PRECAST CONCRETE SPECIAL ISSUE

CONCRETE

CONCRETE SOCIETY

For the Construction

www.concrete.org.uk

VOLUME 42 NUMBER 11 **December 2008/January 2009**

The voice of concrete products

BRITISH PRECAST

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CONCRETE
CONCRETE is the UK's leading magazine on concrete for the construction industry. Contributions are invited on current developments, construction projects and research. Letters to the Editor and news items are also welcome. Notes for authors are available.

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REPRINT SERVICE
Reprints of all articles in *CONCRETE* are available for marketing, publicity and other purposes. Tel: +44 (0)1276 607 140 for information.

SUBSCRIPTIONS
CONCRETE is published eleven times a year and sent free to all Concrete Society members. Annual prepaid subscriptions for 2009: UK £135, Europe £165, outside Europe £180. Prices include postage and packing. Single copies and back issues £18 inclusive of p&p.

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ADVERTISING
CONCRETE is read by construction professionals, practitioners and key decision makers throughout the UK and in more than 60 countries. Concrete Society corporate members are entitled to discounts on advertising rates.

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Printed by Holbrooks Printers Ltd,
Portsmouth, Hampshire

© The Concrete Society, 2008.
ISSN 0010-5317

Periodicals postage paid at Far Rockaway,
New York. Postmaster send address corrections to:
CONCRETE journal c/o IMX World Net, 254 Henry Street,
Inwood, New York 11096 USA

CONCRETE and The Concrete Society are responsible for neither the statements made nor the opinions expressed in this journal.

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THE DECEMBER/JANUARY 2008–2009 COVER

British Precast is the trade federation for concrete product producers and their supply chain partners in Great Britain and Northern Ireland. We have strong market development, technical, safety, sustainability and innovation programmes and provide a wide range of information and advisory services. Subscriptions for concrete producers start at £500.

For more information e-mail: info@britishprecast.org
website: *www.britishprecast.org*

Utzon's grandson, Jeppe (centre), with Martin Clarke (right) and John Sergeant (left) at The Concrete Society Awards Dinner.

Jørn Utzon picks up creativity award

British Precast has awarded its annual Creativity in Concrete Award to the esteemed architect Jørn Utzon of Denmark, for his incredible portfolio that includes the iconic Sydney Opera House. Chief executive of British Precast, Martin Clarke, said, "Utzon's remarkable body of work has stretched the design and structural possibilities of precast concrete into new dimensions in inspiring both fellow architects and the general public. We salute his genius."

Utzon's precast design work includes the Bagsværd Church in Denmark (1976), the Kuwait National Assembly (1983) and the Paustian Furniture Store in Copenhagen (1987), each of which repay close study. But, of course, it is the Sydney Opera House for which he is best known. Jørn, who is now 90 and lives in Denmark, takes a great deal of interest in all his buildings in collaboration with son Jan. Utzon received the RIBA Gold Medal in 1978 and the Pritzer Prize in 2003. This latest award from British Precast was presented to Jørn's grandson Jeppe, who flew to London from Denmark to accept it on Jørn's behalf. Jeppe, himself an architect, was first presented with the award at an informal lunch gathering at the fitting venue The Concrete Bar and Café at The Hayward Gallery, while an official presentation took place later at The Concrete Society Awards Dinner at the London Marriott Hotel.

Milton Precast managing director Andy Goring, chairman Rob Briscall and production manager Dave Mitchell.

Milton Precast joins sustainability charter

Milton Precast has become the 20th member company to sign up to the Precast Sector Sustainability Charter, which was launched last November. At the signing ceremony at their Sittingbourne factory, Milton Precast managing director and chair of the Concrete Pipeline Systems Association, Andy Goring, said, "We are delighted to sign the charter. It is a serious decision that has two important consequences for the company – to improve our bottom line and to improve our competitive position against competing materials. We are facing tough market conditions and a focus on minimising waste of all sorts is vital to the business." Chairman Rob Briscall added, "We have been a successful company for over 60 years and stepping up to the sustainability challenge will help us shape the company for the new challenges that face us in the marketplace and in making us even more efficient in the use of resources." Martin Clarke of British Precast added, "I am delighted that this excellent company has signed the Charter. The construction recession makes it all the more important that we become more sustainable as a sector. Milton Precast's commitment reminds us that the sustainability agenda is just as important in the engineered infrastructure sector as it is in housing and other building construction."

The paving information resource

With over 120,000 technical documents already downloaded this year alone – Interpave's website *www.paving.org.uk* has been expanded to meet the latest industry needs. The website is organised to help users find the right type and level of detail of information for particular needs. The 'Topical Issues' section offers guidance in 15 downloadable brochures on matters of particular importance today. The latest of these is the 20-page Understanding Permeable Paving document which considers statutory requirements, the planning process, overall design, long-term performance, costs and adoption issues surrounding this important sustainable drainage urban system (SUDS) technique. Coming soon is a completely new 'Sustainability' section of the website, as well as a review document on recent changes in approach to the design of external urban spaces. Essential for all those involved with commercial projects, the 'Design and Construction Information Documents' provide the definitive, detailed technical information on concrete block and flag paving, kerbs and channels, as well as SUDS and permeable paving. There is also a special Domestic Paving section for homeowners and contractors, concentrating on drives, patios and paths – including downloads on responsible rainwater management around the home, specifically referred to in Government guidance on new planning regulations for front gardens.

Use of precast concrete is building in the Middle East

The demand for precast concrete panels has been steadily increasing throughout the Gulf region. While precast has been the preferred construction material in many parts of the world for some years now, the Middle East has been slow to catch on. This can be attributed to a number of factors, not least the low cost of labour, allowing concrete to be cast on-site relatively cheaply. The shift to the use of precast has also been fuelled by the new regional impetus towards sustainable development. Due to the consistency of quality that can be achieved in factory conditions, as opposed to on-site, precast offers significantly improved durability, as well as a reduced environmental impact, and a reduction in the completion time for projects. Precast Concrete Middle East 2008, the region's first event with a specific focus on precast concrete, will be held on 14–17 December in the Courtyard by Marriott, in Dubai. The conference will bring together international and regional experts to discuss the present and future implementation, trends and issues for the use of precast in the construction industry. Visit: *www.precastconcretesummit.com*

The British Precast Outstanding Achievement in Health and Safety Award

Health and safety is at the heart of any successful business and Hanson Building Products is at the forefront of safety, with its safety team headed up by David Gilbert. David received his award from David Sarti of Marshalls, president of the British Precast Concrete Federation. The award, nominated by his colleagues in the precast industry, acknowledges the continuing improvements that David has been spearheading. As well as chairing the British Precast Health and Safety Committee in recent years, David has actively represented and supported the precast concrete industry on a number of HSE issues as well as contributing to the work of many other industry committees helping to improve employee conditions. He has selflessly promoted best practice across many member companies and has significantly contributed to the success of the 'Concrete Targets 2010' accident reductions scheme, which has helped reduce accidents

across the precast industry by a total of 65% since the year 2000 and has an ultimate target of zero accidents.

Precast Eurocode: Worked examples launched

A new book that focuses on the practicalities of Eurocode 2 has been launched by British Precast to complement the *Precast Eurocode 2: Design Manual*. *Precast Eurocode 2: Worked examples* illustrates the application of the Eurocode through, as the name suggests, worked examples. It aims to promote greater understanding of the code, which will eventually replace all national codes dealing with the design of structural concrete, such as BS 8110, BS 8007, BS 5400 in the UK, and will be the one design code for all concrete structures in Europe. Designers will find the two Precast Eurocode books as useful companion documents to the new code, both during this transition period and beyond. Published by British Precast Concrete Federation, it is the latest addition to a range of publications. Both Eurocode books are available to buy on-line (*www.britishprecast.org*) and cost £45 each plus p&p.

Precast pavilion at Futurebuild 2009

Futurebuild is the UK event dedicated to what's new in construction: new materials, new products, new methods and new processes. Now in its fourth year, it takes place annually alongside Ecobuild at London's Earls Court, and provides a showcase for the latest products destined for building structures, finishing and services.

The 2009 event takes place from 3–5 March. The organiser estimates that the show will attract in excess of 800 exhibitors and 30,000 visitors, and host more than 100 seminar and conference sessions along with dozens of topical and inspiring visitor attractions.

New for Futurebuild is the Precast Pavilion – a joint initiative between British Precast and organiser IBE. It provides start-ups and small companies specialising in precast concrete solutions with a dedicated area next to the British Precast stand and the Concrete Futures attraction, and creating a focal point for visitors, which highlights the breadth of innovative products, techniques and applications possible.

The Concrete Futures attraction will explore the range of sustainable design and construction options from this dynamic industry, and will feature information boards and products in use. Precast Steps to Sustainability will take you along a discovery trail with a difference. The Precast Infoportal entrance will include: the facts about the carbon footprint and environmental impact of concrete products; what the precast industry is doing to improve its sustainability; and how it is working with its supply chains.

From the Infoportal visitors will be guided on to the paved trail, which will feature a range of attractions including: the latest carbon-labelled concrete products; concrete masonry and panel solutions to the zero carbon housing challenge; roofing solutions with built-in cleaning and emission reduction properties and solar energy cells; intelligent concrete; translucent concrete; and interiors to amaze – elegant furniture, polished worktops even concrete crockery. Exiting through the circular outfall visitors are guaranteed to see precast concrete in a different light!

Futurebuild also features free conferences and over 100 seminar sessions, delivered by 500 highly regarded speakers, on a range of current and future industry topics. Visit: *www.futurebuild.co.uk*

Five questions about concrete...

Martin Clarke is chief executive of British Precast, the trade association of the UK precast concrete industry. He has worked in construction materials since 1972, with ARC, now Hanson, for 18 years and with the British Cement Association for 12 years. He was editor of *Concrete Quarterly* while at the BCA. He has recently published the *Little Book of Concrete* series. He is especially active in the sustainable construction area.

What fascinates you about concrete as a building material?
Its endless scope for reinvention – the inspired, original and creative things that can be done with it. I am amazed by the imaginative way in which many, but not enough, architects and engineers use concrete. When I make concrete myself I am always fascinated by its behaviour – I just wish more designers had the time and opportunity to experiment with materials themselves. It's a miracle product – what is more it's made from natural, abundant and local materials.

Which concrete structure must one have seen?
I am a great fan of the concrete buildings on London's South Bank – the National Theatre, Royal Festival Hall and Hayward Gallery complete with its new bar named Concrete. The place is really buzzing now – the concrete is looked after and creates great spaces, with the subtle board-marked finishes looking terrific. While in London take a look at the Penguin Pool at London Zoo. Designed by Lubetkin it is an iconic structure, currently in need of some tender loving care. I also have a place in my heart for the beautiful art gallery at Niteroi outside Rio designed by my hero Oscar Niemeyer. It looks like a spaceship, a great place to visit – never have I met a man with such a lifeforce as him.

Concrete is...?
Essential to modern life ... it is 'what you make of it', echoing the European promotional phrase. It is responsible for the lengthening of the human lifespan. Without the concrete contribution to sanitation and water supply we would not have defeated disease and enabled potable water for all. Without concrete we would have no durable housing, no hospitals or schools and no transport systems.

Which tendencies do you see in the development of the building material and which new properties would you wish for?
We need to reduce our carbon footprint – in our materials, including the cementitious component in our production, curing and transport and in the way our structures, buildings and landscapes perform. We are good at making concrete, now we really need to heap more added value onto the products. I really would like to see more exploitation of self-compacting concrete, ultra-high-performance concrete, fabric and polymer reinforcing, fibre reinforcement, pigments, fibre optics and RFID and e-tag devices. Translucent concrete amazes architects. Ductal is fantastic. If there is one further step, it would be a way to stop discolouration by microbial growth in damp climates such as we have in Britain, so self-cleaning concrete to me is a great development. I would hope that it will lead to a cost-effective technique to provide an exposed concrete finish that weathers well.

Where would you on no account want to encounter concrete?
Around my ankles while suspended over deep water. Apart from that I like concrete.

Acknowledgement:
Abridged from an article that first appeared in *opus C – Concrete Architecture & Design* magazine (*www.opusC.com*) Issue 4 2008, under the heading 'Creative Concrete Heads'.

Precast in the UK – lean, green and fit for purpose

Welcome to this British Precast special issue of *CONCRETE*. It is our pleasure to be supporting this turn of the year edition – a time to look back, yes, but above all a time to look forwards. You can enjoy reading about some of the industry success stories and technical topics.

"British Precast believes that policy can be influenced if enough of the industry pulls together."

In these challenging times for UK construction the inherent advantages of factory-made concrete products are more relevant than ever.Locally made using plentiful local raw materials that minimise our carbon footprint, we are proud of our sustainability credentials. At the end of 2008 we launch our Responsibly Sourced Materials Credits scheme, developed with BRE, that will allow our members to better meet the demands of the Code for Sustainable Homes, the London 2012 Olympics and the growing number of private and public sector clients that are looking for sustainable and responsible sourcing. Excitingly, we have a real chance of bettering our competitors, especially timber, which has been enjoying an undeserved competitive advantage.

Fighting for a better future

2008 has been a rollercoaster of a year, one that started well for the industry only for the credit crunch to reap its whirlwind toll from April onwards on markets and companies.

Figure 1: Martin Clarke (second left) and his team at British Precast.

Instead of planning for the three million homes by 2020 that Government promised we will be lucky to see 90,000 built next year, the lowest since WWII. On top of that we have a plethora of new rules and regulations to face up to and some crucial challenging hikes in input costs. We have not reached the bottom yet. Public sector projects, despite Government statements to the contrary, seem bound to be hit by the massive injection of tax revenues into the financial sector and we seem to be set for a deep recession that may well last two years or more. Can the future be changed or do we just sit back and accept what the economy delivers? British Precast believes that policy can be influenced if enough of the industry pulls together. Our petition can be signed at: *http://petitions.number10.gov.uk/LetsGetBuilding/*. In addition to calls for active Government construction programmes we are also drawing attention to the serious national security threat from moving to dependency on overseas sources of building materials and products. Please sign up to support the UK concrete products industry.

