

# Innovation & Research



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**IN THIS ISSUE**

<b>Buildings</b>	
Modern Adobe construction	2
Rammed earth design & construction	8
<b>Coastal Engineering</b>	
When earth turns to liquid	5
<b>Construction process</b>	
Water pollution control	5
Site Safety Handbook	5
<b>Design</b>	
Eurocodes for structural steel	6
<b>Drainage</b>	
Getting mains information	2
<b>Geotechnics</b>	
Predicting landslide runoff	3
When earth turns to liquid	5
<b>Highways</b>	
Low-cost road surfaces in Asia	4
<b>IT</b>	
E-readiness assessment tool	6
E-tagging for pre-cast concrete	7
Simulating LNG terminals	7
<b>Materials</b>	
Modern Adobe construction	2
Low-cost road surfaces in Asia	4
Rammed earth design & construction	8
<b>Ports</b>	
Simulating LNG terminals	7
<b>Safety</b>	
Site safety Handbook	5
<b>Structures</b>	
Eurocodes for structural steel	6
<b>Waste</b>	
Demolition waste reconstitution	4

## Recognising environmental achievement in civil engineering

The CEEQUAL project has created a framework for assessment of the environmental quality of civil engineering projects and has established a public award for the recognition of high environmental achievement by clients, designers and contractors. After four years' development and testing, the Scheme is now fully operational and invites Award applications.

The objective of the CEEQUAL project was to provide an incentive for the civil engineering profession and industry to improve the environmental quality of civil engineering projects. The CEEQUAL Scheme was developed by a team led by the Institution of Civil Engineers and managed by Crane Environmental, with financial support from the DTI Partners in Innovation programme, and the active participation of over 40 leading construction industry organisations.



The Twin Rivers Diversion at Heathrow for Terminal 5, which has achieved an 'Excellent' CEEQUAL Award (Photo courtesy of BAA plc)

Assessment of projects is based on the CEEQUAL Manual. Over 180 questions cover 12 environmental issues from Ecology and Biodiversity to Community Relations. Assessors are trained in use of the Manual, which contains supporting references and guidance, and their assessments are checked by CEEQUAL-appointed Verifiers. Awards are made to projects that score sufficiently highly to demonstrate that the project partners have gone well beyond legal and environmental minima to achieve distinctive performance in their project.

The CEEQUAL Scheme and Manual has been extensively tested on real civil engineering projects, and in 2003 the first formal Assessments and Awards were made to eight projects ranging from a £70,000 canal bridge refurbishment to a £70m sewage treatment works.

With publication of Version 3 of the CEEQUAL Manual and completion of the development project, ownership of the Scheme has been passed to a new company, CEEQUAL Ltd. It is currently owned by 11 of the organisations involved in development of the scheme, with more project partners expected to become shareholders soon. CEEQUAL Ltd is being managed by a partnership between CIRIA and Crane Environmental Ltd.

More projects are being assessed for Awards, ranging from the £46m Twin Rivers Diversion

Project at Heathrow Terminal 5 (see illustration) to the £1.3m refurbishment of the Wye Bridge at Bridge Sollers, Herefordshire.

The CEEQUAL Manual, which can also be used as a checklist for environmental actions on any civil engineering project, costs £50+p&p from the CEEQUAL Team at CIRIA, who will also take bookings for Assessor Training Courses, and respond to enquiries about Awards.

For further information visit [www.ceequal.com](http://www.ceequal.com) or contact the CEEQUAL Team at CIRIA (020 7549 3300; E-mail: [ceequal@ciria.org](mailto:ceequal@ciria.org)).

For technical queries contact the CEEQUAL Team at Crane Environmental (020 8399 4389; E-mail: [ceequal@crane-environmental.co.uk](mailto:ceequal@crane-environmental.co.uk)).



## Modern adobe construction

The development of low-cost construction products that use unfired clay as a binder has the potential to bring proven environmental benefits to common building applications. The development of appropriate guidance is seen as the key to achieving a successful transfer of this technology from the specialist field in which it has developed.

**T**he potential for mass market use of unfired clay bricks, mortars and plasters is being assessed in a DTI-funded Partners in Innovation project led by Arc Architects, in collaboration with the Erroll Brick Company, Natural Building Technologies, Communities Scotland, and Dundee & Robert Gordon Universities. A new low-cost house, built without specialist input, is being monitored through design, construction and for a year's post-construction habitation, to assess the degree to which these potential benefits are realised and to develop guidance for use by non-experts.

