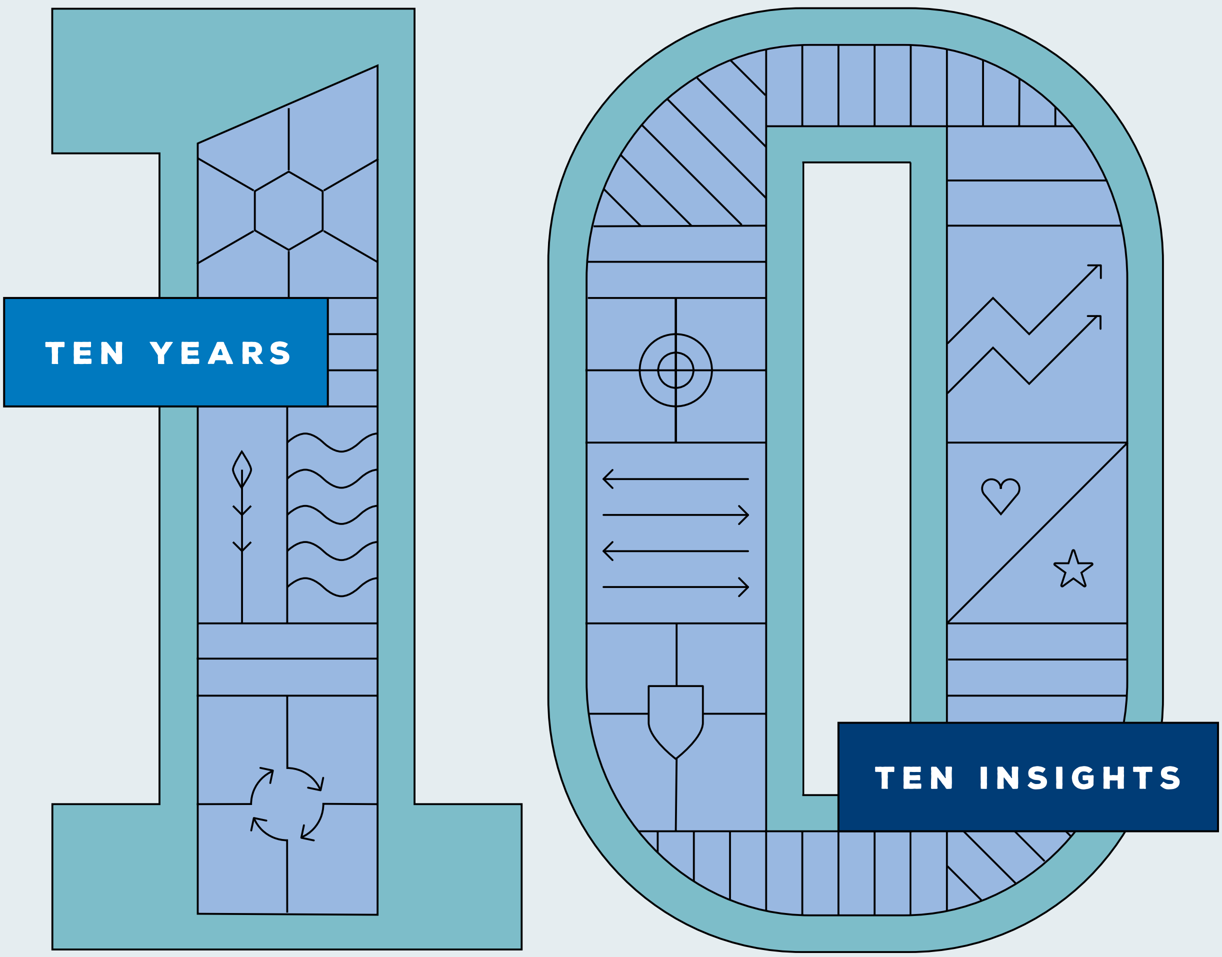
THIS IS CONCRETE

mpa The Concrete Centre

LOW CARBON RESOURCE EFFICIENT RESPONSIBLY SOURCED REDUCING WATER ENHANCING BIODIVERSITY



RESILIENT ECONOMIC VALUE WELLBEING SETTING STANDARDS MEASURING PERFORMANCE

10 YEARS OF THE CONCRETE INDUSTRY SUSTAINABLE CONSTRUCTION STRATEGY

10 INSIGHTS

mpa The Concrete Centre

The Concrete Centre provides guidance, seminars, courses, online resources and industry research for the design community. Our aim is to enable all those involved in the design, use and performance of concrete to realise the potential of the material. The Concrete Centre is part of the Mineral Products Association, the trade association for the aggregates, asphalt, cement, concrete, dimension stone, lime, mortar and silica sand industries.
www.concretecentre.com, @concretecentre

this is concrete

This is Concrete shares interesting facts about concrete and showcases amazing projects via our website, blogs, twitter feed and our project and fact ads. Our mission is to engage the design community and share the endless possibilities of concrete.
www.thisisconcrete.co.uk, @thisisconcrete

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Design by Nick Watts Design **www.nickwattsdesign.co.uk**

Printed on sustainably sourced and 100% recyclable paper.

WELCOME

It isn't often that we have a chance to pause and look back over a whole decade. Launched in 2008, the Concrete Industry Sustainable Construction Strategy had been a year in the making, a milestone for the many organisations that make up the concrete industry. Sustainability was at the forefront of our minds, with the development of sector climate change agreements and the joint government-industry Strategy for Sustainable Construction.

Then came the global economic crash of 2008 and immediate priorities changed. During the ensuing recession, the concrete industry identified sustainability as a way of staying competitive. One advantage of concrete is that it is a local material, with a transparent supply chain that makes it possible to achieve sustainability and high ethical standards at every stage. Responsible sourcing standard BES 6001 became widely adopted, and many more production sites were covered by environmental management systems.

As we look forward to a decade that may become defined by uncertainity and change, the concrete industry is continuing to invest in its UK operations and workforce. It is clear that much more will need to change in the way that buildings are specified and maintained, and that we must take a more holistic view of sustainability that prioritises safety, resilience, health and wellbeing. Concrete's inherent fire and flood resilience and thermal mass support a whole-life view of buildings that is good both for occupants and for the environment.

In the first phase of our strategy, we have focused our work and reporting around a series of performance indicators. As we look beyond 2020, setting new targets and indicators, we invite stakeholders to work with us to shape the role concrete plays in delivering a low-risk, long-life, low-carbon, sustainable built environment. Our strategy joins together the activities of many sectors, as well as the collective best practice of the Mineral Products Association and The Concrete Centre. This review includes some of the highlights of the last ten years, and provides a flavour of what can be achieved by our industry. I'm always heartened by the incredible variety of sustainable practices and solutions that we deliver which are so important for both our quality of life and the economy. I look forward to continuing our journey with your valuable feedback and guidance.
Andy Spencer, chair, Sustainable Concrete Forum

CONCRETE'S TRANSPARENT SUPPLY CHAIN MAKES IT POSSIBLE TO ACHIEVE SUSTAINABILITY AND HIGH ETHICAL STANDARDS AT EVERY STAGE

Opposite: Back in 2008, Concrete Quarterly revealed how AHMM's Westminster City Academy (bottom) used concrete as both thermal mass and finish to create a low-energy building that could "withstand the rigours of school use". Ten years on, the benefits of concrete have been seized upon for speculative office builds too, such as Piercy & Company's Copyright Building for Derwent London

WHAT IS THE CONCRETE INDUSTRY SUSTAINABLE CONSTRUCTION STRATEGY?

WHAT IS THE VISION?

To be recognised as a leader in sustainable construction, by taking a dynamic role in delivering a sustainable, low carbon built environment in a socially, environmentally and economically responsible manner.

WHAT HAS THE INDUSTRY COMMITTED TO DO?

1. Contribute to the delivery of a low-carbon built environment
2. Provide Life Cycle Assessment data compliant with codes and standards
3. Develop a Material and Resource Efficiency Programme to inform best practice across the life cycle of concrete in the built environment
4. Develop a low carbon freight initiative to support improvement in transport through the concrete supply chain to construction sites
5. Develop a water strategy to support the measurement of sustainability performance and target setting
6. Target continuous improvement of sustainable production performance and report annually

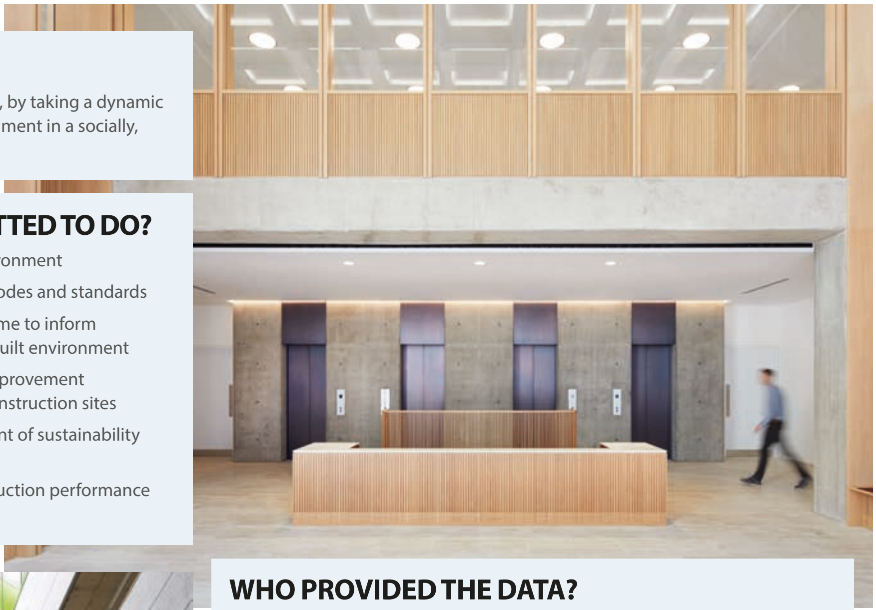


Photo: Jack Hobhouse

Photo: Arcaid Images / Alamy Stock Photo

WHO PROVIDED THE DATA?

The data is sourced from the following sector associations, and we are grateful for their cooperation:

- British Association of Reinforcement **uk-bar.org**
- British Precast **britishprecast.org**
- British Ready-Mixed Concrete Association **brmca.org.uk**
- Cement Admixtures Association **admixtures.org.uk**
- Cementitious Slag Makers Association **ukcsma.co.uk**
- Mineral Products Association **mineralproducts.org**
- MPA Cement **cementindustry.co.uk**
- UK Quality Ash Association **ukqaa.org.uk**

WHERE CAN I FIND OUT MORE?