Supporting our materials suppliers and strengthening the Concrete Alliance

We await with interest details of the structure, priorities and programmes of the new body formed from the merger of the QPA, BCA and The Concrete Centre due to be launched at the start of 2009. We wish it well and look forward to establishing a very strong and progressive relationship. In particular we put a high priority on working for a strong UK-based cement industry. Exporting environmental impact overseas is a morally bankrupt policy and UK/European legislation should support our cement industry not penalise it. We also need an aggregates sector that is backed by a much larger resource of planned mineral reserves. That means a more liberal attitude to mineral planning. We think the penny is dropping that the UK is made of rock – a plentiful, local, low-energy, low-carbon product! The quarrying industry can count on us for strong and vocal support. As the voice of UK precast products we will continue to work with other customer groups including Britpave, Construct and The Concrete Society to create a stronger Concrete Alliance in 2009.

Martin Clarke
Chief executive, British Precast

National Precast Concrete and Concrete Expo 2009

British Precast's Annual General Meeting, Conference and Best Practice Awards ceremony will take place on 12 May 2009 at Athena in Leicester.

It will be a daytime event, which will include a short AGM followed by a conference, a hot and cold buffet lunch and the Federation's annual awards ceremony presented by a guest speaker. There will also be an exhibition area where associate members will be showcasing their latest products and services. The awards being presented in the afternoon will include projects, innovation, sustainability, and health and safety including the Concrete Targets 2010 award and Outstanding Contribution to Health and Safety.

For more information about the event, the awards, sponsorship opportunities or exhibiting, please contact Chrissie Walton at British Precast on +44 (0)116 253 6161.

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* Source: A quote from an article in 'Building' 13th June 2008

Project Award: Buildings Category and Supreme Winner

Malling Products – 154–172 Tooley Street:

Architectural precast concrete plays a key role

Precast concrete was the natural choice to deliver the high-quality exposed fair-faced surfaces paramount to the success of this ground-breaking innovative building. Malling Products used carefully selected materials and techniques to achieve award-winning precast excellence.

CONCRETE REPORT

Located in close proximity to the famous London 'Beehive', home of Mayor Boris Johnson, the design of 154–171 Tooley Street by AHMM Architects for Great Portland Estates uses exposed precast concrete extensively in both the frame and the external cladding. This design, with Arup as consulting engineer, required Malling to use unorthodox production methods and to exploit the use of secondary materials within the concrete designs.

The result, delivered by principal contractor, Laing O'Rourke, is a building that has high thermal mass, a good-quality exposed fair-faced concrete interior and an extremely durable exposed granite precast concrete exterior.

Figure 1 below: Hollowcore column in factory.

Figure 2 bottom left: As-struck column.

Figure 3 bottom right: Soffit panel mould.

The design incorporated some innovative concepts that helped to create a lean office solution. In order to use the thermal mass of the concrete frame, so that it would act as an environmental moderator, all the concrete surfaces are exposed to view. Expanded Structures, who built the concrete frame for Laing O'Rourke, looked to incorporate precast units wherever possible.

The primary structural columns, 1050mm in diameter and over 3m high, were hollow so that they could be used for the supply and distribution of fresh air to the perimeter of the floor plates.

The soffits of the post-tensioned floor slabs constructed by Strongforce are faced with large precast concrete formwork panels, which provide the necessary architectural finish.

The external cladding panels, hung and fixed onto the frame without the use of external scaffolding, were cast using a significant proportion of waste granite aggregate to achieve an interesting exposed blue/grey finish to complement the glazing features.

The manufacturing challenge

The columns

The perimeter columns were rectangular and only visible on three sides so could be cast horizontally, which produced an excellent finish on the primary face. By contrast the internal columns were circular and hollow and had to be cast vertically. The external shutters were constructed in steel, whereas a cardboard Rapidobat column mould was used to form the internal air duct. These cardboard formers, which remained inside the castings, were lined with polystyrene insulation. This insulation prevented the cooling air from heating as it passed down the hollow columns.

It proved impossible to achieve the architectural finish using conventional methods for placing the concrete. The column walls were as thin as 125mm and heavily reinforced so a tremi pour pipe was impractical.

To overcome this problem a self-compacting limestone concrete pump mix was designed with a SF3 high slump flow and the moulds filled from the bottom with concrete pumped in through two inlets pipes. Each column contained over 2m^3 of concrete and was filled at a constant rate. Shut-off valves within the inlet pipes were closed upon completion.

The results were columns with compressive strengths exceeding 60MPa, with an as-struck fair-faced finish and a pleasing light-grey appearance.

The soffit panels

Production of two thousand 3m^2 and 50mm-thick soffit panels presented an additional challenge. Large areas of such thin concrete were not only vulnerable to damage during handling but also susceptible to shrinkage cracks in an air-curing environment. A conventionally designed concrete would not only have been extremely difficult to place without severe vibration but the associated high noise levels would have been now considered unacceptable within the factory environment.

To overcome these problems a self-compacting limestone concrete with a SF3 (750–850mm) slump flow was designed coupled with the inclusion of polypropylene micro-fibres. The resulting pour into steel tray moulds was

Figure 4 above left: Frame for storing soffit.

Figure 5 above centre: As-struck soffit panels stored in specially designed racks.

Figure 6 above: Close-up view of completed cladding panels.

Figure 7 left: Tooley Street south-east corner at low level.

quick, simple and self-levelling. The mix gave a compressive strength in excess of 60MPa in 28 days.

The struck soffit had a perfect fair-faced, durable finish. The fibres prevented plastic cracking with the added bonus of improving the fire resistance of the concrete once in place in the building.

Perhaps the biggest challenge was to store the panels in a way that prevented the exposed surface being stained by timber bearers or rainwater. It is well understood that immature concrete will be marked if pressed against any form of impervious material. To avoid this risk purpose-made storage racks were fabricated, which allowed the panels to be hung from the lattice girders. Each rack was covered by a loose-fitting bespoke plastic bag that prevented rainwater staining but allowed the free flow of air around the panels during the curing process.

The external cladding panels

The external cladding panels gave great opportunity to exploit the use of secondary granite aggregate stent. The blue-grey exposed finish complements the design of the other features of the external elevations.

Again, used in a self-compacting concrete with the rheology controlled using superplasticisers and viscosity modifiers to give flow with a low water:cement ratio, the resulting panels provided a 60MPa concrete specked with mica and quartz particles, which give an uplifting, enhancing appearance to the concrete finish.

The panels were all fitted onto the building frame normally using four-point fixing without the use of scaffolding. As often happens in London, the building envelope was the site boundary so deliveries were co-ordinated to ensure that fitting the precast cladding panels onto the structural frame was straight from the lorry without storage. Erection programmes reflected the ease of fixing, normally carried out with an erection team of three. All wet trades were eliminated from the process.

Traditional two-stage high-modulus silicon panel joint sealant applied to BS 8297[1] ensured that the external envelope was completely waterproofed.

Sustainable concrete

In addition to the original sustainable concretes produced for Tooley Street, Malling has developed a range of decorative and structural concretes using high percentages of secondary products to complement and partially replace the CEM I Portland cement, accepted as a high producer of CO_2. This approach has traditionally been shunned by precast manufacturers who require early strength gain so that moulds can be used on a daily cycle.

Triple mixes based on CEM II Portland limestone cement have also been successfully trialled.

Granite stent and recycled graded glass fines are used to support and replace the primary aggregates. The combination of cementitious and primary aggregates can exceed 65% of the total solids within the mix designs.

Rigid control of the water:cement ratio using modern, third-generation polycarboxylate superplasticisers and viscosity modifiers ensures that the compressive strengths, particularly in the early stage of curing, remain greater than 15MPa to allow early mould release.

Fibre concretes, using steel fibre and polypropylene micro- and macro-fibres coupled with the above have also been developed to reduce the dependency on traditional steel reinforcement.

Careful selection, use and blending of secondary materials can contribute significantly to the quality and durability of the concrete and spectacular results can be achieved.

The future for Tooley Street

Even before piling was complete, Great Portland Estates had sold the development to Global Asset Management, who has let the entire building to Southwark Council. Awarded with a 'B' energy performance certificate with carbon emission of 50kg CO_2/m^2, the new tenants will enjoy a building that is both innovative in design and radical in its construction. ■

"The external cladding panels…were cast using a significant proportion of waste granite aggregate to achieve an interesting exposed blue/grey finish to complement the glazing features."

Reference:

1. BRITISH STANDARDS INSTITUTION, BS 8297. *Code of practice for design and installation of non-loadbearing precast concrete cladding.* BSI, 2000.

Sustainability Award: Site Category

Aggregate Industries' Hulland Ward: Working with the local community

Since 1997, Aggregate Industries has taken a systematic approach to its management of sustainability. This approach has evolved to produce different themes within the strategy, such as Sustainable Construction, Carbon Management, Biodiversity, Community Engagement, Employee Diversity and Futurepath.

CONCRETE REPORT

Figure 1: Aggregate Industries works with a local tertiary college at a national flower show.

Corporate Social Responsibility remains an essential component of Aggregate Industries' approach to sustainability. The company believes the people around its sites are fundamental to the maintenance of its licence to operate.

Hulland Ward, located near Ashbourne in Derbyshire, is the main production and distribution centre for the Building Materials division of Aggregate Industries. It serves as a central point of distribution for a number of its brands such as Charcon, Bradstone, Fyfestone and Masterblock.

Within the 85-acre site, around 500 employees work in the factories and offices dealing with production, marketing and transport management. Hulland Ward handles over 800,000 tonnes of finished product and has approximately 64,000 lorry movements per year.

As an element of Hulland Ward's community engagement plan, Aggregate Industries has consulted with the local community and authorities as to how sustainable improvements could be made at the site. Subjects raised relate to traffic management, how the company can support local educational establishments and local charities.

Figure 2: Signage improvements at Hulland Ward.

Traffic management

Due to the rural location of the site, a number of heavy vehicles pass through the community of Hulland Ward, a small village situated on a main link road about one mile from Aggregate Industries' site. Compounding this was a number of mineral extraction sites nearby, which although not the company's transport vehicles, were adding to the problem.

The consultation with the community also highlighted a perception that the speed of lorries were excessive and caused a potential danger. Second, while signage for the site did exist, it was felt that it should be more prominent.

In order to address the issues, the company carried out a detailed survey during a busy two-week period in the summer months to ascertain an accurate pattern of vehicle movements in and out of Hulland Ward. A 40mph speed check zone was also established.

The results from the survey revealed that while the site is busy with materials coming in and out, speeding was not a serious problem along the road. Aggregate Industries talked to every haulier about taking extra precaution when driving through the village in order to try to reduce the impact on the local community.

Signage was reviewed in terms of distance from the turning into the Hulland Ward site, along with its size and positioning where it could be obscured by vegetation. The company then approached the local highways authority about repositioning and improving the sight line of these signs, thus enabling lorries to follow minimum-impact routes. Aggregate Industries is awaiting final approval on these suggestions and will carry out the improvements as appropriate.

Other smaller traffic management projects have also been undertaken. This includes replacing damaged kerbs, hedge trimming at junctions and installing mirrors on dangerous corners of country lanes. Discussions have also taken place with local landowners to improve the safety of road junctions by resiting hedgerows to give drivers better vision.

To help combat the amount of traffic at the site, Aggregate Industries has had a number of meetings with the local parish council, and after discussions, a one-way system has been recommended to the Highways Authority. The aim of this would be to lessen the amount of lorries passing through the village.

Supporting educational establishments

Employees at the Hulland Ward site have developed a number of links with local schools. This has resulted in a number of organised site visits with secondary schools to explain the company's role within the local and national building and construction markets and to give students an insight into how it operates in terms of manufacturing of precast concrete products. This is then linked back into educational studies of geography and business for the pupils.

Aggregate Industries has also been working with landscaping students at tertiary colleges in the area, showing them the manufacturing process in detail and how quality checks are carried out. The company has also used these colleges to help develop designs for its products for flower shows, including the prestigious Chelsea Flower Show.

Figure 3: A company vehicle on the roads.

To complement these initiatives, Aggregate Industries has sponsored a primary school football team and worked with the school to produce posters promoting health and safety at work, which were displayed on the school's canteen walls. As many of the students were either children or grandchildren of employees at Hulland Ward, there was a payback in promoting health and safety in this way.

Donations to local charities

Since 2000 the lost time injury frequency rate at Hulland Ward has reduced from over 80 to 11. The local community now benefits from the reduction in incidents. For each factory, a month passed with no lost time injuries means money is donated to a charity chosen by people from that factory. The recipient charities are displayed as a roll of honour on the outside of the factories and a waiting list of nominations is on file. In 2007, £6000 was given to local causes from the combined efforts of the factories.

Aggregate Industries has come a long way since the 1950s when Wellington boots and flat caps were worn in the factories at Hulland Ward. These four factories in rural Derbyshire form one of the largest concentrations of precast concrete manufacturing in the business. In 1999, a comprehensive survey of safety across all businesses began a process of significant changes that continue today. The company seeks a state of being unconsciously safe, but to get there it needed first to change some fundamentals.

Changing the culture required a serious investment from the business. The first internal health and safety course made the right impression: five paid hours out of the factory for a workforce who were then still paid by piece-rate. Many of the changes that can be seen now have been put in place through employee-led suggestions. Better communication of both performance and good practice has focused attention and provided the right inspiration for further improvements. ■

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Sustainability Award: Corporate Category

Tarmac Topblock – Take Back Scheme:
Tackling waste demands give and take

While there is a general recognition of the need to create less waste, the drivers for construction companies become ever more tangible. This article looks at the UK's first national block-recycling scheme and its clear sustainability benefits for both customer and supplier.

Trevor Grounds, Tarmac Building Products

"The bags are supplied in flat-packed form, which allows them to be located on-site close to the point where the block waste is produced…saving time and leading to clean waste that is ideal for recycling."

The UK faces a major challenge to manage waste and the construction industry as a contributing sector has a huge responsibility to support national targets.

Construction and demolition is the single largest user of material resources in the economy and accounts for around 33% of controlled waste in the UK (over 100 million tonnes a year), making it the single largest stream. Although around half of the 90 million tonnes of inert waste within this figure is recycled as aggregates, there is still a need to do more.

