sea walls to create parcels of land that can be flooded to create new inter-tidal environments. It is employed in the UK to improve flood risk management within the context of flood risk management strategies, but so far most emphasis has focused upon creation of new wildlife habitat because this has been where the opportunities and funding have been found. Initial projects were relatively small in scale, but recent projects have been much larger. Scaling up the size of realignments introduces a variety of additional engineering and social challenges and the realignment of Wallasea Island in 2006 is one of the largest. There were a variety of issues encountered during the development of the Wallasea Island realignment that make it a good platform for exploring the issues and some of the solutions that have been found to date. This account describes the project and some of the measures taken to give it as high a level of social acceptability as possible. Such measures include design features for fish nurseries, provision of public access and careful liaison with affected communities.

Sustainable construction and UK legislation and policy
H. Waddell
Proceedings of the Institution of Civil Engineers, Management, Procurement and Law, **161**, No. 3, August, 127–132, **doi**: 10.1680/mpal.2008.161.3.127

This paper provides a brief overview of why sustainability has become important and will continue to influence construction and engineering practices. It takes a brief look at current UK legislation and government policy relating to sustainability, future proposed legal reforms and the risks of non-compliance. The paper will highlight the importance of adopting approved practice now. Legal and political reforms will affect the way in which buildings are designed and constructed and will also provide new business opportunities for the construction and engineering industry, so it is important for businesses to plan ahead. Legal and political measures will not be the only factors influencing the sustainable practices of the construction and engineering industry. The paper will also briefly consider other such factors, including corporate social responsibility, market forces, funding and taxation. Although the paper concentrates on measures in the UK, it also notes that the sustainability of buildings is a global issue.

Advancing sustainable urban development in China
J. H. Wang, A. Koizumi and X. Liu
Proceedings of the Institution of Civil Engineers, Municipal Engineer, **161**, No. 1, March, 3–10, **doi**: 10.1680/muen.2008.161.1.3

Chinese urban life is improving rapidly in line with the country's economic growth. However, public services are not able to meet the needs of the improving urban life due to insufficient urban infrastructure. How to provide good public services is a question that needs to be considered further, as well as how to continue sustainable urban development in China. This paper examines the current state of urban development and investment conditions in China. The characteristics of urban infrastructure construction and the associated problems are also investigated. Considering the conditions of urban development in China and similar experiences worldwide, the utilisation of underground space for urban infrastructure construction is suggested as the main direction for sustainable development. Underground utilities, utility tunnels and stormwater systems are recommended for rationalising urban infrastructure construction and city flood prevention, as well as for providing new water resources. In addition, general strategies are proposed for sustainable urban development. If underground space is effectively utilised and general strategies implemented, public services can be improved rapidly and sustainable urban development can be realised for all cities in China.

Dweller perception using fuzzy logic for slum upgrading
O. B. Moraes and A. K. Abiko
Proceedings of the Institution of Civil Engineers, Municipal Engineer, **161**, No. 3, September, 151–161, **doi**: 10.1680/muen.2008.161.3.151

A large number of initiatives in cities in Brazil—including slum clearance and upgrading—have been undertaken over the years in an effort to ameliorate the problems arising from informal occupation; unfortunately, however, little is known about the related performance outcomes. Careful appraisal of the results of such initiatives is thus called for, covering evaluations of dwellers' perceptions of the upgraded environments. Among the available evaluation methods, post-occupancy evaluation (POE) is commonly employed, although it fails adequately to reflect prevailing subjective concepts of quality. The present paper contains the partial findings of a research exercise aimed at developing an original method, using fuzzy logic, for urban environmental quality evaluation in informally occupied areas on the basis of combining quantitative indicators and dweller perception. It combines POE with fuzzy logic in order to develop tools that can better model the uncertain information that emerges from that kind of study. This paper aims to introduce an

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uncertainty measure used in order to identify the strengths and weaknesses of slum upgrading projects. The results show that it is possible to quantify certainty degrees in the findings and to define if additional information is needed.

Global and sustainability issues for engineering graduates

D. Bourn and N. Sharma

Proceedings of the Institution of Civil Engineers, Municipal Engineer, **161**, No. 3, September, 199–206, **doi**: 10.1680/muen.2008.161.3.199

This paper analyses the outcomes of research with students, academics and representatives of engineering companies into the value of learning about global and sustainability issues within higher degree courses. The paper is based on research commissioned by Imperial College London and Engineers Against Poverty in 2007 with support from Engineers Without Borders. The existing literature and perceptions from representatives of key engineering bodies were compared with the findings from students, academics and representatives from engineering businesses. One of the key findings of this research is that there is a mismatch between perception and reality of students, academics and business views of the value of learning about global and sustainability in terms of furthering graduates' careers. Students were particularly keen to learn more about sustainability issues. Companies were looking for graduates who were more than technically competent and had all round skills such as interpersonal, language and communication skills. This research brings together and compares views of three stakeholders in the sector and demonstrates the need for greater dialogue between them. Further, the research provides useful evidence that demonstrates the increased interest in global and sustainability issues that universities need to consider.

Women in water supply, sanitation and hygiene programmes

J. Fisher

Proceedings of the Institution of Civil Engineers, Municipal Engineer, **161**, No. 4, December, 223–229, **doi**: 10.1680/muen.2008.161.4.223

This paper demonstrates the fundamental linkages between the United Nations' third millennium development goal (MDG) 'to promote gender equality and to empower women' and MDG 7 'to ensure environmental sustainability', with target 10 'to halve the proportion of people without access to safe drinking water and sanitation by 2015'. A synthesis of the evidence gathered for the Water Supply and Sanitation Collaborative Council (WSSCC) shows the connections between women's wellbeing and water supply, sanitation facilities and hygiene practice. The paper shows that if women's interests relating to water and sanitation provision are at the centre of planning and implementation of programmes, this has a direct impact on women's life experience, their potential and opportunities. This work goes on to provide examples of the benefits to women when they themselves are involved in the planning, implementation and operation of water supply, sanitation and hygiene programmes.

