PRACTICAL APPLICATIONS FOR CONSTRUCTION AND THE BUILT ENVIRONMENT

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'New thinking' needed for changing terrorism threat

A groundbreaking two-year investigation into how crowded public places can best deal with the changing nature of the terrorism threat has recently started. Led by Dr Jon Coaffee from The University of Manchester, the £1 million RE-DESIGN project will examine how the public are best protected in shopping areas, transport systems and other easily accessible places. Experts from The Universities of Manchester, Birmingham, Loughborough and Newcastle will devise a framework to assist planners, designers, architects, construction engineers, private sector businesses and urban managers – as well as the public – to make decisions about the counter-terrorism design process.

The project focusses upon the changing role of physical intervention and managerial measures – the hardware and software of security planning – in combating new forms of terrorism against public places. The move is a departure from present arrangements where the management of security in public places is largely carried out by the police and security professionals. In addition some counter-terrorism measures have been overt and unattractive (see photograph); however, such measures would not necessarily be acceptable in many public places. The research will therefore evaluate innovative and more-discreet examples of counter-terrorism measures from around the world.

The main purpose of the RE-DESIGN project is to ensure that best practice in the design of effective and acceptable resilient public places can be more-widely achieved. This would be through the structured and considered integration of counter-terrorism measures into the decision-making processes of key stakeholders involved with the planning, design, construction, operation and management of public places and transport systems. In doing so, it will address key questions about the public acceptability of counter-terrorism measures, and the potential for public involvement in these measures. The project will focus on busy shopping areas and light rail systems, but also aims to develop findings that are transferable to other types of public place.

The project is funded jointly by the Engineering and Physical Sciences Research Council, the Economic and Social Research Council, the Arts and Humanities Research Council and the Centre for the Protection of National Infrastructure. The project team comprises Dr Jon Coaffee of The University of Manchester, Dr Cerwyn Moore of Birmingham University, Dr Lee Bosher of Loughborough University and Dr David Fletcher of Newcastle University.

For further information please contact Dr Jon Coaffee, Senior Lecturer in Spatial Planning, The University of Manchester (0161 2756903; E-mail: Jon.Coaffee@manchester.ac.uk) or Dr Lee Bosher (E-mail:L.Bosher@Lboro.ac.uk).

Overt counter-terrorism measures.

New cavitation identified from Three Gorges: finding solutions for large hydro-turbines

The Royal Academy of Engineering

Prof Shengcai Li of Warwick University has identified a new type of cavitation from the turbines at the Three Gorges Project. Supported by the Royal Academy of Engineering's Research Exchanges with China and India (RECI) scheme, his study is investigating the fundamental mechanism underpinning this cavitation in order to find solutions for turbines in giant hydropower schemes.

Increasing demand for clean energy is driving the growth of giant hydropower schemes like the Three Gorges Project, which utilises huge turbines developed by a number of manufacturers (including Alstom, GE and Voith-Siemens). However, soon after commission, all these cutting edge turbines have developed peculiar damage that has never before been reported.

Unlike the commonly seen sponge-like cavitation, damage features that have been observed comprise delicate, long strips with wedged heads and heated tails covered with a corroded surface. By employing a multi-disciplinary approach, in March 2006, Prof Li identified this new type of cavitation as being triggered by turbulence production from the boundary-layer streak breakdowns, which form a long strip through a sustainable dynamic process. He further explained why the manufacturers all failed to predict this type of cavitation from their model tests and emphasised the need for new similarity laws applicable to giant turbines.

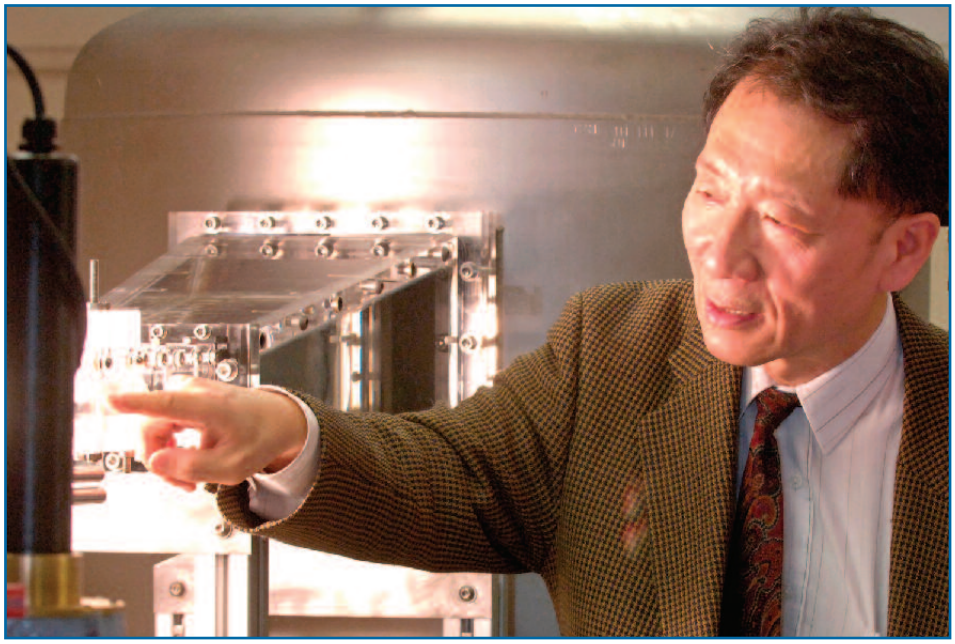
Funded by the RAEng's RECI programme, Prof Li's international team, including Chinese scientists from Tsinghua and Peking Universities, is re-creating the phenomenon in his cavitation laboratory at Warwick University in order to:

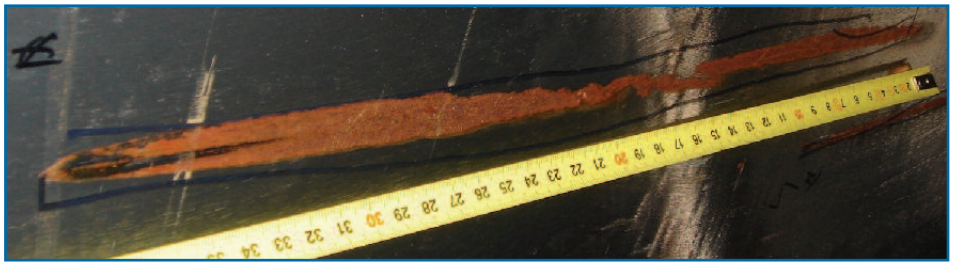
- search for detailed information on triggering processes such as the governing parameters and their correlations;
- develop new similarity laws;
- provide scientific guidelines for a new generation of giant turbines which will assist China's ambitious plan for developing even larger turbines (1000 MW).

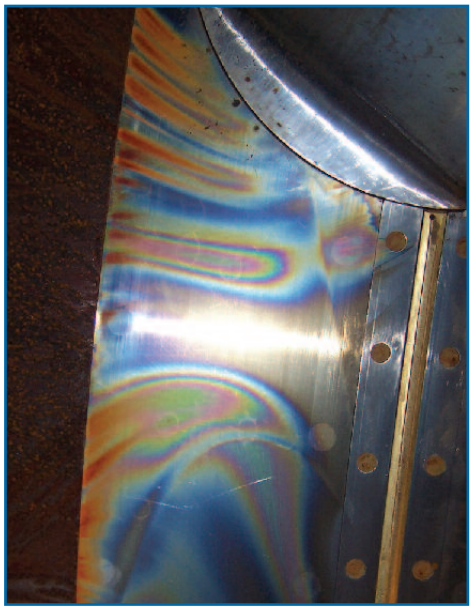
This RAEng project is a development of Professor Li's work on 'Anti-erosion turbine technology' programme supported by the Warwick Innovative Manufacturing Research Centre Phase I scheme. Support was also received from the Three Gorges Authority, Tsinghua & Peking Universities, as well as China's State Key Laboratory of Hydroscience & Engineering.

For further information on the Royal Academy of Engineering's Research Exchanges with China/India Programme, please contact Dr Shafiq Ahmed at shafiq.ahmed@raeng.org.uk.

For further information about this research please contact Prof Shengcai Li of Warwick University (024 7652 3523; E-mail S.Li@warwick.ac.uk).







(Top) *Shengcai Li, a professor with a great passion for cavitation of turbines, working in his cavitation lab.*
(Middle) *A typical damage strip with wedged head and corrosion appearance.*
(Bottom left) *Heated sign associated with the damage.*
(Bottom right) *Commonly seen sponge-like cavitation damage on Europe's largest pump-turbine at Dinorwig pump-storage power station, which was examined by Prof Li in Dec 1987 (for details see his book* Cavitation of Hydraulic Machinery*).*