During 2008, Government has rightly set tough waste targets for our industry. In June, the Government and the Strategic Forum for Construction published their joint *Strategy for Sustainable Construction*[1], which includes the challenging target of 50% reduction of construction, demolition and excavation waste to landfill by 2012 compared to 2008 levels. Site Waste Management Plans (SWMPs), which became compulsory in April this year for all projects over £300,000, have set-out a practical mechanism for contractors to manage waste effectively. A SWMP is also a mandatory element of the Code for Sustainable Homes.

In the near future, sending waste to landfill will come at an even higher price, thanks to the landfill tax where the standard rate for non-inert material is due to hit £48/tonne in 2010–11.

Add these potentially crippling waste disposal costs to the rising price of raw materials and the business case for recycling products in order to conserve energy and virgin aggregates becomes even more compelling.

Recognising the inherent recyclability of concrete, a group of Tarmac employees within its concrete block division, Topblock, identified a way to help both customers and the company meet the need to reduce waste and use materials more effectively by proposing a site collection scheme for unused and offcut product.

In 2007, the Tarmac Topblock Take Back Scheme was launched in partnership with HIPPOWASTE, the national provider of innovative and integrated waste management solutions. The scheme ensures that Topblock customers, such as national and regional housebuilders can take advantage of a nationwide service to remove and recycle their block waste.

Customers purchase labelled 1m^3 HIPPOBAGS into which broken and off-cut blocks on site can be segregated (cost penalties are included to discourage indiscriminate use of the bags for non-segregated materials).

The bags are supplied in flat-packed form, which allows them to be located on-site close to the point where the block waste is produced. This encourages direct segregation at the point of production, saving time and leading to clean waste, which is ideal for recycling.

When ten or more bags are full, HIPPOWASTE collects and transfers them to either a recycling facility operated by Tarmac Recycling Limited (TRL) or an appropriate Topblock plant – which minimises journeys and reduces carbon emissions. The recycled aggregates produced by

Figure 1: The Take Back Scheme was launched in partnership with waste management firm HIPPOWASTE.

Figures 2 and 3: Tarmac Topblock employees identified the way to reduce waste via the site collection scheme for unused and off-cut product.

crushing and screening of the blocks are then reused within Topblock production plants or supplied to other TRL customers.

There are a number of clear benefits to this sustainable practice for customers and Tarmac. The simple and cost-effective scheme facilitates and encourages the recycling of block waste, helps customers to manage on-site waste and reduces the volume of waste sent to landfill.

Critically, the scheme includes traceability of waste, providing customers with the audit trail required for a SWMP. The implementation of a SWMP can also allow additional credits under assessment schemes such as the Code for Sustainable Homes and BREEAM.

The recycling of block waste as an aggregate reduces the consumption of virgin aggregates for Topblock and other TRL customers, providing both environmental and economic benefits. Having traceability of the input material helps ensure the quality and durability of the aggregates produced.

Tarmac continues to review the achievements of the Take Back Scheme to ensure that the proposed social, environmental and economic benefits are being achieved in practice. The potential applicability to other product streams within its building products division is currently being assessed within the framework of the company's overall sustainability strategy.

Involvement in the Take Back Scheme demonstrates Tarmac's clear commitment to responsibly sourced materials throughout the supply chain. As a founder signatory to the precast concrete sector's Sustainability Charter led by British Precast, Tarmac is continuing to support the Federation's efforts to promote sustainable concrete construction.

Government targets to reduce the amount of waste sent to landfill by 2012 will only be met if both suppliers and customers pull together in the same direction. Innovative projects like the Take Back Scheme must become more widespread if we are to deliver significant environmental and cost savings across the supply chain. ■

Reference:

1. DEPARTMENT FOR BUSINESS, ENTERPRISE & REGULATORY REFORM / STRATEGIC FORUM FOR CONSTRUCTION. *Strategy for Sustainable Construction*. Available at: *www.berr.gov.uk*, June 2008.

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Innovation Award

Milton Precast – quick moveable barriers:

Concrete – keeping us on the move

As a long-time supporter of a safer, faster road network, Milton jumped at the chance to be involved in manufacturing a quick moveable highway barrier (QMB) system that would make use of its concrete production experience and technology built up over half a century.

John West, Milton Precast

"The decision was taken to install a moveable concrete barrier system that would enable an extremely rapid method of traffic separation or contra-flow operation when required."

Congestion on the southbound M20, due to a number of French transport, wage and fishing disputes, has long been a regular occurrence. The Department of Transport had looked at several methods to remedy a time-consuming and hugely costly problem affecting all users of the motorway. Traffic jams were often backing up some 30 miles to Junction 4, Snodland, and local towns became gridlocked as motorists attempting to find a way around the problem left the motorway and became entangled in the *mêlée*.

The decision was taken to install a moveable concrete barrier system that would enable an extremely rapid method of traffic separation or contraflow operation when required. The QMB system is an American innovation and uses a specially built vehicle to lift and position the units very quickly and safely. The vehicle can move and position units at up to 10mph. Each unit, which is 1m long, 1m high and 600mm wide, weighs 680kg. The versatility and flexibility of the system, along with the barrier's longevity via its use of concrete, make the system an extremely competitive and safety-conscious option.

The work to provide space for the barrier along the central reservation and to change the layout of Junctions 11a and 12 began in May 2008. To limit disruption, work was carried out 24 hours per day, 7 days per week. 'Operation Stack' was born.

Once the work was completed it would reduce pressure on the A20 diversion route, improve safety, smooth traffic flow and shorten journey times very considerably. The end result would be happier motorists and less stress for all concerned.

Milton has a close relationship with US firm Barrier Systems Inc, but as the company operates from California, telephone calls etc have to be timed correctly so that they do not get them out of their beds too early! Highway Care supported Milton for the whole process, being the UK point of contact. Due to the nature of the work, and to minimise noise and disruption, Milton operated a night shift when the barriers were collected. Good communication between Highway Care and Milton ensured that this inconvenience for the local community was kept to an absolute minimum.

The majority of the components were shipped from the US in containers. Milton had to supply some reinforcing but primarily just the concrete. This 'shipping part' was the most troublesome part of the project due to the fact that Milton Precast has a low bridge on the road to its production site. Some would go under the bridge, others had to be offloaded at the main site and loaded on to their own trailer for transporting – a time- and labour-consuming task.

Safety on-site was the main priority during the whole process. Strict 'truck arrival' timing had to be observed between Milton and its ready-mixed concrete supplier,

Figure 1: Quick moveable concrete barrier units.

(Photos: Milton Precast.)

Gallagher. The pouring process was quite intense and everyone involved had to be fully aware of their position in the team. Keeping the same people in the same positions for the length of the project ensured their safety and a good-quality consistent product.

The two production teams on the project were shown DVDs of the barriers being produced in the US and a team from California came over to take Milton staff through the first few weeks of barrier production. A full risk assessment and safe working procedure were written to ensure that everyone would be kept safe.

Operators were 'walked through' the production process to ensure they understood their roles. Demarcation lines and a one-way system were mapped out to segregate the two teams and to ensure that the ready-mixed concrete trucks were kept to specific areas. Each operator knew his role in the process, from demoulding to pouring, to reassembling to moulds. This continuity made for a safe, slick operation.

The production and quality control had to equal the dynamic simplistic approach to the end usage of the QMB – the goal being one unit per mould per day.

The reo-dynamic high-flowing concrete has been designed to allow for minimal compaction with little to no voids present. The mix was designed to withstand large changes in temperature ranging from 5° to 35°C to allow the concrete to be cast outside; the use of superplasticisers allowed for high workability with the capability of demoulding after 24 hours. The required strength was 31MPa at 28 days, typically reaching 21MPa at two days.

The decision to use ready-mixed concrete allowed large volumes of concrete to be discharged in limited time. Slump tests and cube samples being taken from each truck delivered ensured the quality and consistency of concrete poured, allowing 8m3 of concrete to be discharged into moulds and the truck being able to leave within 30 minutes of arrival on-site. Each operation needed to be quick to allow for smooth production of the units, as casting was not the only task needing to be completed within the day: preparation of the reinforcement and accessories were required for the following day.

The QMB barrier system had three main processes before the finished article could be used: casting, addition of the feet and jointing together in pairs. None of the processes could be undertaken until a strict quality regime had been completed, as strength goals were required for each process.

The entire production operation from the arrival of the first container to the making of the final barrier took approximately three months. In this time, 4500 barriers were produced at 100 per day. In the entire project only one day's production was lost and this was due to bad weather.

Concluding remarks

Milton Precast is convinced that QMB will bring major benefits to both contractors and road users, in terms of safety, efficiency and improved traffic flows. By allowing rapid lane changes, even at peak times, QMB helps ensure that work is completed more quickly, safely and cost-effectively – and that's got to be good news for everyone using, and paying for, Britain's roads. ■

Figures 2 and 3: Installation on the M20.

"QMB will bring major benefits to both contractors and road users, in terms of safety, efficiency and improved traffic flows."

Health and Safety Award

Figure 1: Charcon manufactures a range of products for off-site and hard landscaping projects.

Charcon's Croft Site, Leicestershire:

Moving goods safely

"A self-compacting concrete…has eliminated the need for vibration of the moulds and in turn reduced noise and the potential of hand–arm vibration."

The 'Moving Goods Safely' scheme was introduced by employees at Charcon's Croft site in Leicestershire, a key manufacturing facility, where new ways of working were implemented to improve production processes significantly.

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The plant has been operating for many years, producing a range of specialist products for off-site solutions and hard landscaping. The portfolio of products serves almost every sector of the British construction industry, including civil engineering and house building, as well as hard landscaping for industrial, retail and commercial applications.

The company was awarded the British Precast Concrete Federation 'Health and Safety' Award for its Moving Goods Safely scheme. Pat Hastings, production director, comments, "This award is testament to the good work of our site safety committee and technical department working together to carry out a thorough risk assessment evaluation.

"Together, they reviewed current processes and recommended ways to improve production, such as reduced vehicle and mobile plant activity and a reduction of pedestrian and mobile plant interaction, which has already resulted in a 40% increase in productivity."

Improving health and safety at Croft

Like every business within Aggregate Industries, Charcon is committed to achieving the highest standards in health and safety across its operational and manufacturing facilities. This is no different at the Croft site, where health and safety is paramount and continual improvement is actively sought.

As part of its ongoing risk assessment programme, the company identified that there was an excessive amount of vehicle activity within the factory. It was also recognised that pedestrian routes were not clearly identified. In addition, routes for mobile plant and pedestrians frequently crossed paths, creating a potentially dangerous situation that had to be addressed.

The solution

A pedestrian route was identified around the perimeter of the factory. Using handrails and chains at crossing points meant that all visitors and delivery drivers would be immediately segregated from mobile plant.

Due to the layout of the factory there was no easy, cost-

effective way of distributing the concrete to the mould fillers using the present plant. The company therefore used its technical department to assess the use of a ready-mixed concrete plant owned by a separate Aggregate Industries division. This could then be batched via a ready-mixed truck into specially designed cones and, via gantry crane, fill the moulds, dramatically reducing the movement required by the front loader.

Then, through consultation with the site safety committee, coupled with safety meetings and the involvement of Aggregate Industries' technical department, the company has introduced a different production process at Croft. It is now able to use a self-compacting concrete that has eliminated the need for vibration of the moulds and in turn reduced noise and the potential of hand–arm vibration (HAVS) syndrome.

The results

The Moving Goods Safely scheme has significantly reduced the activity of mobile plant within the department. There has been a dramatic reduction of pedestrian–mobile plant interaction, as well as manual handling improvements and noise and vibration reduction. The process has also resulted in a 40% increase in productivity and excellent quality improvements.

Ian Wright, head of customer marketing for the building materials division of parent company Aggregate Industries, outlines the commitment, "Ultimately, a safe business is a good business. This is even more important in the construction industry, which is why we take health and safety so seriously. Our overall aim is to make everyone within the business feel safe and as a company we are well on our way to achieving this." ■

Figure 2 above left: Charcon's Croft manufacturing facility in Leicestershire.

Figure 3 above: Health and safety measures have brought an increase in productivity.

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Project Award: Civils Category

SLP Precast – Cleveleys Coastal Defences:

Casting the coastline

Cleveleys in Lancashire is a refined and conventionally British seaside town, just a short distance up the coast from its very famous neighbour, Blackpool. Cleveleys offers a haven for visitors and retirees alike who are looking for a traditional seaside experience.

Iain Christie, SLP Precast

"SLP used existing technology to develop vacuum lifting gear that was capable of easing the 16-tonne units from their moulds."

Despite its predominantly tranquil nature, the coastline around Cleveleys can turn into a maelstrom of violent tides with up to a 10m rise and fall. This, in combination with gale force winds, can result in severe storms that dramatically pound the seashore.

The original seawall defences date back to the 1980s and the promenade back even further to the 1920s. Neither the sea wall nor the promenade were in keeping with the modern image that the town wanted to portray and both were in need of replacement. As a result, in 2004, Wyre Borough Council invited design solutions for the redesign of the sea defences and promenade. There were two parameters that had to be satisfied: one was to defend the town against the sea and the second was that the aesthetics had to be in keeping with the requirements of the people of Cleveleys. The project started with a public consultation to find out exactly what the people wanted from their promenade, while at the same time the engineering prerequisites were compiled so that a complete package could be presented to potential designers.

Having chosen the design, Wyre Borough Council had to overcome two more challenges: to find a main contractor with the necessary skills and experience and also to find a precaster with the knowledge, ability and innovative skills to produce the necessary precast elements, with a high-quality finish. Wyre Borough Council found the necessary experience in Birse Coastal and SLP Precast.

Unlike its neighbour Blackpool, where there is a sandy beach, Cleveleys has gravel on the upper beach and as a result, the action of the sea is much more aggressive. In storm conditions, the sea defences have to withstand a continuous attack, which is very similar to shot blasting. Over 12 months of research and development, in conjunction with the ready-mixed concrete supplier Tarmac, went into ensuring that the concrete used for the project was of optimum strength and durability. Steel moulds were used to cast the units to ensure the consistently high levels of accuracy required for the job. In order to eliminate the risk of corrosion and eddy damage on the surface, no lifting fixings were used in the revetment units placed closest to the sea. The revetment units were cast inverted to produce the required high-density durable surface.

