Industrial strategy for construction

The industrial strategy for construction was launched in July at the Government Construction Summit. It marks the beginning of a programme of work that will bring together various initiatives, with the overall aim of delivering growth and efficiency to the industry. A key part will be bringing forward research and innovation into the wider industry, particularly in green construction and digital design.

Publication of the industrial strategy follows six months' work by Government and industry in partnership, which has been led by the Chief Construction Adviser, Peter Hansford. It sets out an ambitious vision for the industry in 2025 and identifies the key drivers of change where co-ordinated action will help deliver our ambitions.

The vision recognises that two key transformations will fundamentally change what is expected of our industry a decade from now. First, the transition to a low carbon economy means that greenhouse gas emissions from the built environment will be reduced by almost half by 2025 (against a 1990 baseline). Second, the rise of smart construction and digital design, along with big data and sensor technologies that promise a revolution in how assets are built and operated, means that a step change is required in the industry's skill set.

A great wealth of research activity is already underway in these two key areas. In green construction, the Technology Strategy Board's Low Impact Buildings programme has helped the UK construction industry to deliver buildings with a much lower environmental impact, whilst the joint industry and Government Green Construction Board provides a platform for collaborative action to ensure we make the most of business opportunities in green and sustainable construction.

Meanwhile, various academic centres across the country are displaying the benefits of smart construction, particularly in infrastructure, where effective use of sensor technology and analysis of data enables dramatic increases in the operational efficiency of assets.

It is absolutely vital that this research activity is marshalled into a position where it is more visible and more usable in the wider industry. Only then will we see the enormous potential of these innovative solutions realised. The example of Building Information Modelling, where collaborative action is beginning to deliver tangible results, must be replicated throughout the entire research agenda. This strategy, and the Construction Leadership Council that will deliver it, provides the framework for this to happen.

For further information please contact Jack Stevens, Policy Adviser in the Construction Unit at the Department for Business, Innovation and Skills (E-mail: jack.stevens@bis.gsi.gov.uk).
SMARTtide: a unique tidal energy modelling tool

HR Wallingford and the Energy Technologies Institute (ETI) launched SMARTtide at the All Energy conference on 21 May 2013. The SMARTtide model (Simulated Marine Array Resource Testing) is a unique tool for use by the tidal energy industry to identify the most efficient sites for tidal energy converters, tidal arrays or tidal barrage schemes around the UK’s continental shelf and the North West European coastline.

SMARTtide calculates how energy extraction at one site may affect the energy available elsewhere. It also identifies how interactions between different sites around the UK combine to form an overall effect. Importantly, it also considers what constraints these interactions will place on the design, development and location of future energy arrays.

How does SMARTtide work?

SMARTtide is available as a fee-for-service via www.hrwallingford.com/projects/SMARTtide. Users will be directed to a user login area where they can download a User Guide, which provides step-by-step instructions to purchase and access the model. Once logged in, the user will be able to download a technical guide and spreadsheet to create a tidal energy scenario of their design.

Submission of the scenario automatically triggers a TELEMAC-2D simulation. Upon completion, the web user interface sends the simulation output back to the user for analysis. Water depth and current velocity components are the primary variables of TELEMAC-2D, from which dynamic interactions and model post-processing steps are defined for end-user consumption.

The SMARTtide suite accepts a scenario that may comprise one or many individual tidal energy schemes. The schemes may include both tidal current and tidal range schemes, although they are entered into the models using different input methods. The schemes can be located close to each other or anywhere within the boundaries of the SMARTtide model.

The SMARTtide model in more detail

SMARTtide is a suite of three powerful hydrodynamic software tools, which include:

- Coarse Continental Shelf Model for a high level review and initial evaluation of tidal schemes;
- Detailed Continental Shelf Model for a feasibility assessment of project development; and
- Detailed Tidal Range Model initially set up for assessment of tidal barrage and lagoon schemes in the Severn Estuary.

SMARTtide is up to 100 times more-detailed than the currently available data set, making it the most highly resolved 2D hydrodynamic model available to the public for tidal energy extraction, modelling, site selection and feasibility optimisation.

SMARTtide has been independently verified by Black & Veatch and the Universities of Oxford, Liverpool and Edinburgh.