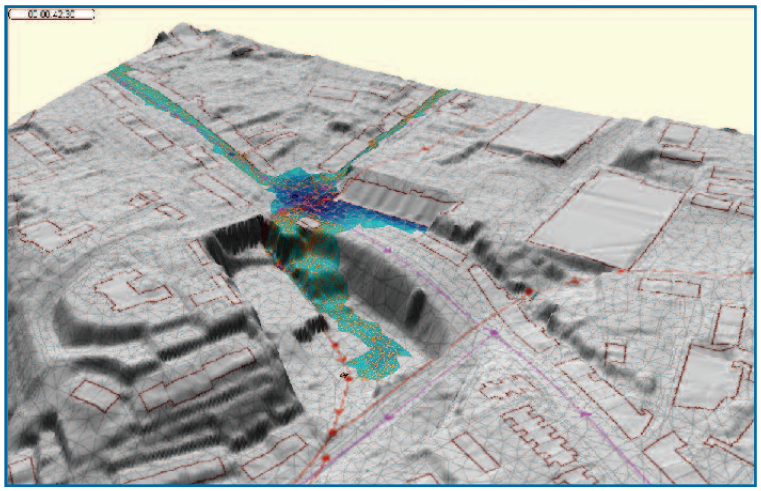
Understanding flood pathways in complex urban environments

The need in the UK for more oversight and management of flooding problems at local and regional level was brought into focus by the 2007 Summer floods. One of the key recommendations in the Pitt Review of those floods was to call for the development of tools to model, forecast and map surface water flooding.

Integrated modelling is widely seen as the tool to enable better management of urban drainage systems and reduce flood risk. It comprises running numerical models together so that their data is actively exchanged between them during the simulation process. For river modellers this approach enables them to link river channel models to flood-plain flow models; and for drainage analysts to link storm flows through urban pipe-drainage systems to any overland flows that occur.

HR Wallingford recently linked a drainage network model with a surface flow model in order to realistically simulate extreme flow conditions in storm vulnerable UK towns in which flood improvement schemes are being contemplated. Recent studies have simulated what exactly happens, and where floods occur when drains become full and excess water moves across the surface. Using the pipe network model InfoworksCS (a 1D model of sewer lines) linked directly with the surface-flow model Infoworks2D, flow regimes were analysed both within and above the pipe system, (including any re-admittance).

The 3D representation of a real UK location in the illustration is of a hypothetical flood situation resulting from drains overflowing and creating surface flood flow. The simulation, using InfoworksCS from Wallingford Software, shows the re-admittance of flow lower down the system where the pipes (red lines) can re-admit the flow. The overland flow (street flooding) is simulated by the Infoworks2D surface water flow model.



3D representation at a real UK location.

The two linked models send data to and from each other so the actual combined response of the surface and sub-surface systems can be more accurately simulated. The figure shows the footprint of buildings, the position of the sub-surface pipe network and the street drain inlets, as well as representing the surface topology (NB with strong vertical exaggeration). Many other factors can be represented and portrayed

In carrying out this study the team tested the applicability and robustness of the integrated model approach, thereby assisting the software development. With increasing computer memory-size and speed, complex models such as these can now complete their processing in fast run-times, and are practical for use at real situations. This resolves the difficulty in probability design with respect to flood management schemes, and planners can carry out simulations that are realistic and accurate.

For further information please contact Juan Gutierrez Andres (01491 822235; E-mail j.gutierrez-andres@hrwallingford.co.uk) or Steven Wade (01491 822214; E-mails.wade@hrwallingford.co.uk), both in the Water Group at HR Wallingford.

Renovation of Buildings using Steel Technologies

Over-cladding of existing buildings is seen as an important way of reducing energy consumption and CO2 emissions, and improving the quality of the built environment. The Steel Construction Institute is co-ordinating a European-funded project, Renovation of Buildings using Steel Technologies (ROBUST), which is investigating the practical use of steel sub-frames and cladding in over-cladding, over-roofing and roof-top extensions. In these applications, speed of construction with minimal disruption, as well as achieving improved levels of thermal insulation and air-tightness, are of crucial importance.

SCI will carry out physical tests on over-cladding systems such as Corus' *Stratascreen* system to assess the basic building physics behaviour and energy saving potential. This will focus on an opportunity at Oxford's Brookes University in which two of their 1960s teaching blocks may be over-clad in the near future, as shown in the architectural representation in the illustration.

Whole building energy models have been used to assess the economics of over-cladding by reducing the U-value of the existing building facade from 1.2 to 0.3 W/m^2°C. The economics depend on the 'mix' of energy supply but, for the assumptions made in this study, the over-clad project was viable over a 15-year payback period. This reduces to less than 10 years when the additional rental income from new roof-top apartments is included.

Over-clad building using 'rain screen' metallic cladding.

SCI is interested in tracking renovation projects using steel, and in publishing case studies on innovative applications.

For more information please contact Mark Lawson, SCI Professor of Construction Systems (01344 636525; E-mail m.lawson@steel-sci.com).