There are believed to be a wide range of potential applications in which unfired clay-based materials could be appropriate to use in place of cement, gypsum or fired-clay-based products, achieving a significant reduction in materials-related waste, pollution, resource depletion and greenhouse gas emissions. Such products have the potential to improve building quality by reducing moisture pressures and avoiding forms of construction that



Internal unfired clay brick & mortar wall in construction

can prove vulnerable to poor quality and low industry skills in mass applications. Potential benefits to occupants include reduction of risk of asthma triggers and respiratory diseases through the regulation of internal relative humidity by the hygroscopic action of the unfired clay.

It is recognised that this field may represent a significant opportunity to established manufacturers of fired clay products for diversification into more sustainable materials, with the long-term potential for the development of more-sophisticated products utilising, for example, structural insulated panels and spray application technologies.

Initial results have been favourable and interim guidance is available at [www.arc-architects.co.uk/archive](http://www.arc-architects.co.uk/archive). Final results and guidance will be published in the summer of 2005.

For further information contact Tom Morton at Arc Architects (01337 828 644; E-mail [tom@arc-architects.co.uk](mailto:tom@arc-architects.co.uk)).

## DRAINAGE

### Getting the main information



New figures from HR Wallingford will help to ensure that sewerage networks function properly and cost-effectively, whilst safeguarding the environment. HR has just completed a two-year DTI-funded project on flow resistance in pumping mains. Data was collected from working systems across the UK and the results have been used to compile a new table of recommended values for the hydraulic roughness of wastewater pumping mains.

**G**ravity-based systems drain sewage into main sewerage networks, but there are many places where the sewage must then be pumped upwards from collection areas to continue its journey to wastewater treatment plants. These pumping systems are key capital assets, valued in the UK at £1.5 Bn and with annual running costs approaching £150M.

To function properly, pumping stations must overcome the flow resistance of the pipes transporting wastewater. Under- or over-estimates of pipe roughness can result in the incorrect sizing of pumps and pipelines which, in turn, can lead to increased risk of pipe fracture, sewer overflow and pollution. Pipeline technology has moved on since the 1960s and 70s when much of the data on flow resistance was collected, and that information therefore needed updating.

The research team worked closely with a Steering Committee, comprising representatives from Black and Veatch, MWH, Thames Water Utilities and United Utilities, to identify locations where new data could be obtained. Data on pipe diame-

ter, material, flow rate, head loss gradients and temperature were logged at 23 sites belonging to Thames Water and United

Utilities. Values of hydraulic roughness were calculated, using the Colebrook-White resistance equation, and analysed to determine how they varied with the different parameters.

Flow velocity was found to be the main factor affecting flow resistance in wastewater pumping mains – as flow velocity increases, hydraulic roughness decreases. A new predictive equation for hydraulic roughness has been derived (based on flow velocity) and an updated table of recommended design values for the hydraulic roughness of wastewater pumping mains has been compiled. HR Wallingford's publication *Tables for the hydraulic design of pipes, sewers and channels* is currently being revised and the new edition, due out in 2005, will incorporate the study's findings.

For further information please contact Christine Lauchlan (Project Engineer) or John Forty at HR Wallingford (01491 822524; E-mail [csj@hrwallingford.co.uk](mailto:csj@hrwallingford.co.uk) or [ejf@hrwallingford.co.uk](mailto:ejf@hrwallingford.co.uk) or visit the project website at: [www.hrwallingford.co.uk/projects/flow\\_resistance/index.html](http://www.hrwallingford.co.uk/projects/flow_resistance/index.html)).