Origins of SMARTtide

In 2011, the ETI commissioned and funded a project team – led by Black & Veatch and supported by HR Wallingford and the University of Edinburgh – to undertake the tidal resource modelling. This project looked at the interactions between tidal energy arrays and tidal barrages and investigated cumulative and combination effects of tidal stream/turbine and tidal range/barrage technologies.

The model was used to look at the cumulative impacts of build out of different scenarios in decades up to 2050 for their far-field and near-field effects. The conclusion was that the development of the UK’s tidal resource needs to be carefully managed so that the resource can be optimised. This then led to the development of the SMARTtide model.

For more information please contact the SMARTtide Support Team (01491 835381; E-mail: SMARTtide@hrwallingford.com).
Whole life auditing of buildings

Increasing attention is being paid to the design and operation of what are defined as ‘zero carbon buildings’, namely zero net carbon emissions during operation. The UK Government has set targets for all new-build housing to be ‘zero carbon’ by 2016, and non-domestic buildings by 2019. Since the mid-1990s, through improved building regulations, technology developments and voluntary and legal target setting, the consumption of energy in buildings (and the resulting CO$_2$ emissions) has reduced year on year. The focus of attention is now turning to embodied energy and CO$_2$, Life-Cycle Assessment (LCA) and Environmental Product Declarations.

A number of pressing questions have been raised on these issues. Those of demolition and rebuild versus building renovation, questions of least cost, most sustainable, greatest longevity, suitability and adaptability are all raised in many design and renovation projects.

The priority placed on recycled content, recyclability, or local availability of materials and components, can dominate the selection process. Whether lower embodied energy and thermal mass constructions have lesser life-cycle CO$_2$ emissions than higher embodied energy and thermal mass buildings is still a topic of much debate, while the whole life justification of financial investments (which aim to lower life-cycle CO$_2$ emissions) are increasingly sought.

A mechanism for fair comparison is therefore required. For each of these questions there is a need to balance energy consumption, CO$_2$ emissions and financial costs over the life of a project. Indeed there is a need to establish the design life of the project, and whether material selections match this design life.

Supported by a Royal Academy of Engineering and Leverhulme Trust Senior Research Fellowship, Dr Gillian Menzies of Heriot Watt University developed an optimisation model to simultaneously consider Estimated Service Life (ESL), Whole Life Cost (WLC) and Life-Cycle Carbon Analysis (LCCA) of building products and components.

A survey of construction industry professionals revealed a strong feeling that LCA and carbon accounting can be unreliable, insufficiently transparent, dependent upon the practitioner, based upon unreliable inventory data, insufficiently inclusive, prohibitively expensive, or just too complex. While it was reported that a degree of tolerance to ambiguity is required, the ease with which LCA data and inventories can be applied was found to be the overriding criterion for carbon accounting in the building sector. As well as the absolute value of findings, the ability to compare results with a benchmark standard was still seen as very important. Comparison between different products and between different projects was deemed very important in selecting carbon accounting tools. This need for carbon benchmarking and accounting across design projects gives a strong argument for whole life analysis to be an integral component of Building Information Modelling.

The optimisation model developed includes Estimated Service Life (ESL) planning guidance from ISO 15686, Net Present Value (NPV) costs over a 60-year building life, and LCA of building materials and components using life-cycle inventory data, estimated service life information, maintenance scheduling and end of life treatment information. This LCA approach delivers information on whole life energy, global warming potential and other environmental impacts. Combining information on service life, financial whole life costs and environmental impacts provides the design professional with a powerful tool to create specifications for buildings and infrastructure that will meet zero carbon targets and industry benchmarks.

Research is continuing to make benchmarked whole life accounting more accessible and reliable across the built environment sector.

For further information please contact Dr Gillian Menzies, (E-mail: G.F.Menzies@hw.ac.uk), or Robert Barrett (E-mail: rob.barrett@raeng.org.uk).
A low-cost field test kit for earth construction applications

Funding from the ICE Research and Development Enabling Fund has supported the University of Bath in its development of a low-cost, portable field laboratory and test kit to determine the material properties relevant to earth construction, thereby allowing reliable quality control.

Led by Dr Andrew Heath, Senior Lecturer in Civil Engineering in the Department of Architecture and Civil Engineering at the University of Bath (assisted by Natalie Price), the research looked at how compressed earth blocks (CEBs) and other forms of earth construction are extensively used in developing and disaster areas as a replacement for fired bricks and concrete blocks in small building construction.