- Water strategy: download from **mineralproducts.org**
- Download from **sustainableconcrete.org.uk:**
    - REAP documents
    - Concrete Industry Guidance Document on Sustainability Performance Indicators, The Concrete Centre, 2016
    - Concrete Industry Guidance to Support BRE Global BES 6001, The Concrete Centre, 2017
- Download from **concretecentre.com/publications:**
    - Specifying Sustainable Concrete, The Concrete Centre, 2017
    - Material Efficiency, The Concrete Centre, 2016
    - Whole Life Carbon and Buildings, The Concrete Centre, 2016
    - Thermal Mass Explained, The Concrete Centre, 2015
    - Concrete and BREEAM, The Concrete Centre, 2015

INSIGHT#1 : CARBON

The embodied carbon of concrete has reduced by 28% since 1990

Carbon emissions is a simplified popular term for greenhouse gas emissions, a contributor to climate change. The concrete industry has made sector carbon-reduction commitments as part of the Climate Change Act, which legally commits the UK to meeting challenging reductions to emissions: a 34% fall by 2020 and 80% by 2050, based on 1990 levels. The inherent performance of concrete means that it can contribute to reducing the carbon emissions of the built environment.

The built environment is a significant contributor to carbon emissions, predominantly through energy use for heating, lighting and electrical goods. The construction industry therefore has an important role to play in upgrading existing buildings and ensuring that future

The recent refurbishment of Centre Point in London demonstrates the longevity of concrete structures – a key factor in assessing whole-life performance. While the glazing had to be upgraded, the precast cladding panels only needed to be cleaned

Photo: Paul Grundy

DID YOU KNOW

Concrete buildings absorb atmospheric CO_2 over their lifetime, due to a natural process called carbonation

EMBODIED AND WHOLE-LIFE CARBON

Over the past 10 years, the construction sector's approach to carbon assessment has begun to evolve from focusing almost exclusively on the embodied emissions associated with material production to a more complex evaluation of whole-life performance. This is the final piece of the carbon jigsaw, giving a more complete indication of what can be delivered by buildings and materials.

At the start of the carbon journey, architects and designers tended to focus exclusively on a material's cradle-to-gate impact, as this could be easily measured and assessed. But when used as the sole metric for carbon performance, design decisions could often be skewed. The advent of Environmental Product Declarations (EPDs), particularly those verified in compliance with BS EN 15804, is helping address this, as these often provide cradle-to-grave data at the material level, which includes emissions from the maintenance, replacement, disposal etc. of a material over its lifecycle.

EPDs are an important stepping stone to whole-life carbon assessment at the building level, which is made possible by the data EPDs provide. BS EN 15978 sets out a methodology, which is now used in tools such as IMPACT, ensuring that a building's embodied, operational and end-of-life carbon emissions are collectively measured and reported.

This is good news for concrete, which is expected to outperform other materials in whole-life carbon terms – a fact that wasn't necessarily reflected in a basic assessment concentrating on embodied carbon.

But with more sophisticated lifecycle tools now becoming available, concrete's contribution to minimising a building's overall carbon footprint can be validated in a more quantitative way. The specific qualities that can now be interrogated include those resulting from:

- durability, and minimal maintenance needs
- the ability to fulfil multiple roles (structural, aesthetic, thermal) often enabling other materials, finishes and services to be designed out or minimised
- inherent thermal mass, which can significantly cut building energy use
- longevity and adaptability, which can enable concrete buildings to be reused, reducing the embodied impacts of new-build.

Finally, in respect of embodied carbon it is worth mentioning that forthcoming updates to BS EN 15804, the standard that governs EPDs, is likely to disallow carbon storage in the figures calculated for construction materials – a change that will reward whole-life thinking.

Tom De Saulles is a building physicist at The Concrete Centre

buildings are more carbon efficient.

The concrete industry, via The Concrete Centre, provides designers with robust, detailed information on how carbon emissions from buildings can be reduced. It also provides guidance on reducing the embodied carbon of concrete through specification.

Concrete is a material made up of many parts to a variety of specifications, giving the designer the ability to control the carbon footprint. The main ingredients are fine and coarse aggregates, but essential to the mix is a 10-15% cementitious content that acts as the binder. This will normally be based on a mix of Portland cement and varying levels of low-carbon industrial by-products such as fly ash or ground granulated blast-furnace slag (GGBS). Overall, the embodied carbon of a normalised mix of concrete (see page 27 for definition) is now 73.7kg per tonne, a reduction of 28% from a 1990 baseline, achieved through the reduction of emissions generated during production.

However, it is crucial to consider carbon emissions not just in terms of the production of materials but on a whole-life basis, from design and specification through to construction, in-use performance and end of life. Concrete construction can contribute to buildings with lower whole-life carbon emissions in five key ways:

- By using concrete with a lower embodied carbon
- Through resource efficient design to minimise the amount of materials required
- Through energy efficient design to lower operational emissions
- By reusing concrete structures or elements of buildings
- By absorbing CO_2 through carbonation.

SPECIFYING FLY ASH OR GGBS CAN REDUCE THE EMBODIED CO_2 OF A REINFORCED CONCRETE FLAT SLAB BY

35%

(RESEARCH CARRIED OUT BY ARUP FOR THE CONCRETE CENTRE, 2010)

DECARBONISING CEMENT

The UK cement industry is a world leader in its drive to reduce carbon emissions. Since 1990, it has reduced absolute emissions by 49% – an achievement that is all the greater when you consider that 67% of the total arose when carbon dioxide (CO_2) was liberated from limestone, a critical and unavoidable part of the cement-making process. This huge reduction has been achieved through innovation and investment in efficient plant. But we know that there is much further to go if the UK is to meet its legally binding commitment to reduce carbon emissions by at least 80% by 2050. In 2013, MPA Cement launched its own ambitious strategy that sets out how an 81% reduction in carbon emissions can be achieved by 2050 with the right action taken by the cement industry, the UK government and others.

This is achievable by greater use of alternative waste-derived fuels and carbon-neutral biomass fuels, and cementitious additions to create lower-carbon cements, and lower indirect CO_2 emissions by improving electrical efficiency and decarbonising the electricity sector.

In the long-term, the development and effective deployment of carbon capture and storage/use technology will be crucial to achieving the target. This is one of the biggest opportunities to make further large-scale emission reductions. Early exploration work shows there are two types of technology that could work, but additional research is needed, and the heavy investment will not be justified until government resolves the practical issues of transport and storage – and the political issue of unequal carbon prices.

Richard Leese is director of industrial policy, energy and climate change at the Mineral Products Association

IN PRACTICE

Twiga Lodge, Surrey

Doctoral researcher Eirini Mantesi at Loughborough University carried out a major evaluation of the energy consumption of Twiga Lodge in Surrey, a newly built house using insulated concrete formwork (ICF), constructed to high levels of thermal efficiency and airtightness. As the UK's first research project on ICF, it provides invaluable data to allow comparisons to be evaluated between software-predicted and "as-built" performance.

The lodge is a two-storey, three-bedroom home, with a floor area of approximately 250m². It was designed with an insulated raft foundation in conjunction with ICF walls and an insulated panel roof system, achieving an overall U-value of 0.11W/m²K.

The monitoring period lasted for 18 months and investigated the thermal performance of ICF under all climatic conditions representative of a UK year.

The results showed that ICF was able to significantly moderate the internal air temperature swings, providing a stable internal environment, and that the average internal air temperature was calculated between 22°C and 25°C during summer and around 21°C during winter.

The total annual electricity and gas consumption of the house was calculated to around 2,015kWh and 8,425kWh, which translates to a total annual utility cost of £691. In addition, the PV panels generated 4,609kWh of electricity. Overall, the net utility cost is zero.

The project is supported by Aggregate Industries.

What's in a typical concrete mix?

Approximate proportions by volume

IN PRACTICE

Tarmac Masonry Homes, Nottingham

These two test homes aimed to demonstrate how zero-carbon housing could be delivered at a low cost using proven and readily available masonry products and techniques, providing a template for UK housing.

Designed by architect Bill Dunster's Zed Factory as part of the University of Nottingham's Creative Energy Homes project, in partnership with Tarmac Buiding Products, both homes have three bedrooms, and are intended to be affordable and easy to maintain. Specifying concrete and masonry had a number of sustainability advantages over other methods of construction, including the use of locally sourced materials, high levels of airtightness, high thermal mass to counteract summer overheating, and the sheer longevity of the buildings. They are also fire-resistant, highly secure and built using traditional low-risk techniques.

Both properties also incorporate sustainable technologies including flat plate solar water heating panels, high-efficiency appliances, rainwater harvesting and sun pipes. Completed in 2010, one home was built to meet Level 4 of the Code for Sustainable Homes, the other to meet Level 6 (the highest). Nottingham University is continuing to monitor the homes in occupation.

Photo: Iwan Baan

At Tate Modern's Switch House extension in London, a pale-coloured concrete mix containing 50% GGBS cement replacement was used for the precast concrete frame

Photo: Wellcome Trust

The use of lattice slabs with a precast soffit providing permanent formwork – such as at The Francis Crick Institute in London – reduces the materials used during construction

INSIGHT#2 : RESOURCE EFFICIENCY

The concrete industry is a net consumer of waste

'Doing more with less' is a useful summary for resource efficiency and one frequently used in the context of structural design solutions. But just as embodied CO_2 does not represent a true carbon footprint, resource or material efficiency should not be considered at just a single lifecycle stage. As with so many aspects of sustainable construction, the most effective solutions require a holistic, whole-life approach.

Concrete and masonry can offer material efficiency at each stage of development, providing varied opportunities to do more with less. This is in part demonstrated by the industry project with WRAP and stakeholders that delivered Resource Efficiency Action Plans for ready-mixed concrete, precast concrete and blocks (see overleaf), outlining opportunities from factory gate to end of life.

The ability of concrete producers to use waste and by-products from other industries has enabled the industry to become an overall net consumer of waste. During the production process for cement, the sector can safely burn a wide range of materials as alternative fuels such as solvents, tyres, meat and bone meal, sewage sludge, un-recyclable paper and plastic.

The raw virgin materials in concrete can also be replaced with recycled materials and by-products from other industries. Ground granulated blast-furnace slag (GGBS) is a by-product of iron production and fly ash is from electricity generation. Both are used, in combination with Portland cement, as the cementitious material in concrete and make a valuable contribution towards the durability of concrete and the

IN 2016, THE CONCRETE INDUSTRY USED

116

TIMES MORE RECOVERED AND WASTE MATERIALS THAN IT SENT TO LANDFILL

lowering of its carbon footprint.