A typical wet well

# Predicting large landslide and avalanche runout

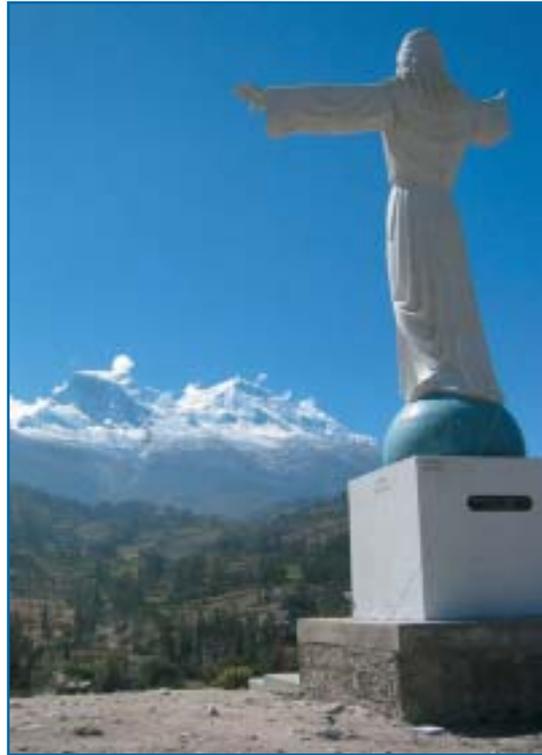


The risk of small landslides, debris flows and rock avalanches is often mitigated by providing engineering solutions, such as drainage, catchment nets and slope-stabilising vegetation. However, with very large-scale, naturally-occurring slides, flows and avalanches, often triggered by earthquakes, the only realistic solution is to carefully site population centres and lifelines such that they will not be in the path of a potential slide.

This leads to two questions: where will a slide occur and how far will it travel? It is becoming increasingly apparent that many large catastrophic slides have had precursors within living memory. Examples of this include the devastating Peruvian Huascarán avalanche and debris flow of 1970, which travelled at approximately 50m/s and which caused the death of over 20000 people (preceded by a smaller event in 1962), and the recent Kolka-Karmadon glacier-and-rock avalanche that occurred in the Russian Caucasus in 2002 and that, travelling at 91m/s, killed 125 people (preceded by an avalanche in 1902). This means that it is possible in many cases to assess the generalised threat on a regional basis.

However, in both examples given, the precursor events were smaller and travelled less far than the later slides that, unexpectedly, travelled for tens of kilometres in minutes before coming to rest. This leads to one of the fundamental problems in assessing the potential hazard faced, i.e. predicting slide reach or “runout”.

In order to understand why large-scale events may travel so far, research is being carried out within Cambridge University’s



Geotechnical Group using emerging experimental methods. Physical modelling coupled with high-speed Particle Image Velocimetry and fabric analysis is used to examine the influence of structure and topography on rock avalanche and debris flow runout. Of particular interest is the role of water in high-speed, high-stress shearing, and that of fragmentation of rock in the transfer of kinetic energy between particles. Landslide and slope stability research is being undertaken in collaboration with the Swiss Federal Institute of Technology, ETH Zurich and the National Institute for Rural Engineering in Japan. The use of geotechnical centrifuges at Cambridge University and ETH Zurich enables many of the mechanisms of large-scale events to be replicated at small-scale.

The goal is to determine the underlying micro- and macro-mechanisms of long-runout slides and flows, and thereby aid the assessment of land-use risk in mountain areas.

*For further information on this project please contact Dr Elisabeth Bowman, Engineering Department, Cambridge University, Trumpington Street, Cambridge CB2 1PZ (01223 567583; fax 01223 46077; E-mail [etb10@eng.cam.ac.uk](mailto:etb10@eng.cam.ac.uk)). Dr Bowman holds one of the Royal Academy of Engineering’s prestigious Post-Doctoral Research Fellowships which support the brightest young engineers through five years of independent research for 5 years following their PhD.*

*For further information on this scheme please contact Robert Barrett, RAE (020 7227 0500; fax 020 7233 0054; E-mail [Robert.barrett@raeng.org.uk](mailto:Robert.barrett@raeng.org.uk)).*

*(Left) Aerial view of the landslide that buried the suburb of Colonia Las Colinas, EL Salvador, during the M=7.6 earthquake in January 2001. The hillside had been the subject of a high-profile battle waged between city officials, environmentalists and local residents, who charged that the hillside had been weakened by recent residential developments. Over 360 people were killed. Picture courtesy of E.D. Harp, USGS. (Above) A huge statue of Christ, erected in 1966, faces Mt Huascarán in a protective gesture towards the now-buried town of Yungay, below. The hill-top cemetery upon which it stands was one of the few surviving structures in the 1970 avalanche that killed 20,000.*



# New, low-cost road surfaces rolled out in Asia **DFID** Department for International Development

Low-cost road surfacing options, developed as part of a DFID-funded international research project carried out by Intech Associates with field works in Cambodia, have been taken up as official Government of Cambodia policy for rural roads. The options are also being trialled in four regions of neighbouring Vietnam with a view to revising the national rural road standards and specifications. They are also being used in the construction of more than 1,000km of roads in Afghanistan as part of a US \$40m World Bank National Emergency Employment Program for Rural Access.