The absence of lifting fixings brought a series of new challenges, namely moving the revetment units from their moulds and turning and lifting them into place on the beach. Teaming up with The Netherlands company Moderniek, SLP used existing technology to develop vacuum lifting gear that was capable of easing the 16-tonne units from their moulds. This vacuum lift took away the need for cast-in lifting provisions, which subsequently reduced costs. It also satisfied the engineers as any components cast in the concrete may have been dislodged as the units weathered. When placing the units on-site, a similar method was also adapted to lift on the correct angle of inclination using a number of smaller vacuum pads on a special frame. This system also meant that there were no unsightly socket holes to be filled in at the tidal zone.

Turning the units also called for inspiration; SLP came up with the idea of a 'giant diablo'. When suspended from a 120-tonne Eiger crawler crane, it was able not only to turn the units but also to present them at the correct angle for transportation on specially designed frames.

Figure 1: Pouring a revetment element.

Figure 2 left: Developing the New Wave theme.

Figure 3 below: Continuing the New Wave theme looking north.

The design concept of the new promenade was based on waves, open vistas and curves, all features that are associated with the seaside. During the design stage, SLP Precast felt that there was a compelling case for using precast concrete in the construction, not only for the practical capabilities of the job but also to provide the vital architectural features that the designers demanded.

The shapes of some of the precast elements required more innovation in the design of the moulds, especially the lighting columns. Apart from the revetments rising up from the beach to the promenade, the design called for the precast elements to be cast in white concrete. A white colouring admixture produced by SLP Colourtone was used to enhance the product and by the use of textured finishes such as acid etching, the company was able to deliver a more aesthetic and comfortable finished product, allowing it to blend more easily into its surroundings.

Concluding remarks

The final result is that some 9000 properties in and around Cleveleys are protected by a new seawall defence and the people are justifiably pleased and proud of their new promenade and seafront. SLP Precast was the winner of the Project Award Civils Category for Cleveleys Coastal Defences and Associated Promenade Works presented by British Precast as part of its 2007–2008 Best Practice Awards.

Once again the company's philosophy of taking the manufacturing base to the end user's site wherever practical has proved vital, enabling all parties involved in the project to communicate closely, ensuring the successful completion of this phase of Cleveleys coastal defence. ■

Figure 4 below left: Phase 2 – revetment elements installed looking south.

Figure 5 below: Phase 3 – curved revetments looking north.

Project Award: Masonry Category Joint Winner

Forticrete – Pegasus Court & Lodge:
Complex detailing for seaside residential scheme

Extensive use of complex cast stone elements has enabled three new buildings in the Victorian seaside resort of Weston-Super-Mare to recapture the elegance of the town's architectural heritage. The project illustrates the ability of cast stone to replicate cost-effectively the aesthetic properties of natural stone and manufacturer Forticrete's capabilities in project management. This project also highlights the benefits of creating integrated supply chain teams.

JOHN LAMBERT, FORTICRETE

"Since the late 20th Century, the use of cast stone has enjoyed a renaissance in modern buildings and is now more popular than ever as a cost-effective and environmentally friendly alternative to natural stone."

Pegasus Court & Lodge involved the creation of three new buildings at the intersection of Severn Street and Beach Road in Weston-Super-Mare, designed to strict planning constraints. There are two apartment blocks for Pegasus Retirement Homes, both designed with traditional load-bearing walls and a short-stay hostel for the Royal British Legion, which is a modern framed structure design.

Each design is individual yet in sympathy both with its immediate neighbours and with the established surrounding buildings. To create visual harmony, some elevations have walling stone to the full height and others at ground-floor level, contrasting in sections with rendered upper storeys and quoins running the full height of the buildings.

For the extensive detailing, cast stone was chosen as the modern equivalent of the natural stone detailing, which would traditionally have been used on the Victorian buildings that are the town's vernacular.

The choice of cast stone

Although seen as a modern material, the use of cast stone dates back to Roman times and many of the intricate detailing features of medieval buildings were actually cast from moulds rather than fashioned from the raw stone by masons. Since the late 20th Century, the use of cast stone has enjoyed a renaissance in modern buildings and is now more popular than ever as a cost-effective and environmentally friendly alternative to natural stone. The expense, long lead times and difficulties in sourcing natural stone have driven the market for cast stone products, which in many cases can exceed the performance of natural materials, in terms of strength, moisture penetration, colour and textural consistency, while delivering the same aesthetic appeal.

There are two basic production processes for the manufacture of cast stone: the semi-dry hammer compacted method and the more traditional wet-cast method. For the detailing on the Weston-Super-Mare project, the former method was chosen.

There were also three further options to consider. First, selecting products from Forticrete's Stone-In-Stock range – a selection of the most popular detailing components available 'off-the-shelf'. This service has become increasingly popular with developers and builders where speed is of the essence. The second option was the selection of components from a more extensive 'standard' range, using existing moulds to produce elements to a standardised design, with the benefits of relatively short lead times. The third option was the creation of 'bespoke' components to individual designs.

Complex detailing design

On the Pegasus Court, Pegasus Lodge and Somerset Legion House project, the detailing for the cast stone elements was highly complex, with the majority being created from individually produced wooden moulds by skilled craftsmen at Forticrete's Cebastone manufacturing facility.

At an early stage, Forticrete was able to offer significant input in cost reduction, by standardising some components across the three buildings. The majority of the components, however, were created to the architect's unique designs and Forticrete was instrumental in translating these into setting-out general arrangement drawings for on-site use and into production specifications.

The project also benefited from the quality of the Forticrete product, enabling units to be handled, packaged and transported more quickly and more confidently, with fewer breakages and enabling the high-quality finish to be retained.

The cast stone details feature prominently on multi-storeyed oriel and rectangular bays, which are topped off with decorative false gable ends reminiscent of Victorian properties from the resort's heyday. In total, the variety of details is extensive, with balustrades, corbels, copings to both gables and boundary walls, piers, spheres, string courses, window cills, heads and jambs also featuring strongly within the designs.

Figure 1 below: Intricate cast stone detailing to the three-storey oriel bays.

Figure 2 below right: The extensive use of cast stone dominates the Pegasus Court design.

Figure 3 top: Cast stone detailing successfully replicates the grandeur of a Victorian façade.

Figure 4 above right: The impressively detailed entrance to the Somerset Legion House.

Figure 5 above: The design has created an imposing appearance in a prominent location.

Figure 6 far right: Intricate window and balcony details are a feature throughout the project.

The benefits of integrated teamwork

Close collaboration between Forticrete, factor Taylor Maxwell, Armstrong Burton Architects, and contractor ROK Group enabled the complex design, production, delivery and construction of the cast stone components to be optimised over a two-year period, ensuring that the programme was completed to schedule.

Continuous liaison between Forticrete's dedicated project manager with the architect and the supply chain ensured that the thousands of individual cast-stone components were designed, produced and scheduled to site in the optimum manner, to create efficiencies in cost, supply and build. Specifically, Forticrete's close working partnership with Taylor Maxwell ensured that the complexities of production and logistics issues of just-in-time deliveries to site were handled effectively.

The success of the project has been recognised by all parties and has led to Forticrete, via Taylor Maxwell, becoming Pegasus' preferred supplier of cast stone for all future projects.

Pegasus Lodge, a building with 14 two-bedroom apartments, was the first to be completed and used as a marketing suite. Pegasus Court, with 54 one- and two-bedroom apartments, and the British Legion Hostel, a short-stay welfare break facility, were both completed in late September 2007.

Bradstone – South Lodge Hotel, Horsham:

Traditional walling for prestigious hotel

Project Award: Masonry Category Joint Winner

South Lodge Hotel, which dates back to 1883, is a luxury 4-star country house hotel. Featuring 89 exquisitely furnished rooms and set in 93 acres of parkland, the hotel is situated in the idyllic South Downs in Sussex.

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When a large extension to the historic hotel was required, a key requirement in the specification and design was the existing aesthetics and architectural style of the hotel and its surroundings. This had to be taken into careful consideration by project architect, Peter Smart, due to the hotel's neo-Jacobean style.

The project

The architect specified Bradstone's 'traditional walling' range based on its ability to create one seamless development. "Our aim was to blend together the new extension with the existing building, while retaining the intended visual appearance and harmony of the original house," explains Peter Smart.

Bradstone supplies reconstructed stone and architectural masonry solutions to the house-building industry. The walling range comes in a number of finishes and shades, sizes and components.

"The traditional walling range has a squared and lightly dressed finish, which is created by moulds, cast directly from hand-dressed natural stone masters and has long been specified as an alternative to natural stone in many regions," explains Ian Wright, head of marketing for the building products division at Aggregate Industries, which includes the Bradstone brand.

"The Southwold shade selected for this project has been specifically blended using colouring pigments to reproduce faithfully the original naturally weathered stone appearance of the stone used on the hotel."

As an alternative to natural stone, the reconstructed stone walling block is aesthetically pleasing and sympathetic to its natural surroundings, as well as being a strong, durable and very cost-effective solution. It is produced at a fraction of the cost of natural stone and produces less waste.

As well as reconstructed stone walling, Bradstone's complete service solution meant it also supplied purpose-made cast stone architectural dressings for the window surrounds, door surrounds and corbels for the extensions. These were cast in the Ashton Buff shade and recreated not only the appearance of the original neo-Jacobean style but also reflected the workmanship and finish of a first-class hotel.

"The innovative use of these precast architectural features allowed the faithful recreation of the old patterns of the surrounds, at a fraction of the cost and time that would have been needed had traditional stone masonry methods been employed," comments Colin Baker, project director of contractor Longley.

Sustainability

Sustainability was another key requirement in the tender process for the specification of structural products at South Lodge Hotel, with Bradstone's range meeting and exceeding these requirements.

"The innovative use of these precast architectural features allowed the faithful recreation of the old patterns of the surrounds, at a fraction of the cost and time."

(Photos: Bradstone.)

Figures 1–2 far left and below: South Lodge Hotel, Horsham.

Figure 3 left: Internal walls at South Lodge.

Figures 4 and 5: The project aim was to retain the intended visual appearance and harmony of the original house. Bradstone's walling range, cast directly from hand dressed natural stone masters, was used for this effect.

First, the range achieves high levels of thermal insulation for the property. This is because they act as a heat store, allowing the new extension building to store heat during the day and be warm in the evening. This has obvious benefits in helping to reduce the hotel's energy bill.

To complement this, the acoustic performance of the blocks provides effective insulation against airborne sound, particularly important to ensure the hotel guests enjoy a peaceful stay.

Other benefits include the inherent characteristics of aggregate concrete blocks, such as the fact they have the potential to last for centuries, while also being flexible enough to accommodate modifications if a user's needs change over the lifetime of the building. The Bradstone range is not attacked by vermin and insects, not adversely affected by water, including floodwater and has excellent fire-resistant properties. ■

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Research developments in precast concrete structures

The Department of Civil Engineering has an established track record of carrying out fundamental and near market research on a range of topics in the field of precast concrete structures, elements and connections. A major theme of the recent work has been structural and materials integration, where the traditional use of precast concrete is both enhanced and complemented by the use of other materials or processes.

Kim S Elliott, **Izni Syahrizal Ibrahim**, **Roslli Mohamed Noor** and **Kamaluddin Abdul Rashid**, Department of Civil Engineering, University of Nottingham

This article reports on three of the most recent projects from the department, which focus on:

- composite action between precast concrete hollowcore slabs with in-situ concrete toppings
- floor diaphragm action using precast concrete hollowcore slabs in an unbraced steel framework
- precast concrete beam half-joints reinforced using reinforcement bars with fibre-reinforced, self-compacting concrete.

Structural toppings

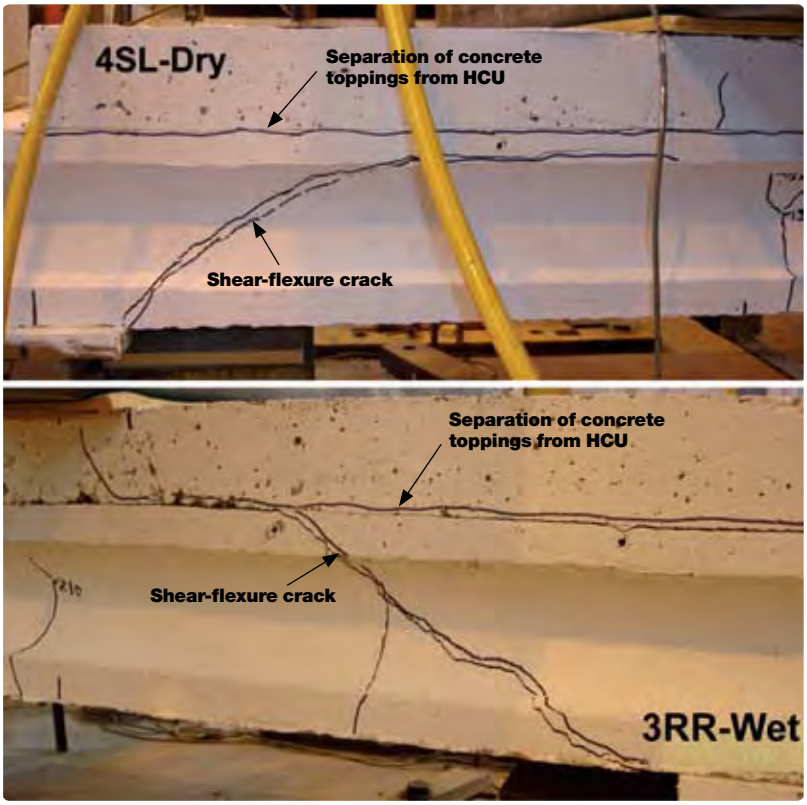
The aim is to study the interface shear behaviour of composite slabs using precast prestressed hollowcore units (hcu) and concrete toppings, and to produce recommendations for the design and construction for use by industry. With no *bona fide* information available for their design, surface preparation and construction, remedial work at the interface can be extremely disruptive and costly. Furthermore, effects of shrinkage, creep and temperature variations are often neglected during the design process.