Recycled and secondary aggregates can be used in concrete (at levels permitted by British Standards) – and the concrete industry's sustainability strategy introduced a performance indicator to chart this (see page 28). However, due to the logistics of retrieving suitable segregated concrete and aggregates from construction sites and returning them to separate concrete production plants, the CO_2 associated with transport alone can outweigh environmental benefits.

The most efficient investment of resources is in a structure that is designed for longevity, and concrete and masonry have the durability and robustness to achieve this. Infrastructure projects often have a design life of over 120 years; our housing stock needs to be robust to the impacts of climate change; and our commercial buildings need to be designed to be adaptable to future requirements. This can all be achieved with concrete. And when refurbishment is no longer an option, concrete can be recycled.

Concrete is often seen as ubiquitous and low cost and so its use may not be considered as carefully as materials that are scarce or expensive. However, its inherent properties and performance make it an asset to any material-efficient design strategy.

The concrete industry, via The Concrete Centre, provides designers with detailed information on how material use in buildings can be reduced using concrete, including guidance on material-efficient solutions such as post-tensioned concrete.

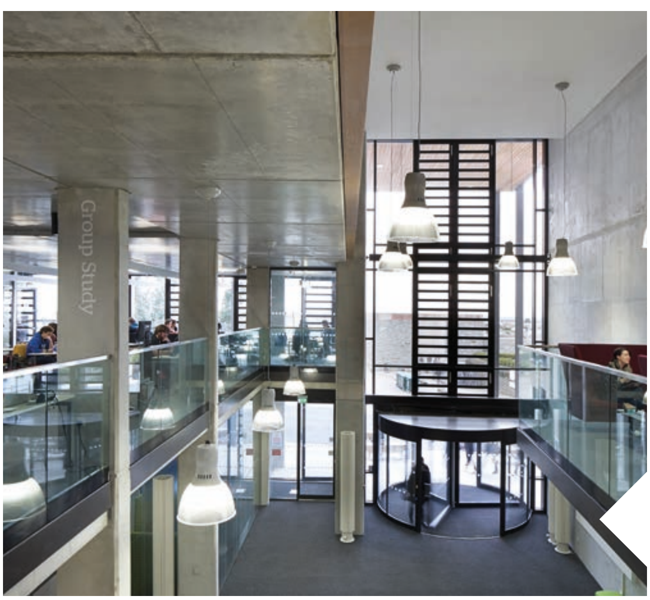


Photo: Hufton + Crow

DESIGNING FOR MATERIAL EFFICIENCY

Reducing the amount of materials required for a project can be achieved by optimising the amount of concrete needed to meet its performance requirements and by using concrete to reduce the need for other materials.

Concrete alone can often meet the performance requirements of structure, fire and acoustic separation, without the need for any other finishing materials. Exposed concrete also optimises the thermal mass performance of the concrete, offering opportunities to make considerable savings on energy and carbon while the building is in use. The durable finish of concrete offers further lifecycle cost savings by reducing the need for maintenance (and replacement) in comparison to other "wearing" finishes.

The design of a concrete structural frame offers opportunities for material efficiency, while maintaining the inherent performance benefits of concrete. Concrete offers a wide variety of solutions including choices between precast, in-situ and hybrid concrete solutions, but also different types and combinations of frame components such as flat slab, ribs, band beams and waffle decks. For example, flat slabs increase the efficiency of the formwork and allow for many subsequent reuses.

The use of prestressed slabs, either precast or post-tensioned (PT) in-situ, will reduce both the concrete and the reinforcement used. Typically, a PT flat slab will be 50-75mm shallower than a normally reinforced one and will use one-third of the steel – this reduces the size of the columns and foundations too. Void formers and hollowcores within the structural slab are another option for reducing the amount of concrete used and hence the self-weight of the structure. This significantly reduces the load to be carried by the slab and the depth of slab needed. The use of lattice slabs with a precast soffit providing permanent formwork reduces the materials used during construction.

Each element of a project affects the others and taking a holistic view can lead to savings in time, as well as materials. Using concrete or masonry as the main structural material offers opportunities to simplify both structure and finishes.

Exposed concrete structures are robust, long-lasting and material efficient because there is no need for additional finishes. This makes them an increasingly popular option for university buildings such as The Exchange in Falmouth by Burwell Deakins Architects

CLOSING THE LOOP: CONCRETE AND THE CIRCULAR ECONOMY

The circular economy is a holistic model wherein, at the end of its life, a product is seen as a resource through the reuse or recycling of its components. This "closed loop" approach is not always easy to apply to construction, where buildings are intended to last for decades, if not centuries, and additional materials have to enter the cycle to meet the need for new infrastructure, housing and so on.

However, if we consider construction's "products" to be end-uses such as schools, homes or bridges, concrete can help designers to harness the underlying principles of the circular economy in a number of ways:

1. Designing for material efficiency (see previous page)

2. Designing for longevity Durable materials such as concrete and masonry can extend the serviceable life of a building/structure. Concrete and masonry products provide a resilience to fire, overheating and flooding. Designers should also ensure that spaces are flexible and able to adapt to occupant needs.

3. Designing for re-use Re-using an existing structure is often the optimum sustainable solution for a redundant building or structure since relatively little energy is required in the process, either for transportation or adaptation of form, and little waste produced. Concrete and masonry structures are durable and robust and frequently able to be adapted for re-use.

The re-use of concrete and masonry elements will be facilitated through tools such as building information modelling (BIM), which will enable them to be tracked, documented and returned to the value chain.

4. Designing for material recovery Concrete is 100% recyclable. Demolished concrete can be relatively simply processed for re-use. This processing and re-use can both take place on site, with crushed concrete providing a cost-effective material for hard core, fill or in landscaping.

New systems will guarantee that products return to the material stream quickly to re-emerge as recycled materials.

David Manley is chair of the concrete industry's Resource Efficiency Working Group

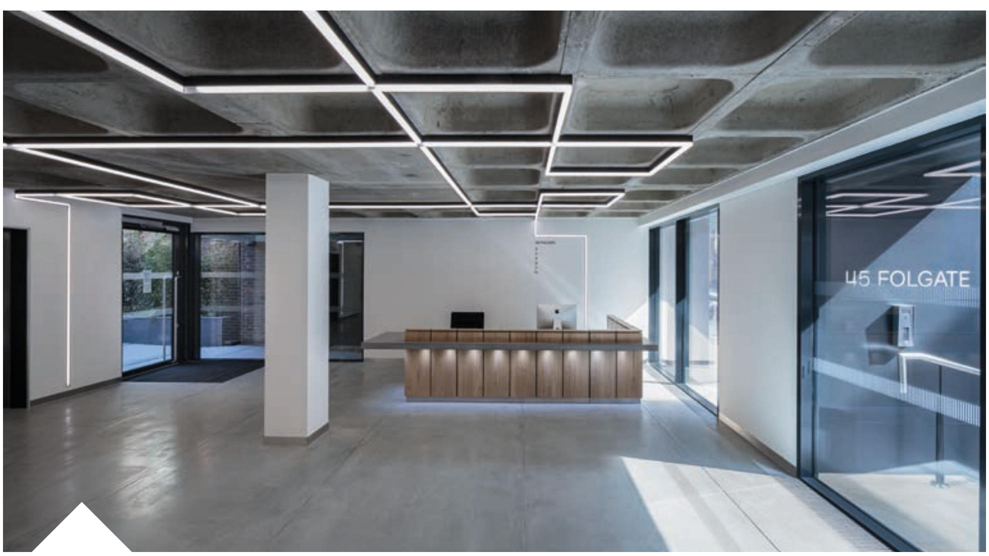


Photo: Dirk Lindner

At Folgate Street in London, a 50-year-old concrete structure has been adapted to create a modern office building. Reusing buildings minimises the need for new materials, while the original waffle slab itself demonstrates a material-efficient approach to design

A Z

RESOURCE EFFICIENCY ACTION PLANS

A Resource Efficiency Action Plan (REAP) identifies the key challenges and actions needed in order to make improvements to resource efficiency throughout a sector.

The brick, block, ready-mixed and precast concrete industries have developed sector-specific REAPs in partnership with the Waste and Resources Action Programme (WRAP). These are intended to assist the supply chain, which ranges from raw material extraction to the demolition or deconstruction of buildings, in identifying and creating an actionable strategy for improving resource efficiency. It addresses a wider range of issues than other REAPs, covering the main impact indicators of waste, water, carbon (energy use and emissions), materials (primary raw materials and secondary/recycled materials) and biodiversity. As such, it accords with the resource efficiency, low carbon and general sustainability themes promoted by the Green Construction Board (GCB) and Construction 2025 Industry Strategy.

On the London 2012 Olympic Park, 170,000 tonnes of recycled and secondary aggregate were used. This accounted for almost a quarter of the concrete content on the project and saved 30,000 tonnes of embodied CO_2. Rationalisation and design efficiency reduced the concrete demand by 65,000m^3, further reducing embodied CO_2

INSIGHT#3 : RESPONSIBLE SOURCING

More than 90% of BES 6001 certified concrete is rated Very Good or Excellent

With increased globalisation, the movement of goods and people has added to the complexity of supply chains and procurement practices. This raises concerns about labour practices, how goods are produced and their environmental impact.

During 2008/9 the concrete industry's sustainable construction strategy adopted BRE's responsible sourcing certification scheme, BES 6001, with the target of achieving 95% certification by 2020. Both concrete product companies and supply chain manufacturers were encouraged to obtain BES 6001 certification, and the industry published guidance detailing more industry-specific explanations of the scheme requirements.

With well-defined, closely controlled and predominantly local supply chains, in 2016 the industry was able to produce 90% of concrete, 100% of cement, 100% of GGBS and 93% of aggregates to BES 6001. More than 90% of the concrete certified was rated Very Good or Excellent.

Clients can also achieve credits for responsible sourcing within

THE CONCRETE INDUSTRY WAS MORE THAN

80%

COMPLIANT WITH BES 6001 WITHIN 12 MONTHS OF ITS LAUNCH IN 2008

the BREEAM, Home Quality Mark (HQM), CEEQUAL and LEED sustainability assessment schemes. For example, BREEAM UK New Buildings has, in its Mat 03 materials section, calculation methods with up to three full credits available, while Section 18 of the HQM scheme, "Responsible sourcing of construction products", offers up to 28 credits.