**T**he new approach is important because it presents a viable alternative to gravel road surfaces. Gravel is the dominant material used worldwide on rural roads, but it wears away by as much as 5cm each year as a result of traffic and the weather, and more if the quality of the original gravel is not good. This makes maintenance costly in labour, equipment and materials.

The development of low-cost alternatives is therefore important to ensure that rural people continue to have road access to markets, education and health facilities. And because the surfaces can be built using labour-based methods, local materials and using a minimum of equipment, there is the potential to create local employment and stimulate business for small contractors.

Speaking about the DFID-funded project, the Cambodian Minister of Rural Development said 'The experience and



(Top) *Bamboo Reinforced Concrete Paving*  
(Above) *Labour based construction of low cost bitumen seals*

knowledge gained on alternative surfaces has helped us substantially to move away from reliance on gravel/laterite surfacing, which is problematic and unsustainable for many situations in Cambodia.'

The Government of Cambodia is eager to use the new approach as its main technique. It is already incorporating the alternative surfaces in new World Bank and Asia Development Bank projects worth US\$40 million. It is also considering the surfacing of 600km of gravel roads which are not economically maintainable.

The Project Manager was awarded the Gold Medal of the Order of Sahametrei, by the Cambodia Prime Minister for service in support of poverty alleviation.

*For more information contact Robert Petts, Intech Associates (E-mail [intech-trl@ipt.vn](mailto:intech-trl@ipt.vn)).*

## WASTE & RECYCLING

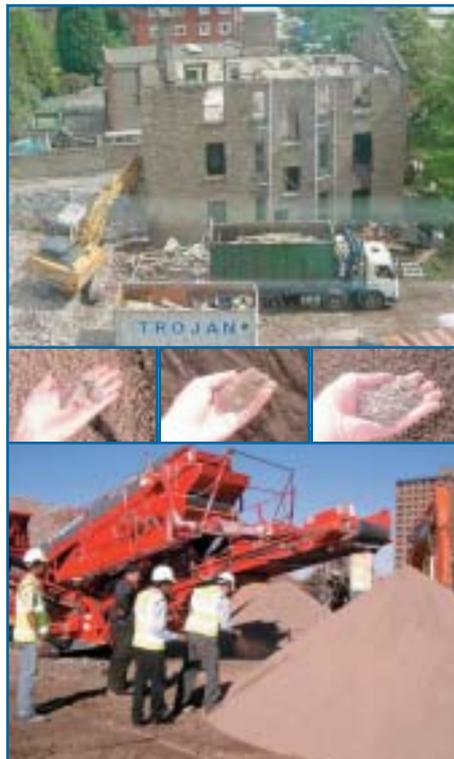
# Adding value via demolition waste reconstitution



This project aims to examine the feasibility of using low-energy reconstitution methods to convert mixed demolition waste streams into medium-value products, suitable for use as concrete constituents. It is funded by the DTI together with William Tracey Ltd, Tayside Contracts, Quarry Products Association, Castle Cement Ltd, WS Atkins, EnviroCentre Ltd, The Business Environmental Partnership and Dundee City Council.

**C**onstruction in the UK consumes primary mineral resources and produces waste in significant quantities – around 260 million tonnes and 90 million tonnes per year respectively. Demolition arisings usually have a low market value and this can make transportation to areas of need uneconomic. Crushing and screening to create a concrete aggregate add only limited value. There could be a step change in this if it were feasible to create cementitious characteristics by off-site processing.

This project examines the feasibility of using low-energy reconstitution methods to convert mixed demolition waste streams into medium-value cementitious products, suitable for use in mortar or concrete. Two simple processing techniques are being considered: (i) ultra-fine grinding, producing materials suitable for use in reactive powder concrete, and (ii) thermal treatment, to create materials with cementitious properties. These methods will employ technologies that



(Top) *Typical modern demolition process*  
(Inset) *Screened demolition arisings prior to added value processing*  
(Below) *Crushing and screening of demolition arisings*

allow blending and processing to be carried out in close proximity to a demolition site, to minimise transport costs.