The work has quantified the effects of surface finishes, surface preparation and long-term external UK exposure to the interface shear strength. Full-scale bending and shear tests of 150mm-deep hcu with 75mm-deep concrete toppings have been carried out to determine the ultimate bending and shear capacity as well as the interface shear strength of the composite slab. Different surface finishes (smooth and rough) and extreme surface moisture contents (dry, ponded and 'optimum wet') were prepared on the top of the hcu before in-situ casting of the toppings.

The results show that moment capacity is 20–25% higher than the calculated ultimate moment of resistance even though the surface condition was dry or ponded, which is not in accordance with the usual requirements for surface moisture conditions. Shear test results were also 10% higher than the design ultimate shear capacity. Failure occurred either by diagonal shear or the concrete topping separating, as shown in Figure 1. The interface shear strength τ increased by 0.3MPa for the rough vs smooth surface texture, for both optimum wet and ponded moisture conditions. This is quite a marked increase in shear strength terms. However, for the dry condition, τ reduced by 0.1MPa between the two textures (as shown in Figure 2), although there was a lot of scatter in the results.

In addition to the full-scale tests, small-scale 'push-off' tests were carried out to study a wider range of surfaces, such as reduced contact area (between 50 and 100% artificial debonding). Compared to the optimum wet, the results of the dry and ponded conditions were less than the ultimate stress values in BS 8110[1] and Eurocode 2[2]. As for the 50% contact area, the interface shear strength remained constant between 0.35 and 0.4MPa regardless of the dry, ponded and optimum wet condition. Although the push-off tests help to explore a greater range of parameters, the results are always much lower than in the full-size counterparts.

To study the effects of shrinkage, creep and thermal stresses, a full-scale composite floor slab field was constructed on-site and exposed to the UK weather for two years. At the end of exposure period, the floor slab field was cut into its single units and tested for ultimate bending and shear. The results found that for the smooth surface, τ



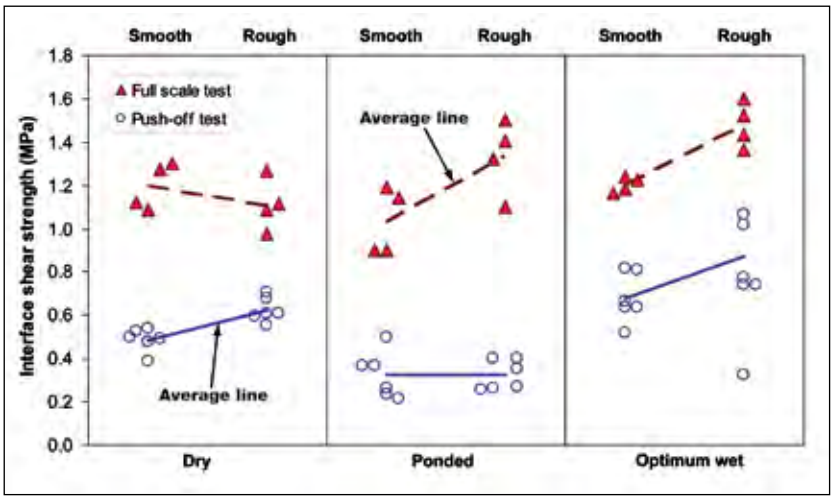


Figure 1 top: Shear-flexure crack and separation of concrete toppings from hcu.

Figure 2 above: Comparison between the full-scale shear test and the small-scale 'push-off' test.

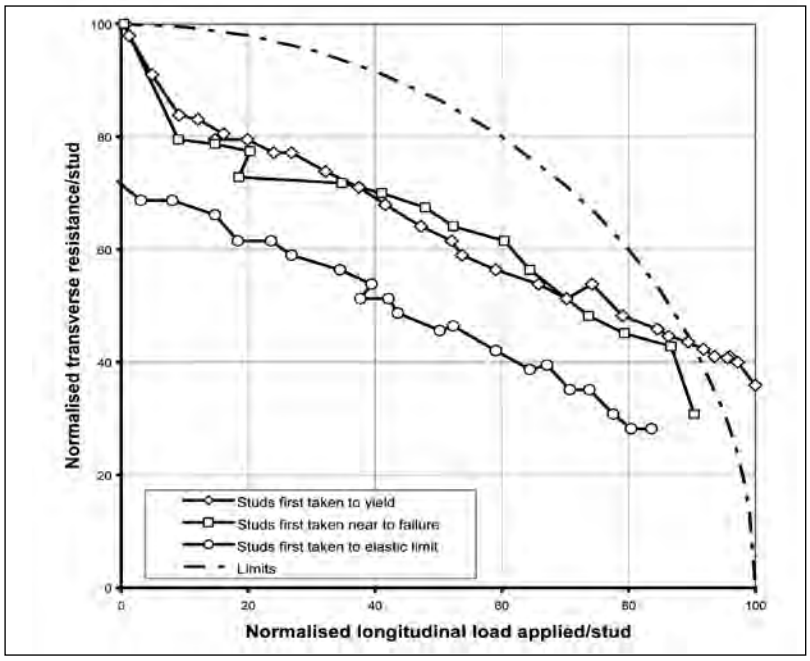


Figure 3: Reduction in shear stud capacity under biaxial loading.

reduced by 0.41MPa compared to the tests carried out in the laboratory of the unexposed specimens. However, the results were still higher than the ultimate stress values in BS 8110 and Eurocode 2. To quantify these results, a semi-empirical equation has been proposed to predict the interface shear strength of the composite section taking into account the standard roughness depth, concrete cohesion, moisture absorption, surface condition and friction coefficient. The comparison between the full-scale test results and the proposed equation was found to be in agreement where experiment/calculated ranged between 1 and 1.44.

Floor diaphragm action

Precast concrete hollowcore floor units act as a horizontal floor diaphragm in multi-storey braced structures. In steel-framed structures, where the steel beams are designed to act compositely with the floor slabs through the mechanism of shear studs, diaphragm forces from the slab are transmitted to the steel beam via the same shear studs, subjecting the studs to biaxial loading. In theory, if the studs are already loaded to full capacity due to beam bending, there is no reserve strength to cater for the diaphragm action and the capacity must be down-rated to allow for the simultaneous actions.

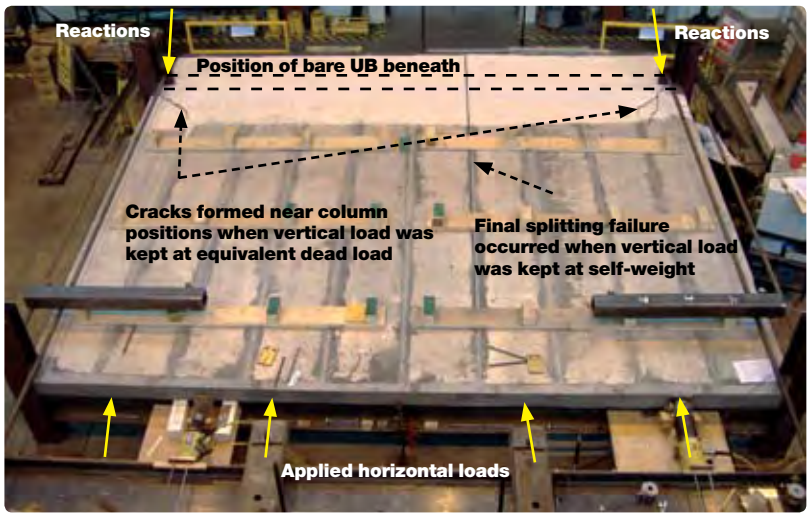
To evaluate these effects in composite steel beams and, consequently, to quantify the influence of biaxial loads on the shear resistance of the studs, push-off tests were carried out under biaxial loads. The shear studs were first loaded in the direction of the beam to either their elastic limit, ultimate capacity or near to complete failure, as shown in the three curves in Figure 3, prior to being loaded crossways to represent horizontal diaphragm forces. As shown in Figure 3, the shear stud capacity under biaxial conditions reduces to 30–40% of its uniaxial capacity, depending on the geometry, chiefly the width of the gap between the ends of the hollowcore units, the initial state of stress in the stud due to beam bending and the magnitude of the horizontal force acting on the studs.

Following this, full-scale floor diaphragms, approximately 6 × 6m in plan with twelve 600mm-wide × 150mm-deep hcu supported on steel UB, with and without shear studs, were subjected to combined horizontal loads (diaphragm forces) of up to 220kN, while the UB was loaded to about 100kNm to induce stress into the shear studs (see Figure 4). The floor diaphragm failed either by shear failure in the first longitudinal joint, or by bending splitting in the fourth longitudinal joint. In these cases, the mean interface shear stress in the longitudinal joint was 0.34 and 0.41MPa, respectively, greater than the ultimate stress of 0.23MPa in BS 8110 or 0.15MPa in EC2.

The test results show that in spite of the reduction in shear capacity of shear studs in biaxial loading, the 150mm-deep floor diaphragm is capable of bracing a steelwork frame up to 240kN horizontal load.

Figure 4 below left: Precast hollowcore floor diaphragm in structural steel frame.

Figure 5 below right: Failure of short recess beam by tension in the horizontal bars above the bearing.



Shear strength of precast concrete half-joints using SFSCC

The ability of steel fibres to partially replace reinforcement in precast concrete beam half-joints was investigated, taking into account the reinforcement configuration, concrete strength as well as nib depth. Self-compacting steel-fibre-reinforced concrete (SFSCC) made with hooked-end steel fibre (aspect ratio 65 and 35mm length) at dosage of 0.5% and 1% volume, was produced with the final goal of reducing the congestion of reinforcement in the precast beams.

In its fresh state highly flowable, yet cohesive SFSCC was achieved. It possessed good self-compactability characteristics even though the fibres significantly affected the workability. SFSCC also had good mechanical properties at both early and late ages with compressive cube strength of more than 50MPa at 28 days.

The final mix design was:

- Ordinary Portland cement 42.5N 422kg/m^3
- Fly ash 132kg/m^3
- Free water 170kg/m^3
- Coarse aggregate 10mm Trent gravel 740kg/m^3
- Medium-grade sand 833kg/m^3
- Superplasticiser, Daracem SP1 2.3kg/m^3
- Steel fibre (1% by volume) 78.5kg/m^3

Key ratios are: water/powder = 0.86, mortar volume = 0.46, water/binder = 0.31. Mean key performance indicators are: slump flow 680mm, L box ratio = 0.89, J ring =

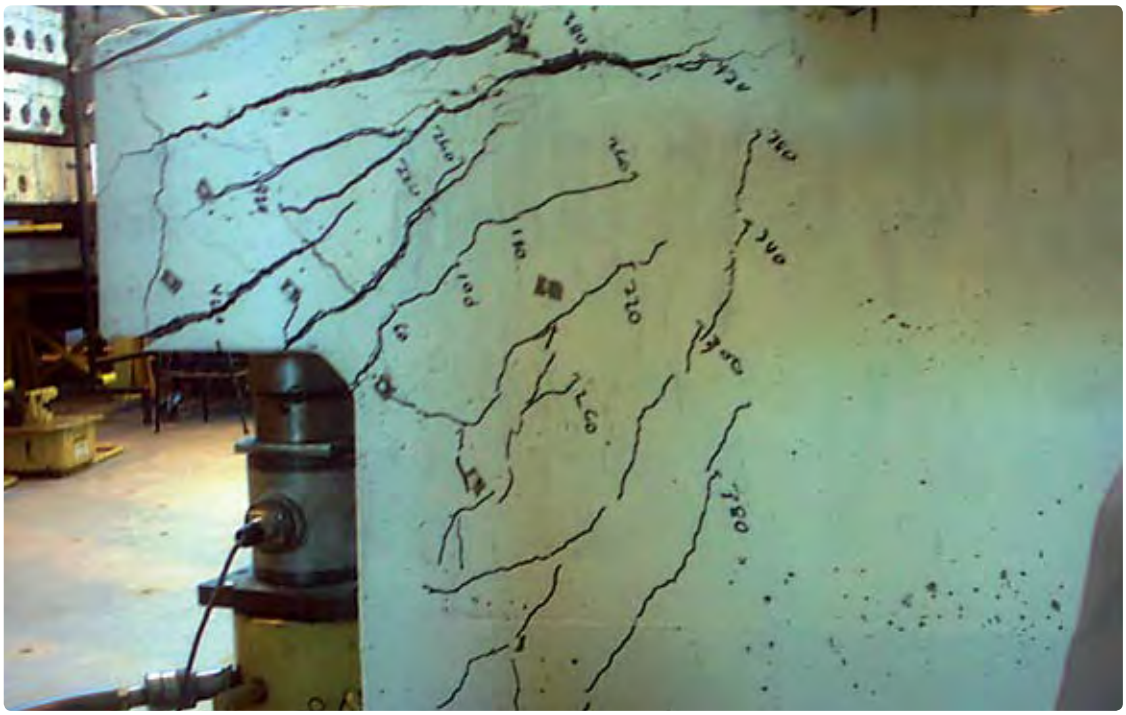


Figure 6: Failure of deep recess beam by yielding of diagonal bars and local splitting of concrete in compression zone.

6mm, V-funnel = 9 seconds. Density = 2380kg/m^3, 28-day cube strength = 66MPa.

Small-scale multi-axial tests showed that it was necessary to use 1% fibre content to achieve the mean tensile stress required in the half-joints.

Full-scale shear test beams with shallow or deep recesses (see Figures 5 and 6 respectively) gave the ultimate shear capacities shown in Figure 7. The inclusion of 1% volume of steel fibres was found to be effective in replacing at least 50% of vertical or horizontal reinforcement. However, the replacement over diagonal reinforcement in the deep recess was, as expected, not effective, indicating that fibres are suitable only for replacing vertical and horizontal bars. Steel fibre contribution is due to fibres' bridging action and an increase in compressive resistance due to fibres arresting the propagation of cracks in the compressive zone.

Semi-empirical equations for predicting the shear strength of precast SCC and SFSCC beam half-joints have been developed[3]. The analytical model based on the crushing of the concrete strut was found to suit the shallow recess beams, while the equations for deep recess beams were based on yielding of reinforcement.