The social aspects of responsible sourcing are becoming more prominent and labour practices are under greater scrutiny. Industries that import into the UK must be particularly vigilant. There has also been a recognition, with the introduction of the Modern Slavery Act 2015, that the UK needs to ensure that its own labour practices are fair and ethical. Using products that are certified as responsibly sourced is an important way to ensure transparency and that highest ethical standards are met.

'ORGANISATIONS WANT TO WORK WITH OTHERS WHO SHARE THEIR VALUES'

Dr Shamir Ghumra is BREEAM director at BRE

What were the drivers for BRE to set standards BES 6001 and BES 6002 on responsible sourcing and ethical sourcing respectively?
BES 6001 has been around for about 10 years. Before, there was nothing for the general construction products sector to reference for responsible sourcing. Now there is BES 6001 and BSI's BS 8902. As the landscape has evolved with more awareness of modern slavery, BES 6002 was introduced to reflect these social and ethical governance considerations. BRE felt it was an opportunity to trial a different approach with a broader appeal not only for the construction product sector but for contractors, clients, designers and architects. Whereas BES 6001 is a certification scheme, BES 6002 is a verification standard where an organisation reflects on its own performance and makes a commitment to continually improve.

What impact have they had?
BES 6001 has had a significant impact with a wide adoption in the concrete sector. Slowly and surely it's growing, with evidence that it's starting to gain traction in other product sectors and in different parts of the world. BES 6002 has only been around for just over a year. Precast and natural stone company Marshalls was the first to achieve verification followed by Sir Robert McAlpine and labour company VGC.

We currently have another six going through verification including clients and contractors.

How might each evolve?
BRE has just made BES 6002 more accessible through the creation of an online platform with a digital version of the standard (www.elsonline.co.uk) where companies can log on and self assess for no fee or resources other than their time. After just two months, we have 60 organisations self-assessing and within a few years we want to have thousands. More and more organisations want to work with others who share their values on issues such as ethical and social governance.

We're now in the process of updating BES 6001 to version 4.0, which will be finalised in autumn 2019. It's got plenty more life in it, in particular going digital and the potential for growth internationally.

Are there any other initiatives relating to responsible sourcing?
We have the Action Programme for Responsible and Ethical Sourcing (APRES), which was set up by Loughborough University and acquired by the BRE in 2015. APRES is a very useful sounding board for thought leadership on responsible sourcing.

Construction workers at labour supply company VGC Group, one of the first to achieve the BES 6002 verification standard on modern slavery, launched by BRE in 2017

Photo: VGC Group

IN PRACTICE

Canary Wharf Group

Photo: Canary Wharf Group

"Our overall message on sustainability is about resilience. We provide a really robust, flexible shell-and-core model that can be adapted to suit different tenants. That's inherently sustainable because it lends itself to a longer life. We design to the Eurocode, which specifies a building design life of 50 years. But we know that concrete can have a much longer lifecycle and we certainly don't intend to tear our buildings down after just 50 years.

Because we're the client, contractor, developer and landlord, we're having this dialogue all the time. We set out as a fully integrated team to develop the most sustainable solution that we can, applying our own, very detailed sustainability brief on all projects. It covers six major elements: tenant fit-outs, refurbishment, biodiversity, sustainable procurement, zero waste, and health, wellbeing and productivity. Only after we've considered what we can achieve through that do we do a BREEAM pre-assessment – and guess what? Through this approach, we're able to achieve Outstanding. When we've used BREEAM as a checklist, it's been challenging to achieve even Excellent [the level below Outstanding].

For our supply chain, it's a given that we only use concrete certified to BES 6001 and we already do a whole-life carbon analysis of our developments. But we will be going a lot further in future, considering the lifecycle of our major materials and supply chain in light of the Paris climate agreement. We will work with our suppliers to explore how, as a team, we can deliver zero-carbon concrete. That's what we've got to get to, and that's where we're going."

Martin Gettings is group head of sustainability at Canary Wharf Group

Photo: Crossrail Ltd

Over 200,000 concrete segments line the 42km of tunnels of London's new east-west Elizabeth Line. All materials on Crossrail had to be procured to high ethical standards. The concrete industry was able to demonstrate compliance because concrete is locally sourced and the BES 6001 standard has been widely adopted

INSIGHT#4 : WATER

The concrete industry has cut mains water consumption by almost 10%

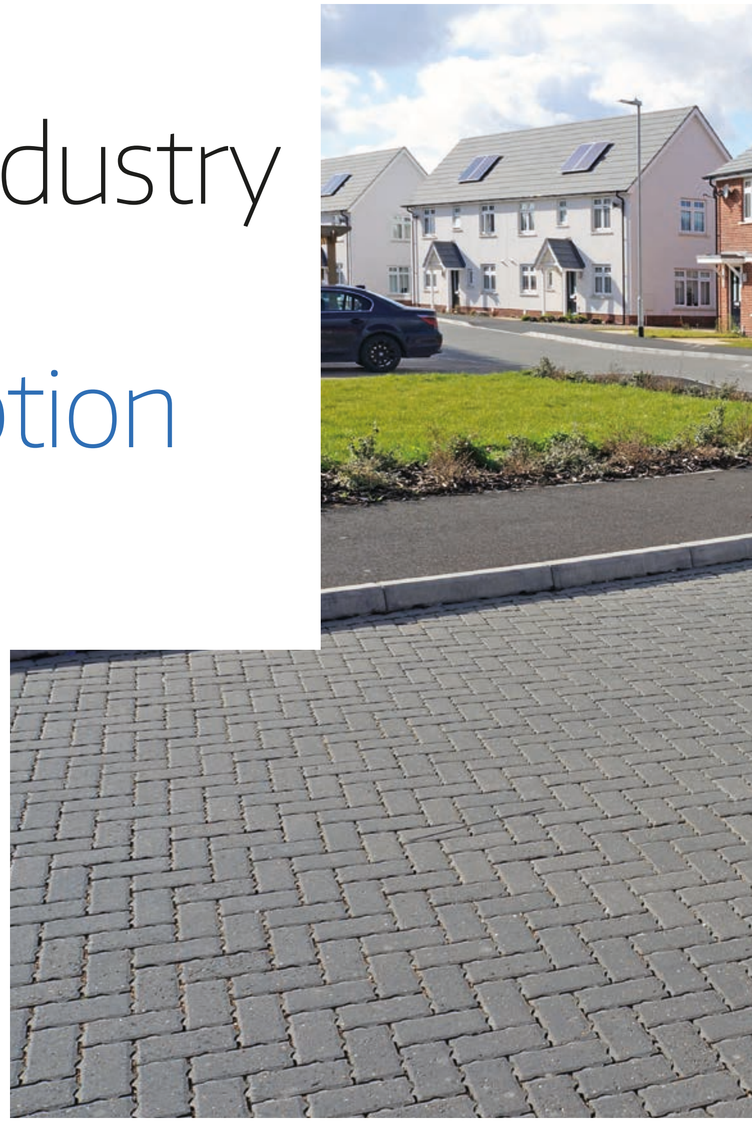


Photo: Interpave

Climate change and population growth are adding to the complexity of water resource management, increasing the incidence of summer drought and large-scale flooding at any time of year.

Water is important at many stages of concrete production. It is essential to the hydration of cement, which enables it to act as the main binder for concrete, and is also used for washing during the extraction of aggregates, as quenching for GGBS, during the mixing and placing of concrete, for cleaning plant and in dust suppression measures. In some parts of the concrete supply chain water use can be reasonably clearly defined. In others, such as the extraction of aggregates, there is often large-scale water movement – for example, for washing – that does not involve "consumption" as such.

The Concrete Industry Sustainable Construction Strategy included a commitment to develop a water strategy and targets for the reduction of water consumption. Recognising that the public mains supply is the least sustainable source of water for concrete production, the industry has been measuring mains water usage and reporting annually on efforts to reduce mains water consumption. In the base year 2008, the value was approximately 86 litres/tonne and in 2016 approximately 78 litres/tonne, a 9.3% reduction.

This has been achieved by using alternative sources such as licensed water abstraction, recycled production water and harvested rainwater. Water-reducing admixtures are now used in most types of concrete. Recent developments in high-performance water reducers and such innovations as "wash-water admixtures", which allow residues in mixer trucks to be treated and reused, have also contributed.

The MPA Water Strategy was published in 2017 following review of the processes used in the concrete supply chain. This is based on three main principles:

1. Minimising water consumption
2. Prioritising use of the most sustainable water sources available
3. Protecting the environment through good water stewardship

The concrete production sectors are now working to produce more detailed action plans, which are also part of the industry Resource Efficiency Action Plans (see page 10).

THE MINERAL PRODUCTS ASSOCIATION WATER STRATEGY WAS PUBLISHED IN 2017

Concrete block permeable paving addresses both flooding and pollution by attenuating and cleaning water run-off at source. Peterborough City Council has trialled this approach at Fleetwood Crescent, a development for Cross Keys Homes. The drainage is designed to temporarily store rainwater run-off on site and remove pollutants before gradual discharge to a surface-water sewer that eventually outfalls into a nearby watercourse. House driveways and shared parking areas are also constructed in permeable paving, linked to the road construction with pipes below the footpath. Block paving supplied by Brett Landscaping.

IN PRACTICE

The water hierarchy

The Mineral Products Association's Water Strategy, adopted by the concrete industry, emphasises a hierarchy of water sources, shown below.

The strategy aims to understand how much water is used from each of these sources, and with this knowledge, to improve water efficiency and to optimise use of the most sustainable sources. MPA encourages its members to measure the amount of water abstracted and promotes best practice in efficient water use. Once sufficient data has been collected, the intention is to set targets for industry-wide reduction.

Over the past ten years, great strides have been made to reduce the use of mains water at mineral extraction and production sites, either by making processes more efficient or by harvesting water from alternative sources that are more sustainable.

For example, at Northfleet Wharf concrete plant in Kent, CEMEX fitted new pipework and valves to a pump that enabled the site team to use surface water in the processing of aggregates. The estimated water saving was 250m^3 a month. In Salford, where there is a very high water table, CEMEX has pumped water from a neighbouring disused rail pit to be used for dust suppression and wheel washing. A system of tanks is used to store up to 70,000 litres of water, saving water and reducing costs.