A total of 40 demolition sites have been sampled from all around the UK and these encompass a broad range of rock type sources in the arisings. To keep the processing simple, the materials are considered to be either siliceous or calcareous. The initial results show that demolition arisings in the calcareous group outperform the siliceous materials both as a reactive powder and as a thermally-processed material. This is primarily down to the greater fineness that can be achieved with calcareous materials and the latent hydraulic characteristics that can be produced, although this is dependant upon the calcite content.

Having demonstrated that it is feasible to add value to such materials, the study will now progress to the analysis of the environmental and economic costs and benefits. The final report will be available in early 2005.

*For further information please contact Professor Ravindra Dhir at the Concrete Technology Unit, University of Dundee (01382 344347; Fax 01382 345524; E-mail [r.k.dhir@dundee.ac.uk](mailto:r.k.dhir@dundee.ac.uk)).*

# A cleaner, safer future

CIRIA is continuing its contribution to safer, less environmentally-damaging work on site with a new project and publication.

## CIRIA's line on linear construction

CIRIA has announced the start of a new project, *Control of water pollution from linear construction projects* (e.g. railway, road or pipeline). It will provide environmental good practice guidance for the industry on controlling water pollution from linear construction projects during their construction. The guidance will cover the project lifecycle from planning, early environmental assessments and design considerations for the construction phase, through to commissioning. The focus will be on prevention of contamination of watercourses; essentially to improve the environmental performance and sustainability of industry.

## Be your own health and safety officer

CIRIA has launched *Site health handbook* (C629) to tackle occupational ill health in the construction industry, which results in the loss of millions of days each year to time off. Many hazards encountered on site can cause irreparable damage to workers' health and, in some cases, permanent damage could arise even before the sufferer becomes aware of the symptoms. It is therefore important to be aware of the activities and practices which may put you and others around you at risk.

The new CIRIA publication provides specific guidance on dealing with hazardous materials to avoid adverse effects on health and highlights the biological, chemical, physical and psychological hazards that may face those working on site. The handbook emphasises that it is everyone's duty to reduce these dangers as much as is reasonably practicable, and gives advice on personal protective equipment, first-aiders, accident reporting and health screening. The core section of the book, on the hazards associated with construction activities and materials, and their effects on specific parts of the body, is also supplied in PDF form on a CD-ROM, so that the information can be made available in handouts.



The employer should provide personal respiratory protection (e.g. face masks) to prevent yourself breathing in dust, etc.

For further information about *Control of water pollution from construction projects* visit [www.ciria.org/rp708.htm](http://www.ciria.org/rp708.htm).

For further information about the *Site health handbook* (C629) visit [www.ciriabooks.com](http://www.ciriabooks.com)

or contact CIRIA direct  
(020 7549 3300;  
fax 020 7253 0523;  
E-mail [enquiries@ciria.org](mailto:enquiries@ciria.org);  
website [www.ciria.org](http://www.ciria.org)).



## GEOTECHNICS & COASTAL ENGINEERING

# When earth turns to liquid ...



'But afterwards there occurred violent earthquakes and floods; and, in a single day and night of misfortune, all your warlike men in a body sank into the earth, and the island of Atlantis in like manner disappeared in the depths of the sea. For which reason the sea in those parts is impassable and impenetrable, because there is a shoal of mud in the way; and this was caused by the subsidence of the island.'\*

So wrote Plato almost 2400 years ago – but is the story of Atlantis far-fetched? Recent research near the Gulf of Corinth in Greece suggests that the legend is based on the disappearance, in 373 BC, of the city of Helike. Theories indicate a massive earthquake caused such pressures that the earth beneath Helike 'turned to liquid'. The foundations of the city sank and a massive tidal wave due to the quake (and accompanying landslides) then engulfed the whole area. Whether this proves to be a correct interpretation or not, it does highlight a phenomenon of interest to engineers – how soil can liquefy under extreme conditions.



Subsea pipeline prior to installation

Either type of loading causes a reduction in soil strength. In extreme cases the soil may fail – a process known as liquefaction – causing structural collapse. There are several 'unknowns' including the:

- conditions under which liquefaction occurs – such as how it relates to wave and water depth, and the gas content of sediment;
- influence that the structure itself exerts;
- influence of liquefaction on scour – another process that can damage structures; and
- behaviour of armouring elements.