The National Platform Strategic Research Agenda BERR

The UK's National Platform Strategic Research Agenda (UK SRA) aims to significantly increase the level of strategic, collaborative research being undertaken in the built environment sector.

The publication of the three strands of the UK SRA is a result of a process started in 2006 when the National Platform undertook a poll of members and colleagues to identify their rankings of broad topic areas from the European Strategic Research Agenda (SRA) published by the European Construction Technology Platform. This poll identified three key areas as high priority for UK:

- ICT and automation;
- a client-driven, knowledge-based construction process; and
- reduced resource consumption.

Accordingly these three topics became the basis of Working Groups developing priority issues within detailed research recommendations for each area. The studies have focussed on issues relating to the industry's delivery capacity and to the practices that it will be facing in 10 to 15 years' time.

National Platform for the Built Environment
CONSTRUCTING EXCELLENCE

Construction of Cardinal Place.

ICT and Automation (ICTA)

The ICT and Automation Working Group seeks to identify, from an industry-led perspective, what types of information, communication and automation technologies need to be developed and, perhaps more importantly, to develop a vision of how they might be integrated.

Strategic research programmes and roadmaps are the key section of the ICTA report and were developed through a combination of work carried out by the National Platform ICTA Working Group, information-gathering and analysis during two road-mapping workshops and desk research to review Built Environment roadmaps from other countries.

In order to achieve the industry's long-term vision, the 'ICT and Automation' priority area identified the following five key research topics:

- collaborative prototyping to define and deliver client requirements (Roadmap R1);
- efficient and seamless sharing of information across the built environment stakeholders (Roadmap R2);
- developing the ability to interact with real-time information regardless of physical location or time zone (Roadmap R3);
- the mass adoption and application of off-site manufacturing, automation and mechanisation processes & systems (Roadmap R4);
- creating a well-trained, well-qualified workforce able to use the latest best practice technologies (Roadmap R5).

Building a client-orientated, knowledge-based, value-driven industry

This study describes a number of priorities that need to be addressed to move the industry towards being client-orientated and knowledge-based. It outlines a vision of an industry delivering tangible social, economic and environmental value to our clients and to wider society.

The industry in ten to fifteen years time will in many ways not be dissimilar from today's. The study identified four factors as being dominant in the future:

- climate change;
- demographics (affecting both the nature of demand on the Built-Environment Construction Industry products and supply of an appropriately skilled work force);
- funding; and
- technological developments (particularly an increase in intelligence at all levels of the built environment: materials, components, buildings, cities, regions; and organisations).

These dominant factors imply:

- the need to take a more integrative, interdisciplinary, whole-life-cycle view of building development, delivery and operation – this calls for a systems-orientated, holistic approach to project work;
- a focus on technology adoption;
- new knowledge management practices; and
- opportunities to improve the industry's competitiveness.

Over 200 research topics were identified relative to these themes – later prioritised and refined into a short list of key topics. The study then reviewed what research was being performed in these areas and proposes a sequence of research activities to be considered over the next ten to fifteen years.

Reduced resource consumption (RRC) in the built environment and the construction industry

Resource efficiency has become a prominent theme within the industry as demonstrated by the large number of business areas which are now addressing it. This study was motivated by the need to create an understanding of current and ongoing research on the subject of RRC in order to identify information gaps and future research priorities.

The study includes an overview of some key existing roadmaps on the subject of reduced resource consumption, likely future issues related to reduced resource consumption in the construction industry, priorities for future research in each of the key areas according to a variety of stakeholders across the construction industry and, finally, a recommendation on gaps and opportunities for research and/or investment needs.

The recommendations are intended to prompt an increase in the quantity and impact of research on RRC as well as improving its focus.

The recommendations in the report cover key issues in Energy and Carbon, Water, and Materials Sustainability. Cross-cutting recommendations include issues such as the development of appropriate research partnerships; improvements in the provision of ongoing training and CPD at site level; simplification of technologies for RRC and the development of intelligent building management systems to eliminate human error; and development of a broader 'systems approach' to the way in which individual technologies for RRC interact.

For further information download the reports from the National Platform Website at http://www.nationalplatform.org.uk/default.jsp, or alternatively contact Constructing Excellence who provide Management Support to the National Technology Platform (020 7592 1100).

Learning across borders: Joint action research on water technology

DFID Department for International Development

Experimenting with innovative research methods was one aim of a multi-country study comparing technological choice in community water supply in Ethiopia and Sudan. The study found that long-term sustainability is often not considered adequately when schemes are planned, but may be improved through tailor-made community-government management systems and by simultaneously implementing natural resource management programmes. The logistical challenges of this research were significant, but were outweighed by the rewards in terms of strengthening regional alliances and exchanging knowledge.