Other innovations by CEMEX include:

- At Kensworth quarry in Bedfordshire, the successful trialling of the Flosperse 3000 additive in chalk slurry, reducing moisture content by 30 million litres a year
- At Pershore, Oakengates and Redditch in the West Midlands, harvesting surface water in empty intermediate bulk containers (IBCs), storing up to 10,000 litres
- At Chorley concrete plant in Lancashire, IBCs are used to store run-off from the access road and neighbouring business
- At Castleford mortar plant in West Yorkshire, replacing high-volume water pumps with low-volume, high pressure lances, resulting in a 36% saving in mains water consumption
- Redesigning the pipework on aggregate conveyors so that water build-up can be re-used.

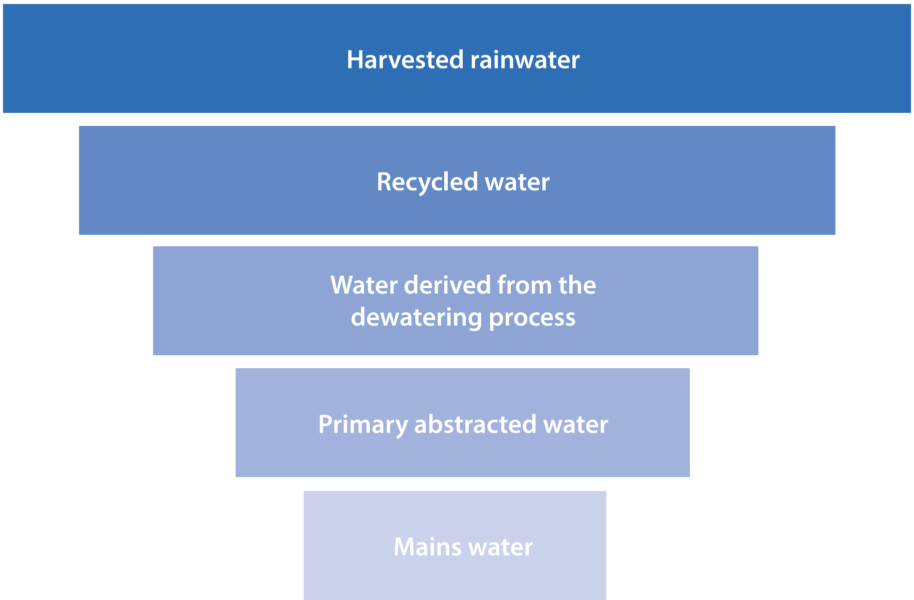


Photo: Fotolia

INSIGHT**#5** : **NATURAL ENVIRONMENT**

More than 99% of relevant sites have a biodiversity action plan

Quarry restoration provides a major opportunity to protect and enhance biodiversity. The industry has a long legacy of high-quality restoration and makes a significant contribution to the UK's wildlife, including many rare and threatened species.

Most ready-mix and precast concrete production plants are located in industrial areas where the impact of dust and light pollution on local residents tends to be minimal. Wildlife and biodiversity also tend to be affected less than in rural areas. The concrete industry has therefore adopted the Mineral Products Association biodiversity strategy which is more focused on the quarrying of limestone for cement and aggregates, where there is a higher potential for effects on local residents and wildlife. Quarries offer a unique opportunity to design and create new landforms and habitats to support local biodiversity. Many plant species already live in quarries, attracted by the low-nutrient habitats that result when soils are removed, so this flora and associated fauna can be encouraged in the final restoration.

? DID YOU KNOW

Since 2012, the mineral products industry has worked with the Bumblebee Conservation Trust to increase bee populations

'PRETTY MUCH ANYTHING CAN LIVE IN A QUARRY'

Nigel Symes is head of the RSPB's Business Advice unit overseeing the Nature After Minerals programme

How much quarry land has been restored through the Nature After Minerals initiative?
We're building up a really good bond between the quarrying sector and the conservation sector. We've been involved in the restoration of 3,500 hectares, helping mineral companies to add value to their restorations. We've found that many quarry companies are very willing and keen to do a good job and should be commended for going above and beyond what they're required to do.

What sort of species can live in quarries?
Pretty much anything. Quarries are located in a wide variety of different rocks such as limestone, granite or sand and gravel, and may be dry or flooded. That means you can design the restoration accordingly to create different habitats for different species. A chalk quarry, for example, would be ideal for calcareous grasses. For willow tits, whose populations have declined by 94% in the last 40 years and need wet scrub, quarries in flood plains are ideal opportunities and we're working with several companies to put in that type of habitat. Quarries can provide a refuge habitat away from rivers for creatures such as the white-clawed crayfish, susceptible to diseases carried by the introduced signal crayfish.

Why do quarries make good habitats?
One reason that a quarry is a good site for restoration is that you're left with bare ground that hasn't had anything done with it except had things removed from it. You therefore have a blank canvas to design the habitat. For example, you can move around the overburden material that's been extracted and left on the site to create the landscape you want. Also, nature doesn't like very fertile ground particularly – habitats do best where nutrients are a bit thin on the ground.

Do you have a favourite quarry restoration?
One of the places where there's been exciting stuff going on is Dove Holes, a huge limestone quarry near Buxton in Derbyshire, where it was discovered that there was a pair of rare twites. The company planted the specific grassland they need to feed and now there are seven pairs.

Photo: Tarmac

8,000

HECTARES OF UK PRIORITY HABITATS CREATED

Members of the Mineral Products Association manage or control over 115 square miles of land; equivalent to a National Park such as the Norfolk Broads. Scores of wild places, such as Threshfield quarry in the Yorkshire Dales (left), owned by Tarmac, are now open to the public as part of the MPA National Nature Park, launched in 2013. Tarmac has also trialled the government's Corporate Natural Capital Accounting Framework at its Mancetter quarry in Warwickshire. The innovative methodology highlighted the impact of its restoration projects, which have increased the renewable natural capital value of the site from £110,000 to over £3.5m.

INSIGHT#6 : RESILIENCE

Concrete offers resilience in an uncertain future

A resilient built environment is one that shows long-term durability, has low maintenance requirements and is resistant to extreme weather events, while remaining adaptable to changing uses. Resilience has become an increasingly important design factor as climate change has moved up the agenda, and issues such as summertime overheating and extreme flooding have come to the fore. Such factors underline the need to consider projects on a whole-life basis for environmental, economic and social impacts.

Concrete is capable of being fit for purpose for thousands of years with relatively little maintenance in a wide range of conditions. It can be used in aggressive and exposed environments such as on brownfield sites and for coastal defences, and can help to mitigate, or even avoid, the impact of extreme weather events.

The inherent thermal mass of concrete is also key to providing future-proof buildings. By moderating temperature extremes, it combats overheating and maintains a comfortable internal environment, particularly when combined with active or passive cooling.

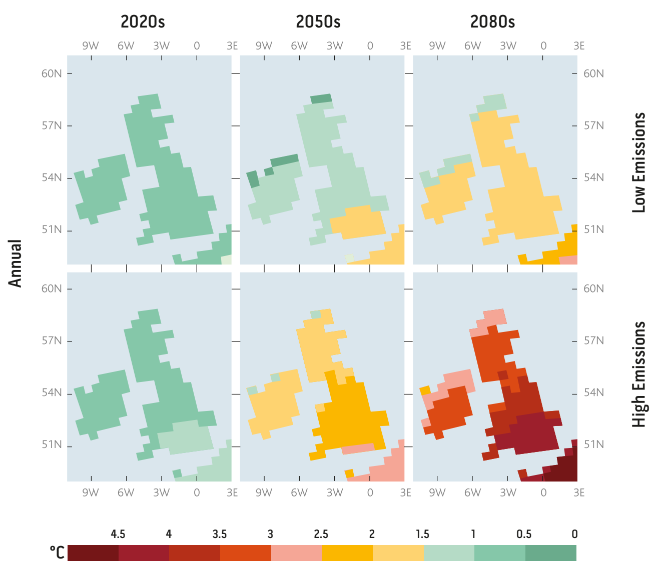
Another important performance benefit of concrete is that it does not burn. This is due in the main to cement and aggregates which, when combined within concrete, form a material that is inert and, importantly for fire safety design, has relatively low thermal conductivity. This means that the effect of fire is limited to the surface zones of the concrete with the middle of the element often unaffected. This resilience to fire ultimately provides life and property safety.

Research and development has established the best means to ensure concrete continues to perform in our changing environments, and this is supported by the latest standards and design codes. Innovation is ongoing – for example in the development of admixtures and alternative cementitious materials, which will ensure that concrete's important properties can be maintained cost-effectively as concrete specifications evolve and material availability changes.

The Hoola development in London Docklands by CZWG comprises two residential towers of 23 and 24 storeys. Both buildings have a concrete core that supports oval in-situ concrete floorplates and distinctive precast-concrete balconies. Concrete is a natural choice for apartment blocks because of its resistance to fire, strong acoustic properties and inherent thermal mass

Right: These maps produced by climate change research body UKCIP show two different forecasts for UK temperature increases in the 2020s, 2050s and 2080s, based on low-emission and high-emission scenarios

Photo: Jack Hobhouse



'DESIGNERS HAVE TO MINIMISE THE RISK OF OVERHEATING'

Lynne Sullivan is founder of LSA architects and chair of the Good Homes Alliance

Why is overheating a problem, and why now?

We are in a warming climate (see map below). We're also getting higher densities and new typologies such as single-aspect apartments. Because there is more focus on energy efficiency, we're getting more airtight buildings but ventilation systems aren't always performing as they should. All these things together create a perfect storm of overheating, which is particularly a problem for vulnerable people and those who are inside all day.

What are the potential solutions?

While overheating is increasing, we're also understanding more about how buildings perform in use. The perfect solution is for designers and planners to understand the causes of overheating and for these to be controlled by the Building Regulations, which are shortly being reviewed to address energy efficiency and other issues. This will take time. Meanwhile, a draft review of the National Planning Policy Framework (NPPF) has flagged overheating as an issue for planning authorities, but until the regulations change a method for managing this is unclear. The Good Homes Alliance is producing guidance to address some of these issues at the early stages of design.

What can designers and planners do to help?

First they have to be aware of the issues causing overheating and design to minimise the risk, including night cooling where possible – this can be a challenge in urban areas with noise and security issues. Exposed thermal mass, which can absorb heat during the day, can help reduce excess heat, provided it can be dissipated at night through ventilation. Any single-aspect flats need to be properly shaded. Designers also need to be aware of the potential for overheating caused by communal heating systems, which need to be highly insulated. It's important to flag up all these issues at an early stage of design review.

What role can concrete play in maintaining comfortable temperatures in a warmer future climate?