Data points in Figure 7 show that these equations give good correlation with the experimental results. The standard variance is 6% and 3% for the shallow and deep recess, respectively. All equations are improvements compared with the equations published by the *PCI Design Handbook*[4] and RILEM[5].

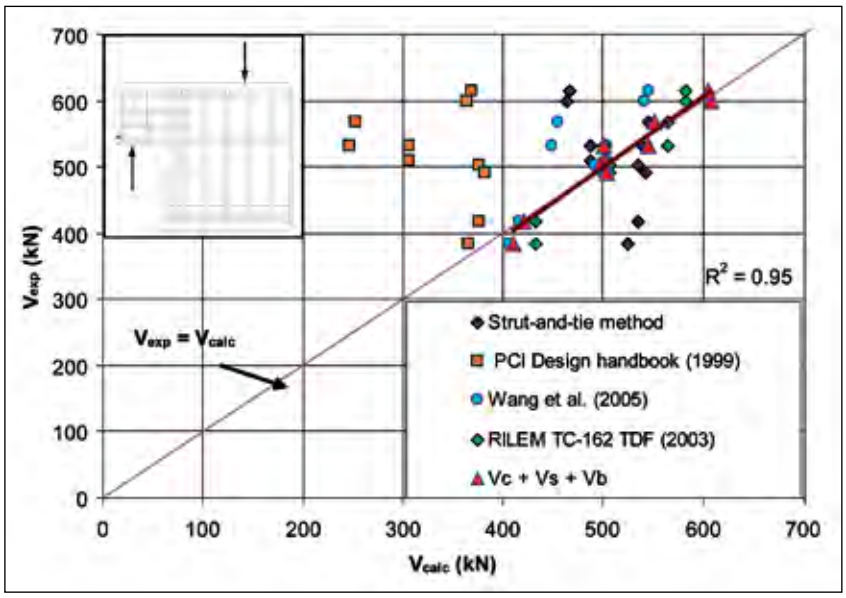


Figure 7: Comparison of experimental test results with analytical equations for deep recess beams.

Concluding remarks

The research presented in this paper has demonstrated a wide range of applications for precast concrete used in combination with other structural and material mediums. The key findings are:

- Composite action between precast hollowcore slabs can be achieved under widely different surface textures and preparations. Although there are clear indications as to which permutations perform best, all full-scale tests exceeded code limits or design values.
- Precast hollowcore slabs can be used to provide the horizontal floor diaphragm in steel frames, without the need for bracing, and in spite of the fact that under combined bending and diaphragm actions, shear studs may lose more than half their uniaxial capacity.
- The research on precast half-joints has demonstrated the success of replacing considerable quantities of congested reinforcement with a small quantity of steel fibre, without loss of strength, and in some cases improvements in ductility. ■

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1. BRITISH STANDARDS INSTITUTION, BS 8110. *Structural use of concrete. Code of practice for design and construction*. BSI, 1997.
2. BRITISH STANDARDS INSTITUTION, BS EN 1992-1-1. *Eurocode 2: Design of concrete structures*. BSI, 2004.
3. NOOR, R.M. *Steel-fibre self-compacting concrete in precast concrete half-joints*. PhD Thesis, University of Nottingham, 2008.
4. PRECAST/PRESTRESSED CONCRETE INSTITUTE. *PCI Design Handbook on Precast and Prestressed Concrete*. PCI, Chicago, Illinois, USA, 1999.
5. RILEM TC 162-TDF. Final recommendations of TC 162-TDF, Test and design methods for steel fibre reinforced concrete, σ-ε design method. *Materials and Structures*, Vol.36, 2003, pp.560–565.

Living with radon

Radon is a naturally occurring radioactive gas, formed during the decay of uranium in the ground. When it surfaces into the open air it is quickly diluted to a harmless concentration but if it enters a building it can become trapped and potentially dangerous levels can accumulate. Indeed, there are around 2500 deaths in the UK every year from lung cancer, linked directly to long-term exposure to high radon concentrations. This article explains how precast concrete beam-and-block flooring can deal with the challenge of unwanted radon.

"Resistance to radon penetration is not the only benefit of a concrete beam-and-block floor. Seepage of methane on brownfield sites is also prevented, and acoustic performance is improved."

George Pickard, Precast Flooring Federation

Radon is found in all parts of the UK but is more prevalent in some areas. Places where the British Geological Survey (BGS) and the Health Protection Agency (HPA) have estimated that more than 1% of homes will contain elevated levels of radon are known as Affected Areas. Exposure is higher in Cornwall, Devon and Somerset, and there are hotspots in Wales, the Cotswolds and the Pennines. Surprisingly, radon is the most common source of exposure to radiation in Britain, exceeding that from nuclear power stations or hospital scans and X-rays.

Floors and walls of dwellings contain many small cracks and gaps formed during and after construction. Any radon from the ground may be drawn into the building through these cracks and gaps because the atmospheric pressure inside the building is usually slightly lower than the pressure in the underlying soil. This small pressure difference is caused by the stack (or chimney) effect of heat in the building and by the effects of wind.

Awareness of the risks has recently been highlighted by the HPA and BGS who have produced a new map of affected areas in England and Wales, accessible via the website *www.UKradon.org*. Although the map gives estimates of the probability that properties would require action, the HPA has also advised that high radon levels can be found in basements anywhere in the country, regardless of Affected Area status.

Significantly, an understanding of the risks posed by radon is relatively recent and in some areas of the country there are architects, developers and builders who have not previously had to consider radon reduction in houses. However, as radon-generating locations are being identified and recorded in greater detail, the need to be aware of and to deal with radon is becoming more of an issue on new-build housing projects.

The gas flows into buildings as a result of:

- the pressure of ongoing gas production
- the stack effect
- the wind
- groundwater movement.

When buildings are constructed on gas-contaminated land, the gas will generally seep upwards through openings such as construction joints and service penetrations, and build-up to dangerous concentrations if it becomes trapped, the extent of which largely depends on the local geology. The key phrase is 'if it becomes trapped', in which case there are two stages to control the situation. The first is to make sure that gas is separated from the living area of the building by an impermeable membrane across the whole footprint of the building and the second is to evacuate the gas continuously to the outside of the building where it will rapidly disperse.

Section Cl (Resistance to Contaminants) of Schedule 1 of the Building Regulations 2000 states that "Reasonable precautions shall be taken to avoid danger to health and safety caused by contaminants on or in the ground covered, or to be covered, by the building and any land associated with the building." Further guidance is given in Approved Document C (2004 edition), where section 2.39 explains that, "To reduce the risk [to occupants of developing lung cancer] all new buildings, extensions and conversions, whether residential or non-domestic, built in areas where there may be elevated radon emissions, may need to incorporate precautions against radon."

The most straightforward and economic solution to such gas penetration is to use suspended precast concrete flooring above a vented plenum. The concrete and membrane form an efficient passive barrier, while natural underfloor ventilation by way of vents and airbricks avoids any potential build-up. In extreme cases, active measures such as radon-laden air being extracted using a gas sump and mechanical ventilation may be required. This is generally the most effective method and will often reduce the

Figure 1 below: Beam and concrete flooring block with insulated overlayer – typical passive gas emission shown.

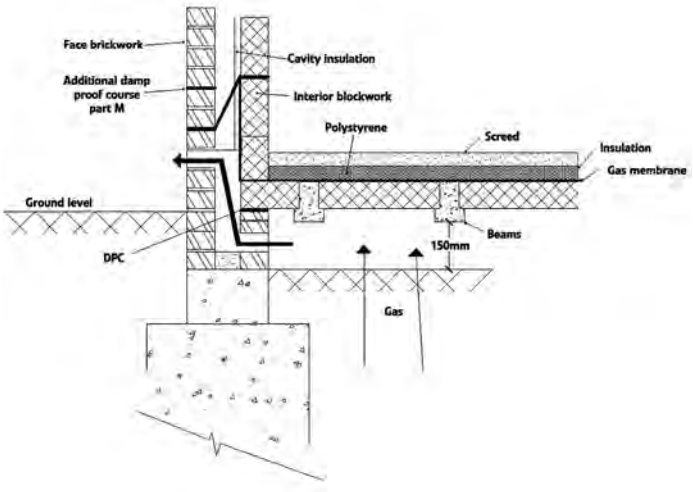

Figure 2 below right: Beam and insulated flooring block – typical gas emission shown.

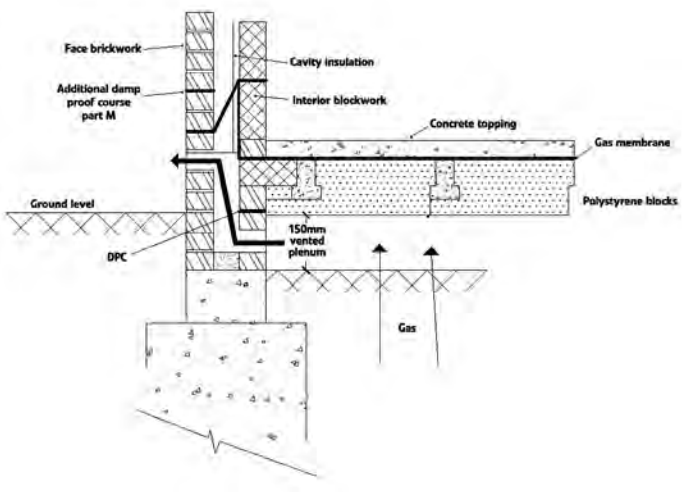

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Figure 3: Hanson's Jetfloor Super system.

radon to less than one-tenth of the original level.

The member companies of the Precast Flooring Federation (PFF) have published, in conjunction with the Radon Council, a data sheet that covers the incorporation of membranes within the precast floor design. A radon barrier consists of a cavity tray through the wall linked to a membrane across the floor. Typically, the cavity tray is formed using a high-performance co-polymer thermoplastic damp-proof course material or prefabricated cavity tray units. This is then sealed to a 1200-gauge polyethylene membrane laid across the beam-and-block floor. Penetration points due to services are sealed with 'top hats' and joints in the membrane are sealed with tape. The micro-porous seepage through these membranes is almost negligible. Any precast concrete system can be used with the incorporation of a gas membrane.

Of course, resistance to radon penetration is not the only benefit of a concrete beam-and-block floor. Seepage of methane on brownfield sites – something about which awareness is also spreading – is also prevented, and acoustic performance is improved. In addition, such floors are more cost-effective than timber and enable thinner floor zones as well as longer spans. They are easy to install using semi-skilled labour and, for above-ground levels, provide a safe working platform for ongoing construction. Add to that their intrinsic one-hour minimum fire resistance and compatibility with other precast concrete components such as stairs and balconies and it is easy to see why the technique continues to gain ground.

Although dealing with radon penetration later in the life of a building is fairly inexpensive, the remedy will probably require an annual maintenance and service contract. Compared with the cost of installing a membrane or plenum during construction, it is clear that the best thing to do is to install effective radon protection at the time of construction. The PFF can supply names of those member companies that manufacture modified beam-and-block flooring. The system is available either as supply-only or preferably as supply-and-fix.

Concluding remarks

Additional detailed information and advice on ways of dealing with radon are available in BRE Report BR211[(1)]. This report identifies the areas of England and Wales where measures should be taken to provide protection against radon and offers guidance on the technical solutions that are required to satisfy Building Regulations requirements. The report can be purchased from: *www.brebookshop.com.*

Figure 4: CEMEX beam-and-block flooring at ground-floor level on a residential site.

Figure 5: Tarmac Topfloor's Fastfloor Heatsave system.

Reference:

1. BUILDING RESEARCH ESTABLISHMENT, BRE Report BR211. *Radon: Protective measures for new dwellings*. BRE Press, Bracknell, 2007.

Shopping around for high-quality concrete

"Visitors will be amazed by the scale and the clean but complementary architecture, while local people will welcome another suitably grand building to join Cambridge's rich cityscape."

Whatever the economic climate, the retail sector of the construction industry is renowned for its optimism. And increasingly it is the member companies of the Architectural Cladding Association that are called upon to contribute to the realisation of this forward-looking philosophy.

Stephen Maddalena, Architectural Cladding Association

Among recent examples of ACA members' contributions are: St David's development in Cardiff (due for completion in 2009); the Barton Square development at Manchester's thriving Trafford Centre; Cambridge's Grand Arcade project; and Leicester's Highcross shopping and cinema complex, previously known as New Shires.

St David's

St David's in the heart of Cardiff is a £675 million investment in the future of the city as a leading national and international centre. It is a retail-led mixed-use urban regeneration project that includes new stores and luxury residential apartments as well as the modernisation of the existing St David's Shopping Centre. The development is being constructed by Bovis Lend Lease with its various specialist trade contractors, including The Marble Mosaic Co, which is responsible for the detail design, manufacture, delivery and installation of the sandstone- and granite-faced precast concrete units that feature in the external cladding.

The typical panelisation of the elevations is based on pairs of storey-height precast column facing units supporting 8m-wide grid-width spandrel units. These are cast using 50mm-thick facings of Warthauer sandstone and are generally 450 × 1250mm, most with a 150mm reinforced concrete backing. Spandrel panels typically include 40–50 stone facings individually secured to the backing concrete by stainless-steel dowel pins. Before despatch, the back faces of the precast panels were faced with insulation to enhance their thermal performance.

Figures 1 and 2: Development of St David's Shopping Centre, Cardiff.

Barton Square

Stunning state-of-the-art architectural stone cladding, designed, manufactured off-site and installed by Trent Concrete as part of a £6.4m contract, is taking pride of place at the new Barton Square development at Manchester's thriving Trafford Centre. The bespoke precast concrete cladding is bringing the cluster of buildings at Barton Square to life – giving them a classical appearance and delivering innate strength and durability.

Figure 3: Barton Square, Manchester.

The latest phase of the development, the 20,000m^2 Barton Square project, comprises four L-shaped blocks forming a central square, mall and colonnade, with reconstructed stone cladding. Working to the architectural drawings, the design concept was easily turned into a reality by specialist contractor Trent Concrete.