Developed by RiPPLE with Practical Action — a network partner — the study piloted the use of collaborative action research to promote sharing and learning between Nile countries, and lead to improved existing and future practice. A multi-disciplinary team carried out all aspects of the study jointly. Reflecting this, a combination of methods was used to explore scheme implementation and sustainability, at a range of sites and against a backdrop of different government policies regarding water service delivery.

During intensive study of 10 sites (with eight different technologies and varying success rates), the team had regular discussions, geared towards shared learning and exchange of ideas. Comparing country experiences allowed the team to understand which issues were country-specific and which were more universally applicable, and offered useful insights for improving practice. Giving one example, researcher Mahmud, (Director of Physical Planning, North Darfur), said, "In Sudan, we don't hand over [projects] as the operations and maintenance is done by the [government] water corporations… [in Ethiopia] we discovered some advantages and disadvantages in handing over to the community."

RiPPLE is a five-year research programme consortium funded by the UK's Department for International Development (DFID). It aims to advance evidence-based learning on water supply and sanitation (WSS) focusing specifically on issues of planning, financing, delivery and sustainability and the links between sector improvements and pro-poor economic growth. RiPPLE is led by the Overseas Development Institute – see www.odi.org.uk.

For further information contact Jojoh Faal, a research team member from the Overseas Development Institute, at j.faal@odi.org.uk. Full research findings will soon be available from the RiPPLE website. (www.rippleethiopia.org).

(Top) *Focus group discussions with the communities were one of the highlights of the study. With the research team consisting of engineers, social scientists, agro-economists, urban planners, project managers and researchers, a well-rounded set of questions was established.*

(Inset) *Researching and developing appropriate technologies with farmers in Kenchera, Ethiopia, promoted ownership, accurate testing and allowed for quick replication.*

(Bottom) *The conflict in Darfur has led to a breakdown in former government management of communal water resources. The community now feels the need to re-establish a management structure in response to rehabilitation needs, despite the ongoing conflict.*

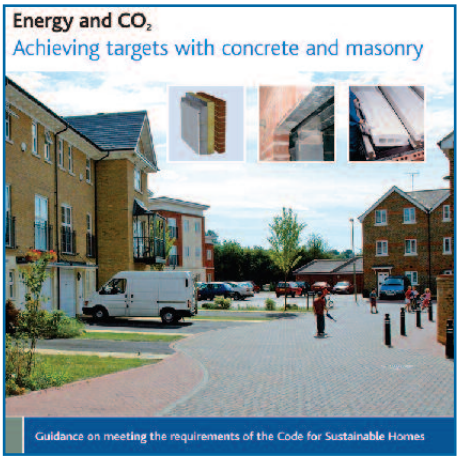
Energy performance in concrete and masonry housing

Since the introduction of the Code for Sustainable Homes in December 2006 there has been a great deal of activity in the field of housing design, particularly with regard to the increasing demands placed on the performance of the building fabric. This has been the focus of a recent study in the concrete and masonry sector.

Of the nine design categories in the Code for Sustainable Homes, 'Energy and CO_2', accounts for up to 36 of the 100 available points. This reflects the importance placed upon minimising operational CO_2 emissions relative to the other impacts included in the Code. Realising these points can require significant use of renewable energy along with enhanced insulation and air leakage performance.

To establish the implications for concrete and masonry construction, a Working Group was formed in 2007, comprising members of the Home Builders Federation and the Modern Masonry Alliance. The Group evaluated a range of fabric and services solutions for meeting different levels of the Code, and were able to derive some useful guidelines for balancing improved fabric performance with the use of renewable technologies such as photovoltaic panels. The results are presented in a short guide entitled '*Energy and CO_2 – Achieving Targets with Concrete and Masonry*' which is free to download from The Concrete Centre website (www.concretecentre.com/publications).

The guide also includes a supporting commentary on the practicalities of achieving enhanced levels of fabric performance. This covers design issues such as thermal bridging, air leakage, orientation and U-values for various types of external wall.



Concrete Centre guidance on meeting the Code for Sustainable Home's mandatory energy and CO_2 requirements.

Some of the key conclusions of the study are summarised below.