A lot of research has been done on the use of exposed concrete for thermal mass. We've been a bit slow to explore its potential, which could also lead to some interesting hybrids – for example, the integration of thermal mass into lightweight buildings. With the reviews of the Building Regulations and NPPF, the overheating issue is clearly on the agenda – we will now need to fine-tune our ability to manage it.

Image: PRP Architects

5.5M

PROPERTIES ARE AT RISK FROM ALL TYPES OF FLOOD IN ENGLAND AND WALES

PRP Architects modelled the impact of climatic conditions up to 2080 as part of its design for 140 apartments/care beds at Red Lodge in York. The architect used overheating risk mapping to understand not only what was required to cope with a predicted temperature rise of 7.5°C by 2080, but also whether this capability should be built in from the start, or whether the building could be adapted over time. The conclusion was to use thermal mass, high-performance glazing and natural ventilation with scope to add in new measures in 2030, 2050 and 2080.

FLOOD-RESILIENT HOMES

Concrete has several properties that make it a good choice for homes in flood-prone areas. It has the strength to keep water at bay and few construction joints to let water through. It can be designed to resist very high loads, and is robust enough to withstand impact from debris.

But concrete doesn't only help to keep water out of a property. If water does get in, concrete is also easier to wash and disinfect than materials such as timber, and more resistant to rot or fungal growth. This reduces cost and disruption, particularly for short-duration floods.

Reinforced concrete or concrete blocks can be used as the structural wall in a solid-wall solution, or as one or both of the leaves in a cavity-wall construction. Another approach is to adopt an insulated concrete formwork system, which uses rigid insulation as the mould within which ready-mixed concrete is cast, before being finished with a surface treatment. The insulation properties are unaffected by moisture, making ICF appropriate for most flood situations. Where it is not possible to place the ground floor above the predicted flood level, a reinforced concrete slab, at least 150mm thick, is the preferred construction solution.

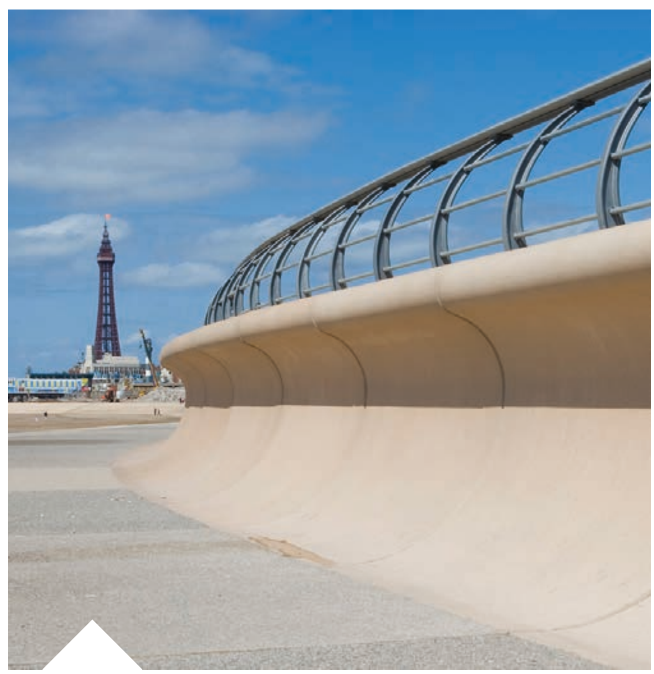


Photo: Hanson UK

The £62m upgrade of Blackpool's sea defences, built using precast concrete containing 50% GGBS. The Environment Agency's National Flood Resilience Review, published in 2016, highlighted the dangers of coastal flooding

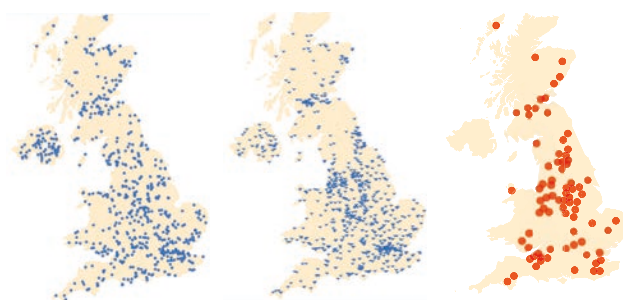
Photo: Hanson UK

INSIGHT#7 : ECONOMY

Reece Phillips is a third-year apprentice with Hanson UK, based at Barton Quarry in North Yorkshire. Apprenticeship programmes such as these equip school leavers for a long-term career in the sector, as they gain both on-the-job experience and academic qualifications

Concrete is essential to UK prosperity

Concrete production sites across the UK



Quarries

Concrete and mortar production sites

Concrete block manufacturing sites

The production and manufacture of concrete and its constituent materials supports regional and rural economies across the UK. The average transport distance of ready-mixed concrete from plant to site is just 12km. In 2016, the average delivery distance for all types of concrete was 45km, and 57km for all of its raw materials.

Concrete is different to other building materials because every single one of its constituent materials is found in the UK. Using locally produced materials reduces demand for imports, ensuring security of supply, and contributes to the UK's economic sustainability.

Concrete is of fundamental importance to construction, a sector that makes up 6.1% of GDP. According to the Office for National Statistics, there was £99.3bn of new construction work in Great Britain during 2016. The Confederation of British Industry has estimated that for every £1 spent in construction, at least 90% stays in the UK.

The manufacture of concrete's constituent materials, such as cement and aggregates, as well the production of concrete products, such as ready-mixed concrete, precast concrete, blocks and mortar, represents the country's largest flow of materials and one of its largest manufacturing sectors. The Mineral Products Association estimates that the mineral products industry contributed £18bn to the UK's GDP in 2016 and directly employed 74,000 people, as well as supporting a further 3.5m jobs.

Concrete is used in many ways on many types of project, from foundations to structures to roof tiles, and in roads, bridges, tunnels and runways. Without a secure supply of high-quality concrete, it would not be possible to deliver essential infrastructure such as high-speed rail or to upgrade our Victorian sewerage network. The UK's National Infrastructure and Construction Pipeline for 2017 projects £600bn of public and private investment over the next 10 years. If delivered, this will require significant volumes of concrete.

Concrete is a good economic choice as a building material too. It is durable, robust and long-lasting, continuing to perform for many years with little or no maintenance.

INSIGHT#8 : WELLBEING

Concrete structures and finishes can improve quality of life

Any sustainable development strategy needs to address a variety of social aspects to maintain the health and wellbeing of employees, neighbours and building users.

The health and safety of employees is the first priority of the concrete industry and it has established continuous improvement targets with the overall aim of zero harm. Two key measures are reported: lost time incidents (LTI) frequency rate, which has reduced by 40% since 2010, and reportable injuries, which have fallen by 19% since 2008. In 2017, the industry also added its support to Mates in Mind, to raise awareness of mental health issues and dispel the stigma surrounding them.

The concrete industry strategy

87%

OF RELEVANT SITES WERE ACTIVE IN THEIR COMMUNITY IN 2016

Photo: Rob Parrish

The White Collar Factory in London, designed by Allford Hall Monaghan Morris – see Matt Massey interview, opposite

DID YOU KNOW

1,500 miles of concrete safety barriers have been installed on UK motorway, reducing the risk of crossover accidents and protecting lives

Photo: Hanson UK

In Hanson's new ready-mixed concrete trucks, a lower driving position and panoramic glass cab gives drivers better visibility of cyclists and pedestrians, improving road safety. They also run on hybrid fuel, helping to lower carbon emissions from transport

'I DON'T SEE EXPOSED CONCRETE AS A FAD – IT WILL STAND THE TEST OF TIME'

Matt Massey is senior project manager at Derwent London, which is at the forefront of office development in the capital

Is wellbeing increasing in importance?
Wellbeing is coming up on tenants' agendas a lot more than it ever did before. Previously, they might have been more likely to put up with what they had. Now, there's an expectation of more and people are quite happy to vocalise what they want. Tenants are demanding more detailed specs at letting stage and asking more detailed questions around wellness to do with local control over temperature, ventilation or lighting. As a result, we're taking on more in relation to wellness as part of the base build. It's all about making places more adaptable for the individual rather than for the masses. At the White Collar Factory, for example, there are five different ways for tenants to control cooling, and we've seen people there embrace that local control over their 5-10m^2 zone.

What is the business case for wellbeing?
Happier tenants! We want people to say that they like their building because it's a Derwent building with openable windows and localized controls. This does give us an edge – we're 98% let across our portfolio. For tenants, the quality of the environment is a massive sales pitch to attract young staff. Tenants can also save on energy bills – WCF's energy bills are 28% less than more traditional buildings.

Why do Derwent London's buildings often feature lots of exposed concrete?
Having a robust concrete structure is key to what we do – at the White Collar Factory we have embedded concrete core cooling which gives a much nicer feel inside the workplace. The wellbeing factor increases because you aren't getting a jet of cold air down your neck, or having that extra level of noise from plant on the same floor. As well as the thermal benefits of using concrete as a heat sink, we effectively have a structure that is also the finish. Having these different purposes in one form is so much less wasteful than throwaway suspended ceilings, and tenants also appreciate the aesthetic benefits. Personally, I don't see exposed concrete as a fad – I think it will stand the test of time. Already its gone from being something for technology and creative companies to being aimed at the banking and legal sectors as well.

How will you take wellbeing further in your future buildings? We haven't had any of our buildings WELL accredited yet but we're looking to adopt WELL in some of our major projects from next year.

includes metrics on local community liaison and its emphasis on manufacturing sites having certified environmental management systems helps to minimise unwanted emissions to air and water. There are also industry initiatives in place to protect vulnerable road users, as well as sector guidance for the safe installation and handling of concrete products.

Concrete structures can also make a significant contribution to society by improving the local surroundings, providing a secure and comfortable space for the activities of its occupants and being an adaptable and durable asset within the built environment.

Concrete's inherent performance credentials, such as fire and acoustic separation, thermal mass with no off-gassing, are increasingly being understood as an important part of their contribution to the health and wellbeing of tenants and occupants.

INSIGHT#9 : STANDARDS AND BENCHMARKING

Concrete goes above and beyond compliance

From the extraction of raw materials through the whole supply chain to production sites, products and buildings, concrete is covered by a wide range of British and European standards, design and construction codes and Building Regulations. Some provide very specific prescriptive requirements while others are based on final performance criteria that can be achieved in many ways.