These and other influences have been studied in the laboratory as well as numerically during the LIMAS study. Field work has also been carried out and case histories involving subsidence and other failures examined.

A final LIMAS Project Workshop was held in April 2004 at the University of Pau, France. Participants heard presentations on the physics of liquefaction and its mathematical modelling. State-of-the-art assessment techniques for marine soils were also discussed and researchers were available to answer delegates' questions. The report on the findings from the LIMAS study will be published in due course. Armed with a better understanding of the processes at work, it should be possible to build more-resistant and cost-effective structures.

For further information please contact Scott Dunn at HR Wallingford (01491 822470; E-mail: [sdu@hrwallingford.co.uk](mailto:sdu@hrwallingford.co.uk)).

\*From *The Timaeus*, written by Plato in 360 BC and translated by Benjamin Jowett (1817–93)

# VERDICT: An E-readiness assessment tool for construction organisations



**VERDICT** (Verify End-user e-Readiness using a Diagnostic Tool) is an Internet-based, questionnaire-type, database application aimed at assessing the overall readiness of end-user companies to use e-commerce technologies. The e-readiness addressed here is from an end-user perspective, specifically in the context of the construction industry.

**V**ERDICT enables construction sector end-users to gauge their readiness for using e-commerce technologies such as Web-based collaboration tools. In order to successfully implement and benefit from new technologies such as e-commerce, it is essential that the *people* (who are the ultimate users of the technology) and the *process* are given due consideration. The *technology* within the company also needs to be assessed in order to ensure that the company has adequate ICT (Information and Communication Technologies) to use existing and new emerging technologies successfully.

Furthermore, successful implementation of any technology requires clear leadership and direction that is provided by the *management*. Taking this into account, the VERDICT system is built around the assumption that, in order to be e-ready, an organisation must have:

- **Management** that believes in the technology and takes strategic measures to drive its adoption, implementation and usage to derive business benefits;
- **Processes** that enable and support the successful adoption of the technology;
- **People** who have adequate skills, understanding of and belief in the technology; and finally
- **Technology**, tools and infrastructure necessary to support the business functions.

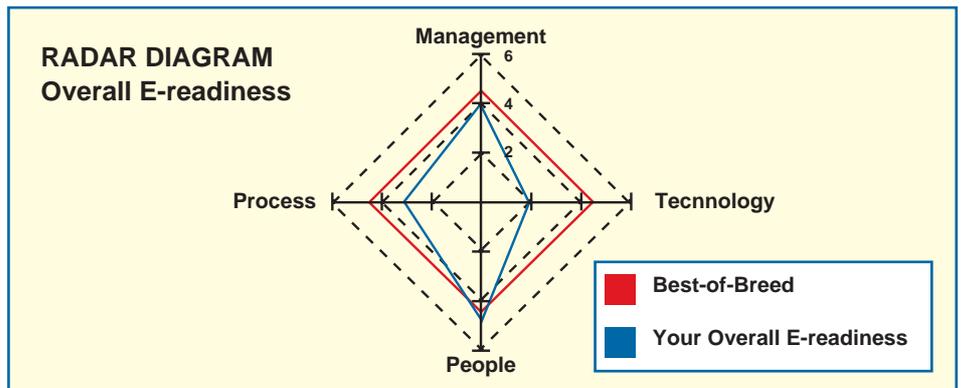
The VERDICT application comprises a series of statements with which respondents may or may not agree to varying degrees. VERDICT relies on the judgment of the respondents (i.e. end-users) as to whether or not they agree with the statement(s) in the context of their organisation, department or group.

Once all the questions are completed, the end-users are instantly presented with a final 'verdict' on their overall e-readiness in all four categories. This is in the form of reports, which include traffic light indicators to visually depict e-readiness. A 'radar diagram' is also automatically generated (see Figure), which enables construction companies to do competitive benchmarking against the 'best-of-breed'.

*For further information please contact Kirti Ruikar, Research Engineer at CICE, Loughborough University (01509-228544; E-mail: k.ruikar@lboro.ac.uk)*

## IRF Sponsors would like your views!

The sponsors of IRF are keen to hear your views on the Newsletter and its associated website. Please respond using the questionnaire on the back of Issue 58 or go to website – [www.innovationandresearchfocus.org.uk](http://www.innovationandresearchfocus.org.uk) – and complete the questionnaire there.