- At each level of the Code the challenges for different house types are essentially the same for all construction materials i.e. light and heavyweight.
- No single design approach to minimising CO_2 emissions will suit all house types. For example, houses with a large exposed area benefit most from improved U-values, whilst smaller attached units benefit more from the introduction of renewable energy.
- For external walls, a U-value of between 0.2 and 0.28 W/m^{2}K was found to be appropriate for Code levels 3 and 4. For levels 5 and 6 the optimal U-value for all types of wall construction may currently be around 0.15-0.17 W/m^{2}K, reflecting the best balance between overall CO_2 reduction and insulation costs.
- Concrete and masonry can provide robust, long-term solutions to airtight construction and can achieve air leakage rates below 2m^3/(h.m^2) with good site practice and detailing.
- At Code levels 5 and 6, insulation and airtightness requirements are essentially the same for all construction systems, and the emphasis shifts to the provision of renewable energy.
- A cavity width of 150mm can provide a U-value of 0.15 W/m^{2}K, which equates with Passiv Haus performance and is suitable for the highest level of the Code.

For further information please contact Tom De Saulles at The Concrete Centre (01276 608714; E-mail: info@concretecentre.com).

The Concrete Centre

Knowledge transfer for sustainable urban environments

The ISSUES Project (Implementing Strategies for Sustainable Urban Environment Systems) is a 4-year £1.3m EPSRC-funded project being undertaken by Heriot-Watt and Cambridge Universities. The project team – led by Professors Paul Jowitt and Peter Guthrie – are working specifically with EPSRC's Sustainable Urban Environments (SUE) consortia, which are multidisciplinary projects conducting research into aspects of urban sustainability. The ISSUES Project is exploring various ways of how best to improve dissemination and knowledge exchange between the SUE research consortia and urban environment practitioners.

The UK's universities are at the forefront of producing cutting edge research across the broad remit of sustainable development, yet much of this work is often confined to journal papers and academic conferences. Journal papers are important for recording research and submitting it to peer review, but researchers need to exploit other media in order to translate their research from academia into practical applications.

The added value afforded by an effective and strategic dissemination strategy can have real long-term benefits both to universities and to practitioners. However, as academics and practitioners operate in two very different worlds, bridging the gulf between them requires development of greater understanding about the differences in their mindsets, motivations, and working practices. The ISSUES Project is aiming to build that bridge.

There is no catch-all solution to effective dissemination and, in the wider scheme of things, it is not simply a case of advocating purely practitioner-driven research, although this clearly has merit for those working on practical applications of technology. Much sustainability research is into more intangible areas of investigation, such as designing urban areas to facilitate behaviour change. In the long term, these could have a much greater impact than technological fixes, but communicating that evidence in a manner that engages practitioners and policy makers is often a difficult task.

In order to build the evidence base needed to present a robust case for a greater focus on effective dissemination, the ISSUES team is conducting short interviews with practitioners with an interest in sustainability and would like to hear from anyone who is willing to participate in this research. The team has already collected a large volume of information but this research is needed to substantiate the conclusions that are beginning to be drawn. The aim is to use these results to put forward a robust set of recommendations for improving knowledge transfer that the team hopes will benefit academics, practitioners, policy makers and, ultimately, our wider society. The interview takes no more than 20 mins and can be done by phone, e-mail or in person at a time that suits you. Please consider taking part and helping us build that bridge.

For further information or to make an appointment for an interview please contact Kate Beckmann (0131 451 8147; E-mail kt-sue@hw.ac.uk; website http://www.urban-sustainabilityexchange.org.uk). Alternatively the survey documents and knowledge matrices can be downloaded from http://www.urbansustainabilityexchange.org.uk/ISSUESProgressCurrent.htm.

The use of remotely operated vehicles at acetylene gas incidents

HIGHWAYS AGENCY

Acetylene gas cylinders involved in fire-related incidents can cause the gas to decompose and become unstable with the potential to explode. Even after a period of cooling, the reaction may begin again if the cylinder is moved or subjected to shock.

Fire and Rescue Services (F&RS) in the UK initially place a 200-metre hazard zone around such incidents while imposing a 24-hour cooling period. As further intelligence is gathered and risks are assessed, the hazard zone may be reduced at the discretion of the Fire Officer in Charge.

For the Strategic Road Network (SRN) this can mean a closure of the road concerned for up to 24-hours, likely to cause massive disruption and congestion. While further research into the properties of the gas continues, through the National Acetylene Stakeholder Group, the Highways Agency, in conjunction with F&RS, has been investigating the use of Remotely Operated Vehicles (ROVs) as a means of accessing the hazard zone safely without the risk to human life. The ROV option is seen as a powerful tool by all incident stakeholders in resolving such incidents more quickly and the Highways Agency has worked closely with F&RS and the gas industry throughout the investigation.

The Highways Agency's Network Services Division has been trialling the capability of a number of ROVs, owned by private company QinetiQ. The trials were designed and supervised by Scott Wilson and were organised to test the current capability of existing ROVs to carry out tasks they would encounter at a real Acetylene incident on the SRN. Scenario testing has been taken from actual experience of Acetylene incidents on the SRN in the past.