Building Regulations, structured around a range of different aspects of construction such as structural integrity, fire, thermal performance and acoustic performance, can introduce potentially conflicting requirements that need to be resolved. Added to these are the more recent schemes for the assessment and rating of the sustainability of projects such as the BREEAM suite, Code for Sustainable Homes (no longer in use for new projects), Home Quality Mark, CEEQUAL and LEED.

The concrete industry also has a role to provide fact-based information to help designers and clients. Industry experts contribute to the development of standards, codes and regulations through representation on technical committees and working groups and by direct comment on public consultations. This is essential to ensure that innovative solutions can meet requirements and performance criteria, while continuing to deliver robust, safe and durable structures.

Although concrete manufacturers usually have technical expertise and information to support designers, the strategy recognises the need for more generic design guidance. The Concrete Centre publishes best practice guidance on general aspects of concrete construction and specific sustainability aspects including thermal mass, whole-life carbon and long-term resilience.

Over the last 10 years, the concrete industry has gone beyond simply complying with regulation, seeking to become a leader in sustainable construction. By consistently improving our performance over and above current best practice, and enlightening clients to ensure a sustainable construction environment downstream, the concrete industry plays a dynamic role in delivering a sustainable, low-carbon built environment in a socially, environmentally and economically responsible manner.

Five Pancras Square, completed in 2014, is the 150,000ft², BREEAM Outstanding headquarters for Camden council. It provides public facilities including two swimming pools and a library on the lower floors, while the upper nine storeys house office space. The building's exceptional environmental performance is underwritten by extensive use of concrete. “Using concrete is the easiest way of achieving the benefits of a large thermal mass,” says Peter Fisher of architect Bennetts Associates, “so the upper nine floors are constructed from precast concrete columns and conventional in-situ concrete slab floors”

Stanton Bonna's precast concrete factory in Stanton by Dale, Ilkeston, Derbyshire, makes manhole rings for roadside drainage systems and is one of many facilities now covered by an ISO 14001-compliant environmental management system

Photo: Stanton Bonna

Photo: Hufton + Crow

PRODUCTION SITE CERTIFICATION

An important element of the concrete industry's sustainability strategy has been the setting of targets for all members to ensure that their production sites are covered by independent (UKAS-approved) certification, such as ISO 14001 for environmental management systems (EMS) and ISO 9001 for quality management systems (QMS).

The international standard ISO 14001 is structured around identifying potential environmental impacts, assessing their relative risk and criticality and implementing procedures to minimise and manage that risk. In 2016, 93% of all concrete and constituent material production sites operated an EMS certified to ISO 14001.

For concrete plants, the focus in the EMS will often be on avoiding pollution through control of dust emissions, spillages and run-off water and the appropriate handling and disposal of any production and consumables waste.

ISO 9001 is structured to identify aspects of raw materials supply and production process, assess their level of influence and risk on quality and fitness for purpose and the implementation of procedures to ensure consistency. In 2016, 92% of production sites were covered by a QMS certified to ISO 9001. Together with the BS OHSAS 18001 health and safety standard, these form a key part of the BRE's BES 6001 responsible sourcing standard (see page 11).

MEETING BREEAM WITH CONCRETE

BREEAM is the world's leading sustainability assessment method for masterplanning projects, infrastructure and buildings. It recognises and reflects the value in higher performing assets across the built environment lifecycle, from new construction to in-use and refurbishment. There are many recent examples of new construction in the UK that have achieved Very Good, Excellent and Outstanding certification using concrete as the principle structural material.

Assessment covers a range of sustainability issues including aspects related to energy and water use, the internal environment, health and wellbeing, pollution, transport, materials, waste, ecology and management. A holistic, whole-life approach is at the core of the assessment methodology.

Uniquely, concrete has the versatility and potential to contribute to achieving credits across a wide range of categories. Many of the credits relate to environmental performance benefits, such as durability, acoustic isolation and flood resilience, but most significantly the use of concrete's high thermal mass assists with the reduction of energy consumption and lower carbon emissions in use.

BREEAM is updated regularly in order to maintain recognition of best practice in sustainable construction, and to take into account changes in regulation and standards. The latest version of BREEAM New Construction was published in 2018, so while some projects already in progress may continue to be assessed against the 2014 Technical Manual up until 2023, new project registrations after 23 March 2018 will be assessed under this slightly amended version.

One interesting amendment in the latest version is a change to the methodology relating to the use of recycled aggregates. The credit now recognises that local aggregates may be the most sustainable source for a given location, so a new metric linking abundance with the method and distance of transportation has been introduced.

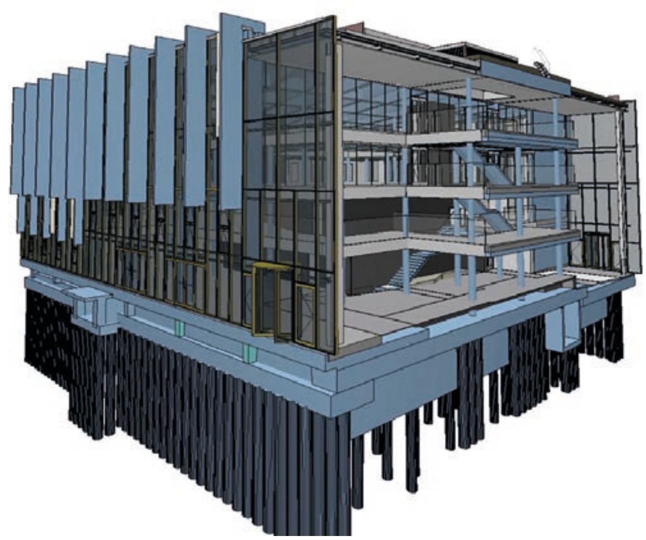
Further details on BREEAM scores can be found in Concrete and BREEAM, published by The Concrete Centre.

93%

OF CONCRETE INDUSTRY PRODUCTION SITES HAVE EMS CERTIFICATION TO ISO 14001

INSIGHT#10 : PERFORMANCE METRICS

Ten years of detailed sustainability data has laid a foundation for the future



Strategies and commitments are vital, but they must be underpinned by credible, appropriate performance indicators. This allows the industry to measure progress and, crucially, to set improvement targets. Consultation with internal and external stakeholders and material analysis enabled the industry to agree a series of indicators in 2008. The industry has reported on these metrics annually ever since.

The data is collected by companies in the nine sectors of the concrete production and supply chain and submitted to their relevant trade associations. This aggregated data is then independently collated to provide the summary values reported. Where possible, the values represent a form of "embodied" indicator as they show data related to concrete production and proportionate contributions from the raw materials used. The values obtained this way do not represent a particular type or grade of concrete but are based on the average proportions of all types of concrete produced.

Both our methodology and indicators are reviewed annually to ensure they remain accurate and relevant. Examples of this are the indicators for "percentage of additional cementitious materials used" and "kg CO_2/ tonne of concrete".

In the case of additional

UNDERSTANDING WHOLE-LIFE IMPACTS

LCA stands for … lifecycle analysis (or assessment), an approach to quantify the environmental impacts of a product against defined indicators. These indicators may include impacts on the climate, global warming potential (carbon footprint), resource and water use, and impacts on water and air quality. The impact is measured against these indicators across all the stages of a product's life from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and end of life.

EPD stands for … environmental product declaration, an independently verified and registered document that communicates the environmental impact of a product assessed by an LCA. EPDs are Type III Environmental Labels and report a specific set of indicators.

PCR stands for … product category rules, the compilation of specific rules, requirements and guidelines for creating EPDs of a certain product group. The PCR ensures consistency and allows for comparison between functionally equivalent products as part of a building level assessment.

Photo: Quintin Lake; BIM image: Penoyre & Prasad

Above and left: The refurbishment and extension of the Templeman Library at the University of Kent by Penoyre & Prasad has a concrete frame and a distinctive facade made up of precast concrete projecting fins. The project team's shared use of data via collaborative BIM software made it possible for the precast contractor to develop the fins concurrently with the structural model (left), contributing to a successful outcome

cementitious materials, the original definition needed to be modified to ensure that only materials beneficial to improving sustainability performance were included. This led to a step reduction in the apparent value but the original 2020 target value of 35% has been retained.

The "rolling mix" value for carbon emissions reporting was found to be influenced strongly by year-on-year changes to the types of concrete requested by the construction market, which is outside the control of the concrete industry. A second indicator was therefore introduced based on maintaining the concrete mix proportions from 2008, in order to provide a "normalised" value for year-on-year comparison.

Each year new indicators are considered based on stakeholder feedback. Several are undergoing testing to ensure that they can be reported consistently and credibly. Examples are indicators related to equal opportunities, local community, health and safety management, verified EPDs and data for building information modelling (BIM).

Accurate data is of course central to the future of BIM, which is another reason why the concrete industry's commitment to provide LCA data compliant with codes and standards is so important. Generic EPDs are now available for concrete and concrete products, which in turn are essential for BIM, as by linking EPD data to BIM objects designers can model the embodied impacts of their material and design choices.

'RESEARCH NEEDS GOOD DATA WITH GOOD TRANSPARENCY'

Dr Craig Jones is director of sustainability consultant Circular Ecology

How important is data to improving lifecycle sustainability?
It is very important as it allows us to produce quantitative rather than qualitative research. If we're to have confidence in them, studies need to be backed up by good data with good transparency. This is particularly important because although sustainability sounds like a simple concept, it's actually complicated since it covers social, environmental and economic factors. Carbon is very important, but it is just one of about 20 environmental impact factors in an LCA.

How can data be used to reduce embodied carbon?
The building design stage is the largest opportunity to reduce carbon – the earlier in the process the better. Data can feed into this by allowing design choices to undergo an embodied carbon assessment, which might lead to choosing longer life materials, for example. However, this isn't used enough. Embodied carbon isn't too difficult to calculate but if you haven't done it before, it can be a barrier.

What are the most important tools and data sources for designers?
There are a number of tools for measuring embodied carbon – eTool (etoolglobal.com) or One Click LCA (oneclicklca.com), for example – but none have really grabbed the market. One free resource is the Inventory of Carbon & Energy database, which I am currently updating (circularecology.com).

What data is available about concrete and how this might be used?
There is useful data on sustainableconcrete.org.uk and mineralproducts.org. Concrete isn't really one material but a blend of many, and the amount of cement is the key indicator of embodied carbon. The next version of the Inventory of Carbon & Energy database allows a larger range of concretes to be modelled.

How could designers and product suppliers collect, manage and use data better?
Product suppliers could provide embodied carbon data for their product. The Concrete Centre has already got EPDs, for example, for an average concrete. We need to try to get carbon measurement alongside the activities that project teams are already doing in the design process. By setting a carbon target that's strong enough to encourage them to do things differently, designers would be more likely to look at things like retaining part of existing structures, or using innovative construction techniques.