There are a number of NGOs and other development organisations involved with this form of construction around the world. However, the quality control on these projects is often limited to visual inspection of materials to determine their suitability for use, without knowledge of their engineering properties. This can lead to inefficient or unsafe use of materials.

The following requirements were determined for a field test kit:

• acceptable accuracy for earth construction;
• lightweight for transport to relatively remote sites;
• robust and easily repairable;
• use without access to a reliable power supply;
• low-cost and sourced from non-specialist suppliers; and
• equipment for soil identification and finished product quality control included.

The test methods are based on existing laboratory methods to aid acceptance by funders and to ensure compatibility with research. It is therefore important that operators are familiar with these tests and training is required for operators who are unfamiliar with the standard tests.

The result is a field test kit which costs £380 (plus three days’ workshop time) to assemble, with a total mass of 23.2kg (10.6kg for soil identification only). This is considerably lighter than the soil which would have to be transported to a central laboratory for testing. Further details of the kit can be found on the University of Bath’s website: www.bath.ac.uk/ace/research/cicm/low-carbon-materials/low-cost-test-kit-construction-apps.html.

For more information please contact Dr Andrew Heath (E-mail: a.heath@bath.ac.uk).

Research over the years has confirmed the required soil properties for both stabilised and unstabilised earth construction, but the tests normally have to be undertaken in a soils laboratory, which are not available in many developing and disaster areas. Hence the project aimed to develop a low-cost, portable field laboratory and test kit to allow for reliable quality control of earth construction.

The Future Cities Catapult has also been established to help UK-based businesses develop integrated products and services to meet the needs of the world’s cities. The Catapult will play a key part in the government’s industrial strategy and will showcase to the world how cities can be smarter in the future.

For further information please contact Alison Nicholl, Programme Manager, Modern Built Environment Knowledge Transfer Network (01923 664550; E-mail: nicholla@bre.co.uk).
iWIDGET: helping to kick start water efficiencies

Did you know that a dripping tap in the home could waste as much as 150 litres in a single week? To examine how to improve water efficiency, HR Wallingford is part of a research consortium working on iWIDGET, a European Commission project. iWIDGET looks to improve water efficiency through the use of novel ICT technologies. Its aim is the development of a more integrated approach to water resources management by working with both consumers and the water industry.

Smart meters and other technologies will be used to gather data about water consumption and wastage in order to help reduce water demand and water loss. iWIDGET stands for ‘Improved Water efficiency through ICT technologies for integrated supply-Demand side manaGEmenT’.

How is iWIDGET trying to achieve improvements in water efficiencies?

Most of the technologies and techniques to bring about a change in consumer behaviour exist and are proven. However, they have yet to be brought together as an integrated system that could be put into production. There are, of course, a number of gaps in both the technologies and techniques and these need to be researched and solutions found.

iWIDGET builds on the electricity supply industry’s experience by developing and trialling monitoring technology for measuring domestic water consumption. The supply of clean water and disposal of wastewater are energy intensive processes. A change of water use behaviour might therefore not only reduce the consumers’ costs but also extend the life of current water resource and wastewater systems.

In addition, it could reduce the demand for energy with its consequent environmental benefits. Smart monitoring (i.e. using devices that allow continuous electronic reading, transmittal and display of the water consumption) has so far focused on the supply side. This includes major facilities and input points to the system with the main aim of monitoring leakage in the distribution system or billing bulk customers, rather than on the demand side, at consumers’ homes.

What will be the focus of the research within iWIDGET?

iWIDGET will investigate the following four areas:

• How best to provide the dynamic, accurate measurement and data transfer of useful information about end-user water consumption.
• How best to use consumption data to improve the operation of utilities and influence end-users to modify their behaviour.
• How to arrive at the best business model to convert a promising technology into a useful and cost-effective product.
• How to arrive, demonstrate and validate the new methodologies on two case studies in the North and South of Europe.

Who is working on iWIDGET?

The partnership assembled to deliver the iWIDGET project is a combination of:

• ICT companies (IBM and SAP);
• technology developers (UPL);
• standardisation organisations (HR Wallingford - OpenMI Association);
• water companies (AGS/Águas de Barcelos, Portugal; Waterwise / Southern Water, UK); and
• top scientists in water management and social sciences (from the University of Exeter, England; Laboratorio Nacional de Engenharia Civil, Portugal; and National Technical University of Athens, Greece).