## STRUCTURES & DESIGN

# Wake up call for S.T.E.E.L!



What attracted 100 busy structural designers from 21 countries in Europe to Brussels on 5th and 6th July? A workshop organized by the Steel Construction Institute and Partners on the implications of the forthcoming Structural Steel Eurocodes. European designers are taking the new Codes very seriously and believe that the S.T.E.E.L Project will help greatly to allay fears about code complexity and provide the right kind of support tools to help them with implementation.

**E**uropean colleagues from both new and old EU countries are very aware of the market for design services. It is clear from the workshop that UK designers cannot afford to be dilatory in addressing the commercial implications of the new Codes.

Countries that do not already have a good national code are already using the European codes and gaining experience fast. Some have identified an opportunity to 'catch up' in areas such as composite construction, whilst others see the introduction of clear design rules for fire engineering as a means of challenging existing restrictive regulatory controls. Unanimity lay in the need to promote simplified approaches, which are otherwise buried in the Eurocodes, and for S.T.E.E.L to provide a unified a set of supporting information to cater for the vast bulk of 'standard' structures.

On the first day, presentations of structures designed to Eurocodes 3 and 4 included the steel roof design for the New High Speed



Railway Station in Florence, Red Bull Headquarters, Salzburg, and Tower Place Office Building, London. SCI and partners then led an intensive user needs analysis, during which delegates split up into 6 mixed nationality groups to identify key conceptual issues and design processes, before considering the kind of information tools they will need for industrial, residential and commercial applications.

Now that the S.T.E.E.L Team has created some momentum, it intends to build on this and respond to the strongest message of all to come out of the workshop – to create tools on a European level and ensure that all designers are ready for the Eurocodes in the lead up to 2008.

*For further information contact Christine Roszykiewicz, STEEL Project Manager, at SCI (01344 623345; E-mail [c.roszykiewicz@steel-sci.com](mailto:c.roszykiewicz@steel-sci.com)).*

# A revolution due for precast concrete industry

**BRITISH  
PRECAST**

The combined application of web technology and wireless communications (such as e-tagging) seems set to completely change the way in which the precast concrete industry runs its production lines and relates to its supply chains. The UK precast concrete industry produces more than 34 million tonnes annually with a turnover of over £2 billion, and directly employs 22,000 people. Any adaptation of new technologies that improve the handling and life-cycle performance of precast products and elements will have considerable economic and environmental benefits.

**B**ritish Precast, the industry trade federation, has been involved with the Building Research Establishment (BRE) and other partners in several projects investigating the possibilities of using e-tagging, radio frequency identification devices (RFID), and similar technologies to improve the economic and environmental efficiency of precast concrete production. Unlike other construction materials, concrete is proving to be an ideal benign medium for tags – with no interference to signal transmission.

Electronic tags with growing built-in memory can store significant amounts of information about a product, its manufacturer, technical specifications, and order information. These e-tags can be read quickly and accurately – using a reading device to provide a non-contact solution. Attaching these e-tags to precast products and elements has demonstrated several advantages.

In one project (the DTI-ICT Carrier Programme) a system for tracking construction products, including precast, was developed. Data exchange and management is a major element in precast supply chains. Materials and finished product stock control, order management, communication, and information handling between supply chain partners are tough tasks that usually involve a substantial amount of man-hours and paperwork. The use of such information carriers, directly attached



(Top) Smart chip for embedding in concrete  
(Above) PDA used to read smart chip and register precast concrete unit

to the product itself, adds considerable value to the process as the excessive paper work can be eliminated and the time consumed by different product handlers in logging and checking inventory or location can be reduced. Current trials are involving several precast companies, and significant savings are expected through the factories and the construction process.

Another advantage of e-tagging is the possibility of tracking and documenting the life-cycles of precast elements even after the *end-of-life* stage. This possibility was a major element in another study, funded under the DTI Sustainable Technology Initiative, exploring the possibility of long-term leasing for precast products.

The BPCF and BRE have also applied for another EC-funded study exploring the integration of new technologies, such as e-tagging and other forms of communication technology, into the wider European construction sector.

Full copies of the RFID and e-tagging reports are available free from [info@britishprecast.org](mailto:info@britishprecast.org) and at [www.britishprecast.org](http://www.britishprecast.org).