Summary of performance indicators

The concrete industry publishes performance data annually. Reports are available at sustainableconcrete.org.uk/reports.
More information about the indicators can be found in the Concrete Industry Guidance Document on Sustainability Performance Indicators.

Performance indicator	Baseline		Performance	Target
	Year	Value	2016	2020
Sustainable consumption and production: action on materials				
% of production sites covered by a UKAS-certified ISO 14001 environmental management system (EMS)	2008	72.3%	92.9%	95.0%
% of production sites covered by a UKAS-certified ISO 9001 quality management system (QMS)	2008	84.2%	91.9%	95.0%
% of additional cementitious materials (GGBS, fly ash, etc.) as a proportion of total cementitious materials used	2008	30.0%	27.2%	35.0%
Recycled/secondary aggregates as a proportion of total concrete aggregates	2008	5.3%	7.7%	No targets set *
% of production certified to responsible sourcing standard BES 6001	2008	n/a	90.0%	95.0%
Climate change and energy: action on carbon				
Kilowatt hours of energy used in production as a proportion of production output (kWh/tonne)	2008	132.1	134.4	Deliver the industry CO_2 target and sector climate change agreement targets
Energy intensity as a proportion of production output – normalised mix (kWh/tonne)	2008	132.1	118.9	
CO_2 emissions as a proportion of production output – rolling mix (kg CO_2/tonne)	1990	102.6	82.8	Reduce by 30% from 1990 baseline (72.2)
	2008	87.5		
CO_2 emissions as a proportion of production output – normalised mix (kg CO_2/tonne)	1990	102.6	73.7	
	2008	87.5		
CO_2 emissions from delivery transport through the industry supply chain as a proportion of production output (kg CO_2/tonne)	2009	7.2	7.3	Under review
Natural resource protection and enhancing the environment: action on waste, biodiversity and water				
Materials diverted from the waste stream for use as a fuel source, as % of total energy use	2008	17.3%	28.7%	50.0%
Waste to landfill as a proportion of production output (kg/tonne)	2008	5.0	1.0	90% reduction from 2008 baseline (0.5)
Net waste consumption ratio	2008	19	116	
Mains water consumption as a proportion of production output (litres/tonne)	2008	86.0	78.1	Under review
% of relevant production sites that have specific action plans on biodiversity	2008	94.3%	99.4%	100%
Creating sustainable communities: action on wellbeing				
Reportable injuries per 100,000 direct employees per annum	2008	799	647	
Lost time injuries (LTI) frequency rate for direct employee per 1,000,000 hours worked	2010	6.5	3.9	From 2014-19, reduce LTIs by 65% with an aim of zero harm
% of employees covered by UKAS-certified training and evaluation process	2008	84.4%	96.4%	100%
Number of convictions for air and water emissions per annum	2008	6	1	0
% of relevant sites that have community liaison activities	2008	85.9%	87.1%	100%

* This is because increasing recycled content is not always indicative of sustainable performance

Sustainable consumption and production: **action on materials**

Key
- Concrete
- Concrete plus reinforcement
- 2012 target
- 2020 target

% of production sites covered by a UKAS-certified ISO 14001 environmental management system (EMS)

Recycled/secondary aggregates as a proportion of total concrete aggregates

% of production sites covered by a UKAS-certified ISO 9001 quality management system (QMS)

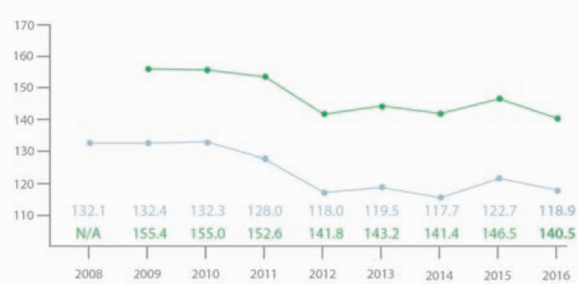
% of production certified to responsible sourcing standard BES 6001

% of additional cementitious materials (GGBS, fly ash, etc.) as a proportion of total cementitious materials used

Climate change and energy: **action on carbon**

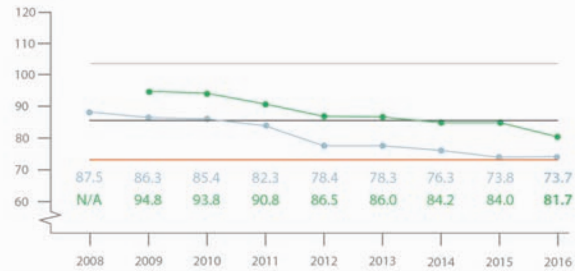
Kilowatt hours of energy used in production as a proportion of production output (kWh/tonne)

Energy intensity as a proportion of production output – normalised mix (kWh/tonne)



CO_2 emissions as a proportion of production output – rolling mix (kg CO_2/tonne)

CO_2 emissions as a proportion of production output – normalised mix (kg CO_2/tonne)



Natural resource protection and enhancing the environment: **action on waste, biodiversity and water**

CO_2 emissions from delivery transport through the industry supply chain as a proportion of production output (kg CO_2/tonne)

% of relevant production sites that have specific action plans on biodiversity

Mains water consumption as a proportion of production output (litres/tonne)

Materials diverted from the waste stream for use as a fuel source, as % of total energy use

Net waste consumption ratio

Waste to landfill as a proportion of production output (kg/tonne)

Creating sustainable communities: **action on wellbeing**

Lost time injuries (LTIs) frequency rate for direct employees per 1,000,000 hours worked

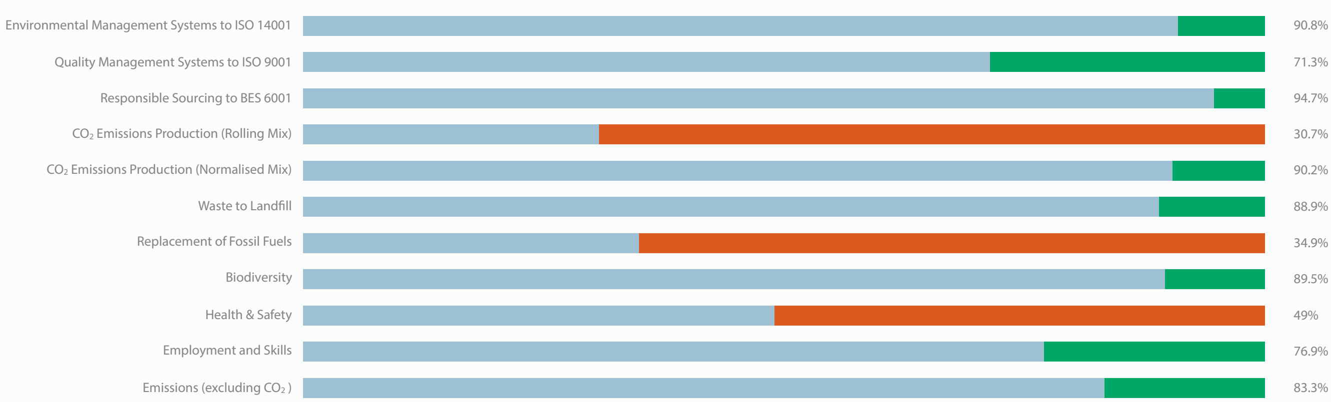
Number of convictions for air and water emissions per annum

Reportable injuries per 100,000 direct employees per annum

% of relevant sites that have community liaison activities

% of employees covered by UKAS-certified training and evaluation process

Progress to 2020 targets based on 2016 performance from a 2008 baseline



Published by MPA The Concrete Centre, on behalf of the Sustainable Concrete Forum, Gillingham House, 38-44 Gillingham Street, London SW1V 1HU **www.concretecentre.com**

PERFORMANCE BENEFITS OF CONCRETE AND MASONRY

How heavyweight construction contributes to a sustainable, low-carbon built environment

	ENVIRONMENTAL	SOCIAL	ECONOMIC
FIRE RESISTANCE	Concrete and masonry do not burn and therefore reduce both the waste of materials and the noxious emissions caused by fire.	The resilience of concrete and masonry reduces damage and limits the potential loss of homes and livelihoods as a result of fire. During construction, concrete and masonry present no fire risk to neighbours.	Regulations require the safe evacuation of occupants but do not ensure the survival of property. Concrete structures comply with life safety regulations but also resist fire, enabling cost-effective repair and re-use.
THERMAL MASS	The thermal mass of concrete and masonry allows them to be used to reduce buildings' heating and cooling energy.	The thermal mass inherent in concrete provides a simple and effective means to reduce overheating – a growing health and wellbeing issue, particularly among the elderly. Projections show a three-fold increase in heat-related mortality by the 2050s.	Using the thermal mass in concrete and masonry will lower the running costs of a building. It will also reduce the plant equipment needed in the building, leading to lower operating and maintenance costs.
DURABILITY	Due to the long life of all concrete and masonry structures, material impacts on the environment are kept to an absolute minimum.	The durability of concrete structures means that, once built, they are rarely out of use for maintenance and hence cause minimal social disruption.	Concrete and masonry are very stable and durable materials with extremely long lives. As a result, maintenance costs are extremely low.
ACOUSTIC ISOLATION PERFORMANCE	Concrete and masonry have good acoustic performance and rely very little on additional finishes and materials that have a short lifespan. As a result, less material is used and potential waste is avoided.	The mass provided by concrete and masonry absorbs sound, ensuring a better quality of life, particularly in high-density environments where noise from neighbours can be a major issue.	Concrete walls/floors provide the required acoustic separation with minimal finishes, and therefore minimal costs and maintenance.
ROBUSTNESS AND SECURITY	Concrete structures are robust, reducing the risk of damage to finishes. Therefore, less material is used throughout a structure's whole lifecycle.	Concrete and masonry walls and floors provide safe and secure means of enclosure. Prevention of intruders helps to build safer communities.	Concrete and masonry structures, particularly those with minimal finishes, will suffer less damage and cost less to repair and maintain.
FLOOD RESILIENCE	Concrete and masonry retain their structural integrity, resulting in minimal waste of materials following a flood.	Concrete and masonry structures can be designed to resist water penetration, keeping inconvenience and disruption to business, homeowners and the community to a minimum.	Downtime of businesses, homes and essential community services is minimised if flooded buildings have been constructed from concrete and masonry.