The project will also obtain input from householders through two case studies and input from the broader water industry through its Advisory Panel.

HR Wallingford is involved in all work areas of the project, and specifically applies its expertise in:

• overseeing the iWIDGET dissemination programme;
• defining the interfaces between the architectural components of the iWIDGET system;
• the application of the OpenMI interface standard and other relevant standards;
• defining scenario modelling and decision support systems; and
• reviewing developments in the field.

iWIDGET is a collaborative ICT research project, funded under the European Union’s Seventh Framework Programme (total fund €5M, grant number 318272), and will run for three years until November 2015.

For more information please contact Lesley Mansfield, Analyst Developer, HR Wallingford (01491 822201; E-mail: l.mansfield@hrwallingford.com).
Understanding the effect of timber soleplate and masonry plinth interaction on the racking performance of timber frame shear walls

In this article, Thomas Bell of Edinburgh Napier University summarises his prize-winning research funded by the Institution of Structural Engineers’ MSc Research Grant Scheme. This scheme supports research undertaken as part of an MSc programme. Typically, up to five grants of £500 are offered annually with a prize for the best project poster. Applications for the 2013/14 scheme will be invited from September. See the Institution’s website (www.istructe.org/msc-grants) for further details and other research funded by this scheme.

The current design standards for timber shear wall systems rely on the existence of base fixings that are adequately designed against the potential of sliding and of overturning against lateral loading. However, these do not give direct recommendations for their design and specification. A major concern is that many timber-framed buildings have been installed onto masonry plinths without fundamental guidance or understanding of the factors that affect the vertical and lateral restraint connections in these situations.

This research aimed to develop relationships between the racking resistance of a panel and the soleplate connection characteristics in order to inform and facilitate the robust construction of timber shear walls with varying base boundary conditions.

The work investigated the influence that base fixing arrangements have on the strength and stiffness of timber frame shear panels and what potential effects there are on existing timber framed structures built in this manner. This involved a series of laboratory experiments on timber shear panels sited on typical masonry plinths, arrangements that are fixed at the base with mechanical fixings, to evaluate overall system performance. The test rig is illustrated in the figure below.

Additionally, on each of the soleplate fixing arrangements, a laboratory-based parametric evaluation in shear and withdrawal was carried out to appraise the strength and stiffness characteristics of the individual connection.

The shear panel tests indicated that under low levels of vertical loading there was a 20% reduction in the lateral strength of the panel. This occurred in all fixing arrangements, due to pull out and pull through of the fixing on the windward edge. In each instance it was found that the second windward fixing provided vertical resistance, causing lifting of the block work and separation of the mortar bed joint, but the panel did not fail catastrophically. A ductile failure persisted after maximum lateral load was reached.

The observed failure mechanism of an isolated connection test was a combination of embedment in the timber and yielding in the fastener at the interface of the concrete block. Moreover, there was shown to be no correlation between the density of the concrete block work and the withdrawal strength of the connection.

The results highlighted that the lateral stiffness using the methodology within EN 1995-1-1 for a timber-to-concrete block connection is inaccurate, and each connection should be tested independently to obtain the stiffness parameters.

Notably, within construction there is an increased application of lightweight materials, to provide easier and safe fabrication. The results show that when a timber-framed building is erected off a variable base boundary condition that is not covered in the current design standards (i.e. any situation where the panel is not fixed to a mass in-situ concrete element with embedded hold down anchors), there is a significant reduction in the lateral strength and stiffness of the panel.

To counteract the myriad of potential fixing arrangements, it is recommended that any designed timber shear panel situated on varied base boundary conditions should be stabilised against lateral loading solely by the application of vertical dead load until further research has been implemented.

For further information about this project view the on-line poster at: www.istructe.org/thomas-bell or contact Dr. Abdy Kermani, Edinburgh Napier University (0131 455 2556; E-mail: a.kermani@napier.ac.uk).
Sport surfaces: engineering sustainable solutions

Sport surfaces comprise a niche market that incorporates the latest technologies in both polymeric materials and natural materials. It incorporates advanced material science and construction, both indoor and outdoor. It interfaces with sport science and sport medicine with regard to meeting the performance requirements of sporting activities and safety with regard to injury risk of users. Recent innovations include long-pile artificial turf that is intended to simulate natural turf and has seen widespread acceptance into elite level football and rugby, with detailed tests and compliance standards set by the sports’ governing bodies.