Network Services Project Sponsor, Paul Hupton explains: "The object of this research was to use ROVs to enter the 200m zone safely, to deal with or remove the hazard and hence open the road more quickly and relieve traffic congestion. ROV existing capability was tested using various scenarios based both on what has occurred at past incidents on the SRN and what might occur in the future. To test the ROV's ability to gain access, search and identify the contents of vehicles involved in incidents, a large closed van containing a number of different types of cylinders covered in debris was used. The operation was conducted from outside a 200m cordon using cameras on the ROV and remote monitoring.

Sand was used to replace gas inside the cylinders for safety reasons and to simulate equivalent weight to test the ROV's lifting and manipulating capability. The cylinders chosen were a mixture of Acetylene, Propane and Oxygen of different sizes and weights, kindly provided by gas supplier Air Products plc. The ROV was required to enter the van, remove any debris inside and report on the number of cylinders present. Close camera observations identified labels on the cylinders which indicated contents and ownership. These camera images also showed whether the cylinders were dented, were bulging or had split, which are common signs of damage or Acetylene cylinder failure after a fire. The larger ROV was required to lift each cylinder to check the whole circumference of the cylinder."

Thermal imaging cameras are used at incidents to identify hotspots at the cylinder surface, so it is important for the ROV to be able to manipulate the cylinder in this way. Paul explained:

"Having successfully conducted trials during daylight hours, we repeated the exercise at night using lights on the ROVs to see if additional lighting would be required for night-time incidents. Fortunately, the quality of imaging proved to be as good at night as it had been during the day."

The trials also tested the ROV's capability to drag a fire hose across the 200m zone and apply water directly to the fire. "Incidents can occur on remote stretches of the network where water supplies are at a premium, so wastage can be a problem. Combine this with F&RS applying water from outside the 200m zone and supplies can be exhausted quickly without actually putting the fire out. The use of an ROV to directly apply water to the fire removes this hurdle.

A variation on taking the cylinder to a safer, less disruptive location was demonstrated by an ROV lifting the whole van and transporting it for a distance with the cylinders inside. One ROV demonstrated an ability to lift a cylinder, manipulate it out of the van before placing it inside simulated blast containment. The trials were designed to push the boundaries out and go beyond the normal duties of an ROV, as Paul explains further. "We wanted the trials to go beyond simple search and to identify operations and deal with the problem completely. In practice, an ROV that identified the presence at an incident of an Acetylene cylinder that had not vented, would not resolve the incident any faster than at present unless the cylinder could be carefully lifted and taken outside the 200m zone or be placed inside some kind of blast containment facility." Having proved this capability, further research work is planned by the Highways Agency Network Services for 2008/09. This will look at the design of blast containment, with the intention for its deployment at the scene using an ROV within the 200m zone, so that the hazard is eliminated completely and the road can be reopened.

"Proving capability is only part of the solution," Paul was keen to point out. "With the support for use of ROVs by F&RS there is further work required to develop working protocols for fire-fighters at the scene that would ensure that ROVs were mobilised as soon as possible after the incident is known about, in order to reduce mounting road congestion at an incident. The findings from these trials are intended to inform this protocol development.

As we move toward a better understanding of the gas itself and its properties, ROVs may become less attractive as an option, but for now it remains a viable option for dealing more expeditiously with Acetylene incidents to the satisfaction of all incident responders."

For further information please contact Paul Hupton, Highways Agency (0161 930 5641; E-mail paul.hupton@highways.gsi.gov.uk).

Photo 1 – An ROV gains access before searching and identifying types, sizes and ownership of the cylinders inside.
Photo 2 – Night-times search and identify exercise.
Photo 3 – ROV applies water directly at the incident scene from metres away.
Photo 4 – An ROV removes a cylinder towards simulated blast containment.

Dense discharge plumes – a new assessment procedure

HR Wallingford

Assessing discharges from power stations and refineries into the sea is an issue in which HR Wallingford has long experience. For discharges that are less dense than the receiving seawater due to their temperature or salinity, such as those from power station outfalls, the discharged waters form plumes *at* the sea surface. This behaviour has been widely researched and is relatively well-understood. Increasingly, assessments are required for dense discharges that form plumes *below* the sea-surface.

Such dense discharges include:

- desalination plants – saline discharges;
- salt cavern leaching operations – saline discharges;
- LNG (Liquefied Natural Gas) regasification plants – cold discharges.