*For further information please contact Martin Clarke, British Precast Concrete Federation (BPCF), 60 Charles Street, Leicester, LE1 1FB. (07850 278494; Fax 01162 514568; E-mail [mac@britishprecast.org](mailto:mac@britishprecast.org)).*



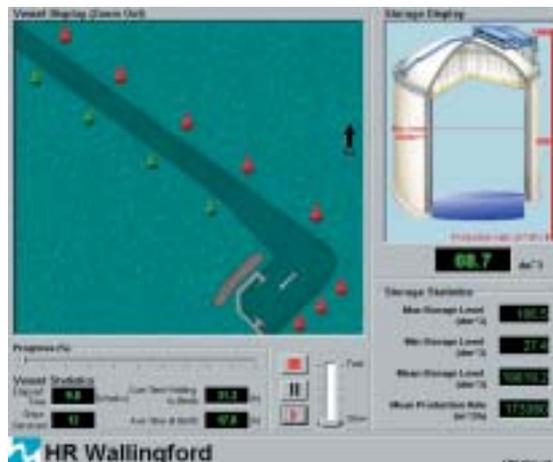
## PORTS & IT

# Simulating LNG terminal operations

HR Wallingford has invested its own research funds to develop a computer simulation package for liquid natural gas (LNG) terminals. The work was prompted by the needs of clients and is proving valuable in the planning and design of new terminals. The package, known as LNGsim, is used by HR during their LNG studies worldwide.

**L**NGsim has been developed as a 'shell' software package, into which individual terminal components can be 'clipped'. These include ship arrivals, allocation of pilots, tugs, equipment and labour as well as different types of cargo handling. The model can integrate historical and/or forecast weather patterns, allowing for a better approximation of terminal downtime, storage requirements and throughput.

Proposed designs can then be assessed and modified (where necessary) to help achieve the optimal working outcome. In addition, the model can be applied to examine the entire shipping supply chain, looking at the inter-connectivity of a network of liquefaction and regasification terminals.



Example output from LNGsim

HR Wallingford has worked with major oil and gas companies to apply the LNGsim model to examine shipping logistics, storage and throughput of interconnected networks of LNG liquefaction plants and regasification terminals, as well as examining the behaviour of individual terminals. Feedback indicates that the LNGsim system has helped to answer several terminal-specific design and operational planning challenges, has identified opportunities for whole-life-cycle cost saving and provided insights into probable outcomes of future investment decisions.

*For further information, please contact Mark McBride at HR Wallingford ((01491 822263; E-mail: [mmcb@hrwallingford.co.uk](mailto:mmcb@hrwallingford.co.uk)).*

# Rammed earth design & construction guidelines



The DTI's Partners in Innovation scheme is currently supporting a project seeking to promote the increased use of rammed earth walling in sustainable housing construction through the preparation and publication of design and construction guidelines. The research project, coordinated by the University of Bath and due for completion in February 2005, has 14 industrial partners, including leading architectural practices, BRE, structural engineering consultants, specialist rammed earth practitioners and consultants, builders, mortgage lenders, and local authority representatives.

**R**ammed earth is a form of unbaked earthen construction in which walls are formed by compacting moist sub-soil inside temporary formwork. The moist soil is placed in layers of around 100-150 mm depth and compacted using pneumatic rammers. Walls are typically 300-450 mm thick. Recent rammed earth projects in the UK



*Eden project visitors centre (Architect: Grimshaw Architects; Contractor: Insitu Rammed Earth Co. Ltd)*

include the visitors' centre at the Eden Project, and loadbearing walls at the Centre for Alternative Technology and Woodley Park Sports Centre in Skelmersdale.

Rammed earth walls commonly exhibit a distinctive layered form as a result of the construction process, corresponding to the successive layers of soil compacted within the forms. This attractive appearance is undoubtedly one of its major appeals. Using locally sourced natural sub-soils, rammed earth also has very low embodied carbon and great potential for recycling on demolition. Though thermal insulation qualities are comparative-

ly poor, rammed earth offers high thermal mass for passive design.

The project has included a series of large-scale wall and column tests to determine structural capacity of rammed earth under concentric and eccentric axial compression at varying slenderness ratios. The relationship between material strength and

wall capacity is also under investigation. The aim is to provide guidelines giving authoritative advice for design, construction and maintenance of rammed earth walls. The guidelines, scheduled for publication in late 2004, will cover application, material selection, structural design, construction, detailing, and maintenance.

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