The result is a series of magnificent and commanding buff-coloured pilasters, up to 8m high, with accompanying cornice units, band course and plinth. Each unit, some weighing up to 24 tonnes, was handcrafted at the Nottingham manufacturing plant. Cast in a buff reconstructed stone mix, with an acid-etched finish, the precast cladding was chosen to blend with similar stone architecture at the existing Trafford Centre – visited last year by more than 30 million shoppers. Shop fronts inside the Barton Square mall feature part-brick-faced pilaster/cornice units and support beams, while the colonnade is formed from 7m-high tapered circular columns. The central feature in the mall is a coliseum made from square columns, again 7m high, faced with granite and a curved cornice.

Cambridge Grand Arcade

New buildings in Cambridge are not an easy prospect for many reasons, mainly perhaps because it will always be a daunting prospect to complement the city's rich historic architectural heritage within the confines of building regulations and client expectation. The Grand Arcade project provides a giant new car park accessed from St Tibbs Row, while the Downing Street/St Andrews Street corner presents a prestigious John Lewis Partnership (JLP) retail outlet dressed in light honey-toned natural stone-clad precast units. The JLP logo has even been carved into the façade to remove the necessity for vulgar signage.

Further down St Andrews Street, the development absorbs a row of retained buildings, which have been incorporated and completely refurbished internally, though the façades have been sensitively restored to preserve the ambience and artistic influences of Cambridge's varied past. However, running through the building and

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Over 170 black polished precast units (totalling 1270m^2) were cast and delivered to form the ground-floor façade to the flagship four-storey JLP store and a 12-screen Cinema de Lux.

linking into the retained façade is the St Andrews Arcade that divides the JLP facility from the Magistrates Court for the full height of the building. Both sides of the arcade are clad with stone-faced precast concrete pilasters with horizontal stone-faced cladding panels and a complementary mix of curtain walling, all covered by a stunning glazed roof 25m overhead. This arcade leads into the main atrium where link bridges allow access to retail units at each level. Again, the atrium is formed by stone-faced precast units that run above the incoming St Andrews Arcade up to an even higher glazed roof 30m high.

From here the arcade curves serenely away along the flank of the car park, separating the north side of the magistrates court from the shoppers and leading into the existing Lion Yard shopping centre. The Grand Arcade is, as the name suggests, very grand and this is further emphasised by the ground floor, which curves down a gentle slope towards the Lion Yard. At Level 1 is a curved and colonnaded walkway to the car park elevation; to the magistrates court elevation, the arcade sets back to form an open walkway linking back into the atrium. Aptly named, this is a grand project built on a grand scale. Visitors will be amazed by the scale and the clean but complementary architecture, while the local people will welcome another suitably grand building to join Cambridge's rich cityscape. Techrete's involvement included casting and erecting several mock-ups and sample panels in Cambridge for testing and aesthetic approval. The company provided design advice from an early stage to ensure that the project realised its potential and also supplied and fitted several large areas of natural stone where it was impractical to use precast units because of access limitations.

Leicester Highcross

The John Lewis Partnership was also the client for Decomo's contribution to main contractor Sir Robert McAlpine for Leicester's Highcross shopping and cinema complex. Over 170 black polished precast units (totalling 1270m^2) were cast and delivered to form the ground-floor façade to the flagship four-storey JLP store and a 12-screen Cinema de Lux. The contract involved sandwich panels, assorted precast units and slender delicate single-skin panels that had to be turned in the air on-site by the installation crew. Due to the proximity of busy city centre roads it was necessary to install one elevation at night and weekends. One unusual feature was the inset concrete doors, produced to match the panel façade. These were produced by Decomo in Mouscron, Belgium, by filling open galvanised steel tray doors with the concrete and polishing in the automated plant along with the other panels. ■

Figure 4 above left: Grand Arcade, Cambridge.

Figure 5 above: Highcross, Leicester.

Making the *Dream* a reality

Standing at the side of the M62 in the North West, up to 150,000 people a day will see Evans Concrete's most ambitious project to date. The Derbyshire bespoke precast concrete firm has been commissioned to produce a highly prestigious piece of public art by world-renowned artist, Jaume Plensa, for the town of St Helens.

Garry McBride, Evans Concrete Products

Figure 1: The author (and chairman of Evans Concrete) and artist Jaume Plensa discussing the sculpture before viewing samples.

Figure 2: A number of jointing methods were discussed.

Figure 3: Showing Jaume a sample of the colour and finish.

(Photos: Evans Concrete Products.)

The 20m-high sculpture, named *Dream*, has been commissioned by St Helens Council and curated by Liverpool Biennial as part of *The Big Art Project*, a public art initiative from Channel 4 supported by Arts Council England and The Art Fund, the UK's leading independent art charity.

Fabricated entirely from precast concrete, the sculpture will take the form of a head of a girl with her eyes closed, seemingly in a dream-like state. It will stand on the former Sutton Manor Colliery, overlooking the M62, and will become a landmark feature for the North West, symbolising regeneration in the region.

Evans Concrete will be working for main contractor Cheetham Hill Construction with Arup acting as structural engineer on the project. Evans will be taking on the role as the lead partner for the manufacture and installation of the precast concrete elements. Others involved in the delivery of the precast concrete elements include: Erskine Hurt, consulting engineer; ICP, installer of concrete products; and Cordek, manufacturer/supplier of specialist moulds.

There are three key stages to the project: design and development, manufacture and installation.

Design and development

Due to the size and weight of the sculpture, *Dream* is being constructed from 53 individual panels. This was one of the most important aspects of the design stage and, as well as artistic requirements, the fundamental design of the connection method, production and erection were all carefully considered.

Throughout the design and development stage, Evans advised on the casting method for the best quality finish and the individual unit sizes for handling and transportation. Joint locations and panel sizes with respect to mould manufacture, fixing types and buildability, and structural issues including handling and loading criteria, were also discussed among the team during this stage.

This phase also included several design workshops for the entire team, production of initial general-arrangement drawings and their finalisation, review of the initial design in an open forum, approval periods and the production of detailed design of components and reinforcement drawings and schedules.

The design and development stage of the project has now been completed, and the manufacturing process has begun.

Manufacture

Polystyrene formers are being used to create the intricate details and features of the 'head' and these are being produced now by Cordek. The production of the precast panels is due to commence in December 2008. Once the production of the mould shapes has been completed by Cordek, they will be transported to Evans' facility in Ripley, Derbyshire, where they will be assembled into an actual production mould.

Reinforcement will be ordered from a CARES-certificated supplier and all cast-in fixings will also be preordered and delivered to the workshop for incorporation into the elements. Evans Concrete will be responsible for fixing the reinforcement and for batching the concrete.

Evans operates an in-house quality control procedure, which is adhered to at every step of the production process. Checks will be conducted on the mould dimensions, reinforcement and cast-in fixing positions prior to pouring and

Figure 4 far left: Jaume discusses a mould sample produced by Cordek.

Figure 5 left: Jaume was shown the acid-etching process.

Figure 6: Concept model of *Dream*.

on unit dimensions and fixing position post-strike. Cover checks will also be carried out throughout the project and recorded in a comprehensive quality file. In addition, concrete cube results will be tested in accordance with BS EN 12390[1] by a third-party UKAS-accredited laboratory.

Materials and samples

The mix to be used for the *Dream* project is SD1, a unique concrete using Spanish dolomite main aggregate, Spanish dolomite fines, white cement and titanium dioxide pigment, which will give the *Dream* sculpture a high-quality brilliant white finish.

All mix designs will be in accordance with BS 8500 (Parts 1 and 2)[2] and based on a 100-year design life. All requirements for the mix will be determined through BS 8500 using the appropriate exposure class XC3/4 and any other relevant factors.

The precast concrete elements will be finished with an acid wash to remove the cement laitence from the cast units and expose the Spanish dolomite main aggregate.

Installation

In total, 53 precast elements totalling approximately 500,000kg of architectural manufactured concrete will be installed. The units will be joined with 20,000kg of cementitious grouting material, over a four-week construction programme.

All deliveries will be just-in-time, controlled on a daily basis by a working site manager who will be directly responsible for health and safety, quality control and planning and organising deliveries in conjunction with Evans Concrete.

Installation will commence at the base plinth. All units will be lifted using proprietary cast-in lifters attached to two sets of 4.2-tonne adjustable chain brothers attached to the hook block of the mobile crane. Initial unit setting-out positions will be clearly defined at the base foundation along with prelevelled shims for each unit.

A certified CPCS slinger banksman will then signal the crane driver, who will lift a unit from the storage area into its required location on the structure. The unit will be slewed into position where two erectors and the site engineer will be waiting on-site to install the unit. The installers will take hold of the unit and control the lift into its fixed position on the prelevelled shims. The CPCS slinger signaller will lower the units onto the shims, reducing around 15% of its overall weight. Units will be installed on a level-by-level basis of four sections per level with fixed over dowels.

Where grouts and mortars are to be used, these will be high-strength proprietary materials. All materials will be prebagged and samples of the mixed materials will be cube tested at each segment level. Grouters will follow the sequence of installation and commence grouting works on completion of each level.

Materials will be mixed at ground-floor level and lifted to each level by the mobile crane. Grouters will then pour units at each level behind the bespoke handrail system. Horizontal seals for grouting purposes will be fixed into position by installers when installing levelling shims.

The installation sequence will continue from the base plinth to the capping head with units lifted in sequence over the four-week programme, with a further week to complete finishing works to the external finish of the head; this will include sealing of the horizontal and vertical exposed joints if applicable. ■

"The mix to be used for the Dream *project is SD1, which will give the sculpture a high-quality brilliant white finish."*

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1. BRITISH STANDARDS INSTITUTION, BS EN 12390. *Testing hardened concrete.* BSI, 2000.
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Precast concrete and 3D building information modelling – improving Britain's schools

The design and construction of school buildings can have a direct impact on the effectiveness of teaching and learning. In seeking to address this, the Government's Building Schools for the Future (BSF) initiative offers the chance for every local authority in England to renovate its secondary schools. It is enabling local authorities to move from 'patch and mend' spending on schools to rebuilding and renewal, with a more strategic approach to everything from funding and procurement to the design and management of buildings.

"In applying 3D modelling technologies to the design and construction of school buildings, the manufacturers of the concrete components in these buildings stand to make significant productivity gains."

Andrew Bellerby, Tekla UK

BSF is more than just a building programme. Its main aim is to create learning environments that inspire young people to reach their full potential and provide teachers with 21st Century workplaces, offering access to facilities which can be used by all members of the local community. The programme is also committed to reducing the carbon emissions from schools, with all buildings making the most of sustainable features to help protect the environment and reduce overheads. Another key design issue is robustness, aiming for reduced levels of maintenance by using robust wall finishes for internal and external walls and ceilings.

With ever more ambitious designs for buildings in the education sector making construction in this area more complex, manufacturers of the concrete components stand to make huge gains by adopting 3D building information modelling (BIM) practices. BIM can streamline the entire construction process, enabling every stage to be completed more efficiently, cost-effectively and on time, providing optimisation of structural solutions and consistent drawings and reports that contain full structural information. It's what the industry expected CAD to be from the beginning. More than just CAD, BIM supports collaborative working between the different parties involved in a building project, including architects and designers, steel and concrete detailers and manufacturers, structural engineers as well as contractors.

Concrete in the construction of school buildings

Concrete is an ideal material for use in the construction of school buildings because of the specific design considerations that apply. Hard durable finishes, that require minimum maintenance, are important features for a new school. Internal and cladding walls are subject to harsh treatment and precast concrete walls have the advantage of being able to withstand significant impact and water damage.

Concrete is an excellent material for meeting the sustainability goals of the BSF initiative. Naturally good at moderating peak temperatures, concrete overcomes problems with summer overheating, which is already recognised as a problem for lightweight construction materials, and can overcome the need for air conditioning systems. Concrete also offers further environmental efficiencies through superior acoustics, giving excellent sound insulation performance with minimum additional finishes required, making it the construction material of choice for today's modern school buildings.

Innovative approach to construction in the education sector

Structherm is a Yorkshire-based building systems manufacturer, with over 20 years' experience in the construction industry, specialising in insulated cladding systems. It has

Figure 1: Fastbuild panels integrated with steel frame.

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Figure 2 left: Fastbuild panel being lowered into position.

Figure 3 above: Elevation of propped panels sitting on beam-and-block floor.

solutions for both the external refurbishment of buildings and new-build projects and vast experience in both areas in the education sector.

Its Fastbuild building system is a rapid, flexible system consisting of prefabricated concrete panels with a unique system of fixing brackets and channels. This modern method of construction can reduce contract times by as much as 40%, which is key to the construction of public sector buildings. For improved sustainability, the pre-engineered design of the system also means there is minimal waste.

The design options available are endless due to the various sizes of the components that make up the system. A range of aesthetic variations and rendered finishes can be applied to the system. With so many complex elements and with strict deadlines for completion, 3D BIM has helped the company to address the unique challenges of constructing buildings for the educational sector.

3D BIM in constructing school buildings

Structherm has used the Tekla Structures 3D BIM software solution to model its Fastbuild walling system on a number of projects involving school buildings. The Tekla system has allowed Structherm's engineers to reduce the time taken to produce the 3D building models, which are required to generate manufacturing schedules, by as much as 60% over standard 3D packages.

Through its use of the software, not only has productivity been increased, but at the same time inaccuracies caused by human error have also been greatly reduced. The software was used to model the wall panels on a recently completed special needs school with very specialised building requirements in King's Lynn, Norfolk, involving over 1290 wall panels. This would have taken up to two weeks to complete using standard 3D CAD software but by using Tekla Structures, the model was completed in just four working days. Tekla's 3D BIM solution enables a functional building information model in extreme detail, right down to every nut and bolt, to be shared by the entire project team, visually indicating progress and significantly reducing on-site errors.

Concluding remarks

In applying 3D modelling technologies to the design and construction of school buildings, the manufacturers of the concrete components in these buildings stand to make significant productivity gains. It allows them to offer, as part of the BSF initiative, real value to the taxpayer not only in renovating the nation's secondary school buildings but also in the reform and redesign of the pattern of secondary education provision, to serve communities better, now and for decades to come. ■

Figure 4: Panels propped in position to form classrooms and corridors.