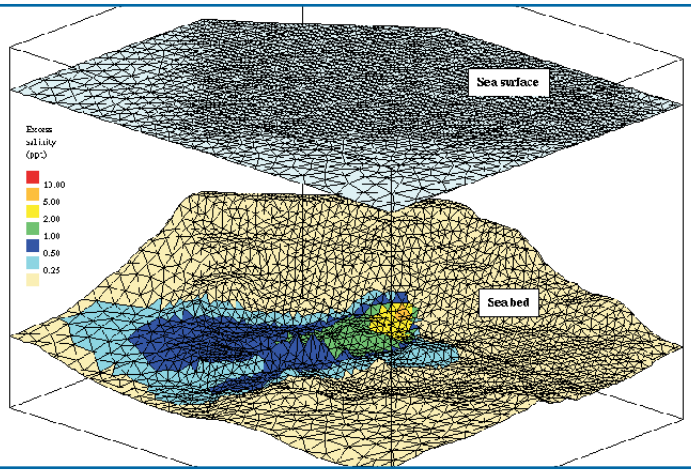
Since these discharges are more dense than the receiving seawater, they tend to descend towards, or remain near, the sea bed. Of key environmental concern because of their direct contact with benthic flora and fauna, the behaviour of such discharges is less well understood, and research in this area is more limited.

In response to this growing need, HR Wallingford has developed a procedure for assessing dense discharges. The new procedure utilises the results of international cutting-edge research and HR Wallingford's experience in consultancy studies for such discharges. The procedure has been applied at several sites, analysing the dense discharge plumes both in close proximity to the discharge sites, and further away from the points of release.

The visualisation in the picture is from a dispersion model and indicates the behaviour of a dense discharge plume at the sea bed. It enables HR to identify which areas of the sea bed will be affected by the discharge. The figure illustrates an area of some 6km^2 (sea bed depth is around 10m). The model calculates how the discharge plume will be dissipated by turbulent mixing, taking into account the effects of gravity, tidal currents and possibly wind-driven currents.

The Dense Jet Assessment procedure is now in use at HR Wallingford. As more and more dense discharge studies are carried out (for example, through the increasing development of desalination plants), it is hoped that the amount of field data available to validate assessment results will continuously grow.

For further information about HR Wallingford's Dense Jet Assessment procedure please contact Matthew Wood, Scientist, Hydrodynamics & Metocean Group, HR Wallingford Ltd (01491 822496; E-mail m.wood@hrwallingford.co.uk).



3D image of a dense discharge plume.

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E-mail: terence.boniface@berr.gsi.gov.uk

Department for International Development
1 Palace St, London SW1E 5HE
(020 7023 7000; fax: 020 7023 0072)
Website: www.dfid.gov.uk
E-mail: p-oneill@dfid.gov.uk.

Highways Agency
5th Floor, 123 Buckingham Palace Road,
London SW1 9HA
Website: www.highways.gov.uk.
Email Julie.prince@highways.gsi.gov.uk.

RESEARCH ORGANISATIONS

British Cement Association and The Concrete Centre
Riverside House, 4 Meadows Business Park, Station Approach, Blackwater, Camberley, Surrey, GU17 9AB
BCA: 01276 608700; E-mail: info@bca.org.uk
TCC: 01276 608700; E-mail: info@concretecentre.com
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Centre for Innovative and Collaborative Engineering (CICE)
Loughborough University, Loughborough, LE11 3TU (01509 228549; fax: 01509 223982)
Website: www.cice.org.uk
E-mail: j.c.brewin@lboro.ac.uk

Centre for Window and Cladding Technology
University of Bath, Claverton Down, Bath, BA2 7AY (01225 386541; fax: 01225 386556)
Website: www.cwct.co.uk E-mail: cwct@bath.co.uk

HR Wallingford Ltd
Wallingford, Oxfordshire, OX10 8BA
(01491 835381; fax: 01491 832233)
Website: www.hrwallingford.co.uk
E-mail: hrinfo@hrwallingford.co.uk

The Steel Construction Institute
Silwood Park, Ascot, Berkshire, SL5 7QN
(01344 636525; fax: 01344 636570)
Website: www.steel-sci.org
E-mail: reception@steel-sci.com

PROFESSIONAL INSTITUTIONS

Institution of Civil Engineers
1 Great George Street, Westminster, London, SW1P 3AA (020 7222 7722; fax: 020 7222 7500)
Website: www.ice.org.uk
E-mail: library@ice.org.uk

Institution of Structural Engineers
11 Upper Belgrave Street, London SW1X 8BH
(020 7235 4535; fax: 020 7235 4294)
Website: www.istructe.org.uk
E-mail: mail@istructe.org.uk

Royal Academy of Engineering
3 Carlton House Terrace, London SW1Y 5DG
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website: www.raeng.org.uk
E-mail: robert.barrett@raeng.org.uk

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