Sewerage: a return to basics to benefit the poor

D. Mara and J. Broome

Proceedings of the Institution of Civil Engineers, Municipal Engineer, **161**, No. 4, December, 231–237, **doi**: 10.1680/muen.2008.161.4.231

Around 2$8 billion people, mostly in developing countries, currently lack adequate sanitation. Approximately half live in urban areas, where the most appropriate sanitation solution is commonly simplified sewerage. This paper presents the rigorous hydraulic design basis of simplified sewerage and compares this design approach with that used in the UK for conventional sewerage. It reviews simplified sewerage construction and how this achieves major cost savings and also avoids the problems commonly experienced with manholes.

Better practice in supplying water to the poor in global PPPs

J. Jacobs and R. Franceys

Proceedings of the Institution of Civil Engineers, Municipal Engineer, **161**, No. 4, December, 247–254, **doi**: 10.1680/muen.2008.161.4.247

Amidst the general controversy surrounding public– private partnerships (PPPs) in lower-income countries, there has been little consideration of the successes and failures of international private operators in serving the urban poor, a subset of the overall task in any concession contract. This paper reports on research undertaken over a number of years in target communities, completed recently through private operator head office interviews, investigating the techniques and approaches used to serve slums with clean water. Following the demise of the PPP 'experiment' and with the present one billion slum dwellers projected to increase to two billion over the next generation, there is a clear need for these 'better practice' experiences to be made accessible to, and used by, public sector operators for whom serving the poor is the only real justification for their existence–the rich always find a way to access what they need.

Integrating counter-terrorist resilience into sustainability

J. Coaffee and L. Bosher

Proceedings of the Institution of Civil Engineers, Urban Design and Planning, **161**, No. 2, June, 75–83, **doi**: 10.1680/udap.2008.161.2.75

In recent years ideas of resilience have been increasingly embedded within urban planning and design practice as attempts have been made to make the built environment and critical infrastructure more resistant to external risk from natural hazards, particularly those associated with climate change, or from new security challenges facing many cities as a result of the ongoing threat of terrorism. The rapid renaissance of central urban areas in the last decade has given ample opportunities to apply such resilient principles to the construction of new buildings or regeneration areas, facilitated by changes in building regulations and the planning system concerned with broader issues of safety and sustainability. This paper argues that the embedding of resilience into the planning, design and engineering of the built environment is about not only security and community safety concerns but also the environmental benefits that might be achieved by integrating

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secure and sustainable design. The authors also argue that to date there has been limited integration of security and sustainability construction principles but that significant opportunities exist in the future for such sustainable urbanism to be commonplace.

Using eggshell waste in red wall tiles
M. N. Freire, S. J. G. Sousa and J. N. F. Holanda
Proceedings of the Institution of Civil Engineers, Waste and Resource Management, **161**, No. 1, February, 23–27, **doi**: 10.1680/warm.2008.161.1.23

Large quantities of eggshell waste are discarded in the food processing industry. This work investigates the incorporation of eggshell waste as a raw material into a wall tile body, replacing natural carbonate material by up to 15 wt%. Formulations containing eggshell were uniaxially dry pressed and fired at 1150°C using a fast-firing cycle. Physico-mechanical properties of the fired tiles (e.g. linear shrinkage, water absorption, apparent density, flexural strength) were then determined. Development of the microstructure was followed by scanning electron microscope (SEM) and X-ray diffraction (XRD) analyses. The results showed that eggshell waste could be used in wall tiles, in the range 5–10 wt%, as a partial replacement for traditional carbonate-based materials with only a slight decrease in the end product properties.

Demolition waste: are we doing our best?
M. Bjerregaard
Proceedings of the Institution of Civil Engineers, Waste and Resource Management, **161**, No. 2, May, 45–49, **doi**: 10.1680/warm.2008.161.2.45

This paper questions whether the right issues are being addressed when designing projects that involve both demolition and construction on the same site. With current UK industry focus on achieving high recycling rates, the effect that these recycling rates have on other impacts that could result from demolition and construction works is not being assessed. This paper discusses the benefits and challenges involved in adoption of the UK demolition protocol. It is suggested that industry needs to build on the protocol's approach in order to integrate sustainability into the design and implementation of projects—and recycling rates are only one of the factors to be taken into account. To support this further development, a call is made for a more holistic approach with quantifiable comparison tools; project teams could then make informed decisions regarding health and safety, recycling rates, inclusion of local employment, support for local businesses, carbon footprints, fuel consumption, and so on.

Resource flow analysis for sustainable construction: metrics for an integrated supply chain approach
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'Sustainable construction' is a topical agenda, with a great diversity of metrics, targets, performance measures and benchmarks. This paper explores a range of metrics and benchmarks that are based on understanding of the whole construction supply chain, together with its impacts on the global climate and resource base. It draws on new evidence from the UK resource analysis framework with an associated toolkit, the Resource and Energy Analysis Program modelling and data system. The resource flow and metabolism of the construction industry has been explored within this framework, by application of input– output analysis, at national and regional level. The result provides a first-estimate evidence base for issues such as 'carbon neutral' buildings, housing replacement against rehabilitation, local against imported materials and 'one planet' performance targets for sustainable construction. These first results also show future directions for improved methods of assessment and benchmarking.

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