Structural solutions to modern demands

Two products dominate construction – concrete and steel. All structural concrete is reinforced with steel and, especially where fire resistance is required, steel is generally protected by concrete. Of the two, concrete is arguably the more versatile in that it can be delivered to site in a plastic state and can be moulded to virtually any form or shape. It is this property of being able to be produced in a range of shapes, surface textures and colours that makes it also desirable in its precast form.

Gerry Feenan, Structural Precast Association

"The common theme is to adopt modular construction wherever possible, to increase speed and keep down costs. A good example is precast crosswall construction."

The fact that off-site construction today is almost the norm is often attributed to the increase in construction in general and the ever-growing shortage of skilled labour on-site. But there are other reasons that account for the growing popularity of precast concrete, such as faster erection time, higher quality and the intrinsic lifetime energy reductions from concrete's thermal mass.

Techniques such as crosswall construction, modular construction and so-called flatpack construction – all making use of precast concrete – are being adopted for a range of projects. This comes at a time when Government statistics show that the average density of new homes has increased from 25 dwellings per hectare to 40, an increase of 60% in eight years. Inevitably, this higher density creates challenges such as noise transmission, and so concrete, which offers acoustic benefits, is increasingly becoming the construction material of choice, for builders and homeowners alike, who appreciate its durability, robustness and energy-saving features.

Sustainability

At the same time, more and more emphasis is being placed on sustainability and the environment. As recently as 11 June this year, the Government and the Strategic Forum for Construction published *Strategy for Sustainable Construction*[1]. This translates the priority areas from the earlier *Securing the Future*[2] report into a series of targets, actions and measurable deliverables designed to enable the construction industry to meet the challenge of making both its own operations and the built environment more sustainable.

It is clear that the industry faces some tough challenges but how is precast concrete positioned to play a key role in the improvements required? Although it may come as something of a surprise to those outside of the industry, the precast concrete sector recognised long ago that many of the principles that underpin sustainable consumption and production also make good business sense and are, therefore, already embedded into many of the sector's operations.

Member companies of the Structural Precast Association are approaching the market in various ways, each technique tailored to the type of structure. The common theme is to adopt modular construction wherever possible, to increase speed and keep down costs. A good example is precast crosswall construction. By design, the method provides flat soffits with no intruding downstand beams and also solves the increasingly onerous acoustic requirements of the Building Regulations. At the same time, wet trades are usually eliminated, permitting early follow-on of other trades such as cladding and mechanical/electrical fit-out. Typically, programme gains over traditional and lightweight methods are 30–50%.

A few examples of recent work carried out by members of the Structural Precast Association are given below.

Precast concrete wall system for rapid housing

When PCE Design and Build needed to deliver a full structural package of 196 one- and two- bedroom stylish apartments in the centre of St Helens for Countryside Properties Northern, it turned to Milbank for support. Block A at St Helens has 119 apartments with part of the ground floor providing car parking. The structure consists of precast beams and columns to the car parking areas with the main eight-storey structure built using precast wall units and staircases. Five-storey Block B contains 77 apartments in a wall frame of similar construction. External walls are 150mm precast concrete with internal dry lining and in-situ brickwork to the external façade. Internal crosswalls and corridor walls are 180mm thick to provide the minimum density for sound insulation. Most walls are 6m long with the corridor and external walls up to 10m long. Typical storey height is 2.85m with 250mm-deep precast hollowcore floor units spanning up to 10m between crosswalls and all structural floor ties have been incorporated within the floor units.

SCC's column-and-beam system

To meet the demands of increasingly restricted sites, which place a premium on minimising time on site, Hill Cannon and SCC adopted a fast-track approach to building car parks, moving from a hybrid precast/in-situ to totally precast. The structure was based on columns, beams,

Figures 1 and 2: Apartments under development in St Helens.

Figure 3: The Ramada Hotel, in Crewe.

Figures 4 and 5: Car park and hotel at Liverpool John Lennon airport

prefinished floor slabs, parapet upstands and 'flat-pack' wall panels for stairs and lift cores. At the same time, Manus O'Donnell, managing director of SCC, was keen to improve quality and programme times and looked at designing the columns and beams as a single unit, combining the columns and beams into an 'H' frame with a clear span of 15.6m. Void formers were adopted to limit the unit to a manageable weight. The other design issue was dealing with deflections and the resulting outward 'kick' at the base of the columns when the frame was being lifted. Careful analysis and feedback from site allowed for appropriate precamber and compensatory misalignments to be built into the basic frame that, when erected, became horizontal and plumb.

Recently, the technique was adopted for the 875-space multi-storey car park at Liverpool John Lennon Airport. The short-stay multi-storey car park offers parking over five levels with a six-storey hotel above. The car park includes projecting coloured glazed boxes on the exterior, with ribbed precast concrete decks with beam/column H-frames and pod stairwells, a technique also applied to the bedroom pods of the hotel. Constructed off-site, the pods reduced build time and ensured minimum disruption. The system is now being used for the country's first purpose-built media centre at Salford Quays, in preparation for the relocation of BBC staff from London.

Buchan the trend in Crewe

In Crewe, work on the 112-bedroom Ramada Hotel began in November 2007 with the installation of 139 driven precast 17m piles by Roger Bullivant, each designed for 600kN. Buchan Concrete Solutions designed, manufactured and erected the concrete walls, floors and stairs for the four accommodation floors and roof. Floor slabs are a mixture of prestressed and solid reinforced concrete, the former for carrying the bathroom pods to minimise any floor finishing by main contractor Tolent. All told, the precast contribution consisted of 200m^3 external walls, 315m^3 internal walls, 450m^3 precast floor slabs, 290m^3 prestressed floor slabs, eight staircases and four landings. ■

"Inevitably, this higher density creates challenges such as noise transmission, and so concrete, which offers acoustic benefits, is increasingly becoming the construction material of choice, for builders and home-owners alike."

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2. DEPARTMENT FOR ENVIRONMENT, FOOD AND RURAL AFFAIRS. *Securing the Future – delivering UK sustainable development strategy.* The Stationery Office, London, March 2005.

Permeable paving regulations explained

The new *Guidance on the permeable surfacing of front gardens*[1] has finally been published by the Department for Communities and Local Government, so the industry can now see exactly where it stands with regard to domestic front garden hard landscaping. The purpose of the guidance is to advise householders of the options for achieving permeability and meeting the condition for permitted development status.

Steve Wharton, Brett Landscaping

"The use of a permeable paving system can reduce the volume of water entering the sewer system by up to 80%."

Guidance on the permeable surfacing of front gardens relates to changes to the General Permitted Development Order. This effectively cancels the right to pave over the front garden of a domestic property with any reasonable-sized area of impermeable surfacing material without making allowances for controlling water run-off. The guidance states that the combined effect of paving over many front gardens in a typical road or street can increase the risk of flooding, as most urban areas were built many years ago and were not designed to cope with increased rainfall. In addition, as the rainwater passes quickly into the drainage system and onto local waterways, it can carry pollutants such as oil and petrol, which can affect wildlife and the wider environment.

As from 1 October 2008, the hard surfacing of more than 5m^2 of domestic front gardens is now only a permitted development where the surface is permeable, or water run-off is controlled within the property through the use of a soakaway or rain garden (a soakaway upon which grass, shrubs or other vegetation has been grown). Local authority planning permission is now required for the use of traditional materials, such as standard designs of block paving or tarmacadam. This may be because there is no facility in place to ensure permeability, or it is not possible to produce a design that prevents water discharge into drainage sewer systems or onto any adjacent highway.

The guidance illustrates the various options available to home-owners and contractors in deciding upon the type of paving required and how to deal with surface water, and pays particular attention to impermeable paving and the conditions that now apply. The use of a permeable paving system can reduce the volume of water entering the sewer system by up to 80%.

The new regulations are a necessary reaction to an increasingly serious problem. Flooding in 2007 deluged 57,000 homes and affected the lives of many people and even resulted in some loss of life. The cost of the damage has been estimated at approximately £3 billion. In many instances, the existing drains could not cope with the amount of excessive rainwater that flowed into them. The Environment Agency has calculated that 33% of the water was the result of the flooded rivers and watercourses and 67% was from water run-off and overloaded drainage systems.

The Government's *Foresight* report[2] estimates that 80,000 properties are currently at very high risk from flooding, causing, on average, £270 million of damage each year. When you consider that three million new homes are proposed by 2020, this will place even greater demand on the existing drainage infrastructure. To further compound the problem, climate change is expected to result in higher occurrences of heavy rainfall and subsequent flooding in the future.

Hard surfacing at domestic properties is becom-

(Photos: Brett Landscaping)

Figure 1 right: Domestic parking areas installed with Brett Omega-Flow paving reduces the burden on highway drains and sewer systems.

Figure 2 far right: Shared accessways featuring permeable paving provide an easier surface to maintain with no channel and drain requirements.

ing increasingly popular as householders look to expand the size of low-maintenance living and functional space around the home, avoiding the need to move to larger properties. On-road parking availability is lessening with the increased number of cars and it has been estimated that some 12 square miles of front gardens in London alone have been transformed into parking spaces – the equivalent of 5200 football pitches. The result is a massive loss in water to top-up the aquifers and less plants and trees to soak up the water. Additionally, it is estimated that around two-thirds of front gardens in London are already partially paved over.

Gaining planning permission is the responsibility of the home-owner and costs £150. The homeowner will have to fill in an application form and supply a scale drawing to their local authority. Typically, it takes eight weeks for a decision from the date of submission. If traditional paving that drains to a rain garden or soakaway is planned, the council will require levels and gradients to be shown on the drawing to illustrate that drainage is possible.

In some parts of the country, known as 'designated areas', permitted development rights are more restricted. These may include: conservation areas, World Heritage sites, Areas of Outstanding Natural Beauty or the Norfolk or Suffolk Broads. Planning permission may be required in these instances. If the property is a listed building, then the local authority planning department should be consulted for additional guidance.

Soil types and ground conditions vary dramatically across the country, affecting the ability to specify a standard permeable solution. Brett Landscaping offers a number of permeable paving and drainage solutions supported by sustainable urban drainage system (SUDS) advice and design service to help surveyors and contractors with the task of specifying the right solution for the local environment.

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2. EVANS, E.P, ASHLEY, R, HALL, J.W, *et al*. *Foresight Future Flooding, Scientific Summary: Volume 1: Future risks and their drivers. Volume 2: Managing future risks.* Office of Science and Technology, London, 2004.

A modular concrete concept

This article looks at a new approach to multi-storey modular concrete construction. This is geared towards providing a complete solution, offering a finished external façade along with the supporting internal structure.

CONCRETE REPORT

PCE Design and Build is integrating the fenestration, insulation and internal structure as an all-in-one construction solution. The company claims that this approach, coupled with its award-winning safety systems, will allow the construction of precast structures of 20-plus storeys without the need for expensive scaffolding or external works teams. The solutions combine the design principles of both structural and architectural concrete along with established manufacturing and construction techniques.

"It's almost a case of the sky's the limit," explains PCE Design and Build construction manager Simon Harold. "We have taken forward the concept of precast concrete sandwich panels to produce what we believe to be the next quantum leap in modular construction using precast concrete. Using our supply chain, along with many years of design, manufacture and construction expertise, we are able to optimise the performance and benefits of using precast concrete as a construction system."

By bringing together all the key elements required for the external envelope of a structure, PCE's Design and Build team believes it will bring programme efficiencies, construction savings, labour reductions and safety benefits.

Harold adds, "It significantly reduces the number of construction activities along with eliminating the problem of co-ordinating follow-on trades undertaking external finishing works. The structure becomes weathertight much earlier and both the costs and safety issues associated with providing external scaffolding are removed altogether. The associated risks with 'fitting out' the structure are significantly reduced as the need to try to 'close the envelope' in tandem with installing weather-sensitive finishes is no longer an issue.

Figure 1: A section through the sample panel showing the precast concrete and insulation 'sandwich' along with the integral balcony.

"By combining all of the elements required to construct the structural frame and its façade with the benefits of a quality-controlled off-site manufacturing environment, the outcomes are significantly more predictable, much quicker to install and more cost-effective."

"We have taken forward the concept of precast concrete sandwich panels to produce what we believe to be the next quantum leap in modular construction using precast concrete."

Figure 2 right: Built as one complete unit, PCE's system incorporates precast concrete façade and wall panels, fenestration, insulation and exterior features 'all in one'.

Figure 3 below: The unit can be delivered direct to site with features such as balconies already in place, ready for just-in-time erection.

'It significantly reduces the number of construction activities along with eliminating the problem of co-ordinating follow-on trades undertaking external finishing works.'

The 'mock-up' structure has integral insulation within a sandwich of precast concrete skins which will provide U-values exceeding the requirements of Part L, Fenestration, in the form of pre-installed patio doors, windows, balconies and ironmongery. The high-quality external finish is available in a number of colours and textures and can be complemented with features and patterns to provide complete flexibility.

Precast elements can be manufactured at one of PCE's supply chain partners. The company's in-house site teams can simply lift the components to their designated position as they arrive at site on a just-in-time basis. The units are fixed to the adjacent supporting structure using robust construction details. By delivering the wall or slab units with the Ambitus guard rails already fitted or fitting them on-site using factory-fitted location holes, each module can be lifted into place and fixed to a concrete or steel frame without creating an external exposed edge. Internally, operatives are protected using a netting system, which gives a totally passive solution to falls from height.

Simon Harold explains, "The initial 'mock-up' includes all the essentials for the external envelope. There's no real reason why this cannot be extended to other requirements internally, such as ducting for heating, plumbing, electrics and ventilation.

"We are confident that this approach to the use of precast concrete to provide a hybrid construction solution is the secret to fulfilling its potential. We are urging designers, developers and constructors to see the benefits of specifying and working with precast concrete as a total solution to their needs." ■

Calling *CONCRETE* contributors

Editorial contributions – technical papers, articles, case studies etc – for the February 2009 issue are most welcome. Topics include:

Concrete and Water, **Concrete Repair**,
Admixtures, **Concrete Frame Construction**

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