Loughborough University’s sport surfaces research group are undertaking a number of research projects in this area aimed at enhancing the current understanding of sport surface behaviour and its influence on the user – developing ‘sport surface science’. In addition, a research network was set up at Loughborough in 2005, which is supported by a team of UK-wide academics and aims to bring together academics and the industry from around the world (currently 360 members from 20 countries) through workshops and conferences. The focus is on establishing coherent dialogue on this somewhat disparate topic.

Within the sports surfaces research group, current projects include doctoral studies into player-surface interaction and technology to measure surface response under human loading. This has involved complex multifactorial investigations into 3D motion analysis of human movement, kinetics of lower limb-surface interaction and the engineering behaviour of multi-component sport surface systems.

A current example is the investigation of the boot outsole to surface interaction for football and rugby on long-pile artificial turf, utilising bespoke research tests to simulate human movements, such as running, turning and sliding. This includes a modified industrial robot, to control a test foot, contacting surface samples on a mechanical force plate with additional thin film pressure mats to measure the mobilised surface resistance and the effects of both surface properties and stud configurations.

Two example projects (part funded or supported by industry partners) include firstly a 4-year Engineering Doctorate focussed on developing the science of surface maintenance technologies partnered with Technical Surfaces Ltd. of Leicester. This aims to provide understanding of how surfaces degrade and to develop more quantitative and objective ‘toolkits’ to assess and manage the effective long-term performance protection of outdoor artificial surfaces across a range of types. The second project is aimed at supporting industry guidance on the development of sustainable drainage solutions for outdoor artificial and natural turf pitches and is supported by the Institute of Groundsmanship, Sport England and the Sport and Play Construction Association. Through enhanced understanding of the fate of rainfall within the surface and sub-surface construction layers, new guidance will emerge on more sustainable water management for storage, infiltration into the sub-soil and outfall control to reduce flood risk. Forthcoming projects include computational modelling of artificial turf, artificial turf for elite rugby and new surface friction test methods for industry standards.

These collaborative projects, through industry engagement, develop sustainable engineering solutions to benefit the sports facilities, construction industry and sports’ governing bodies for their challenges to optimise surface design for performance, safety and longevity.

For further information please contact Dr Paul Fleming, Dr Steph Forrester or Matthew Frost (Emails: p.r.fleming@lboro.ac.uk; s.forrester@lboro.ac.uk; m.w.frost@lboro.ac.uk).
Development of modular construction systems for high-rise buildings

The Steel Construction Institute (SCI), modular supplier Futureform, architects HTA, and five other partners from across Europe, have been awarded a €1.4 million project by the European Commission under the Framework 7 programme (FP7) to support Small and Medium Sized Enterprises (SMEs). The project has the working title of MODCONS and is aimed at developing and extending the use of modular construction systems in the residential building sector in the participating countries of Spain, Finland and the UK. The work will involve physical testing, structural modelling, architectural studies, and preparation of design guidance in accordance with European standards and Eurocodes.

The project was one of a very few awarded by FP7 for support to SMEs in the construction sector, and it was considered to be innovative in terms of the off-site nature of the construction technology and also the need to develop application rules in Eurocodes and for CE marking.

Modules are highly manufactured products, which act as three-dimensional ‘building blocks’ and require a different discipline of design from the linear or planar elements with which designers are generally more familiar. Modular construction can be used for buildings up to 25 storeys high, as evidenced by recent projects and, for this scale of construction, questions of stability, robustness, fire resistance, and (in some European regions) seismic resistance are important.

The partners are SCI (co-ordinator of the project), Futureform and HTA (who are both active in the housing and residential fields), NEAPO (a modular supplier in Finland), the Technical University of Tampere, Tecnalia (a materials-based research organisation in the Basque country, Spain) and two specialist consultancies AST and IA3 in Spain. The project started in January 2013 and will run for two years.

The work will lead to improved design provisions for modular systems in accordance with Eurocodes, and to supporting research on the stability, robustness and seismic resilience of these systems for the European market. Three work packages will also address aspects of architectural versatility, acoustic performance and the quantified sustainability benefits of modular systems, which are important to users and stakeholders in the design of modern modular construction systems.

For further information please contact Mark Lawson (Email: m.lawson@steel-sci.com) or Andrew Way (Email: a.way@steel-sci.com) of SCI (01344 636525).

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