LESS IS MORE

Guy Thompson explains the many facets of material efficiency, a key focus for the Concrete Industry Sustainable Construction Strategy over the last decade

Material efficiency can be defined simply as doing more with less. The target is to use fewer resources in the most sustainable way, minimising the environmental impact, while extracting maximum value from those resources by providing buildings and infrastructure that will be useful for the long term – and therefore promoting the transition to a circular economy.

So the reduction of waste and the use of recycled content are just two elements of material efficiency in the built environment. Just as embodied CO_2 is not by itself the whole of a carbon footprint, material efficiency assessments should not be limited to a single life-cycle stage.

For the last ten years, the Concrete Industry Sustainable Construction Strategy has been reporting annually on a wide range of metrics that demonstrate sector performance, and many of these relate to material efficiency.

Unless all of these elements are considered holistically, opportunities for whole-life efficiency may be lost or muddled, along with a host of related design criteria such as whole-life carbon and cost, climate change mitigation and adaptation, and fire resistance. As with all materials, the use of concrete must be carefully considered, and an awareness of how to design for long-term efficiency is vital to achieving the greatest benefit from the least amount of resources.

Much is made of the quantities of concrete used around the world to enable societies to achieve their goals and to shelter and protect their citizens. But when you consider the material efficiency that concrete and masonry can offer, and the many opportunities to do more with less, it is hardly surprising that clients and their design and construction teams depend so much on a material that provides such powerful benefits from cradle to grave.

Responsible sourcing

Concrete is an inert material created primarily from natural minerals that can be locally and sustainably sourced throughout the UK, reducing imports, transport costs and carbon emissions.

Recycled/secondary aggregates

Depending on the application and the type of concrete, there is often an opportunity to incorporate recycled aggregates that have been previously used in other projects and secondary aggregates that may be by-products from other industrial processes.

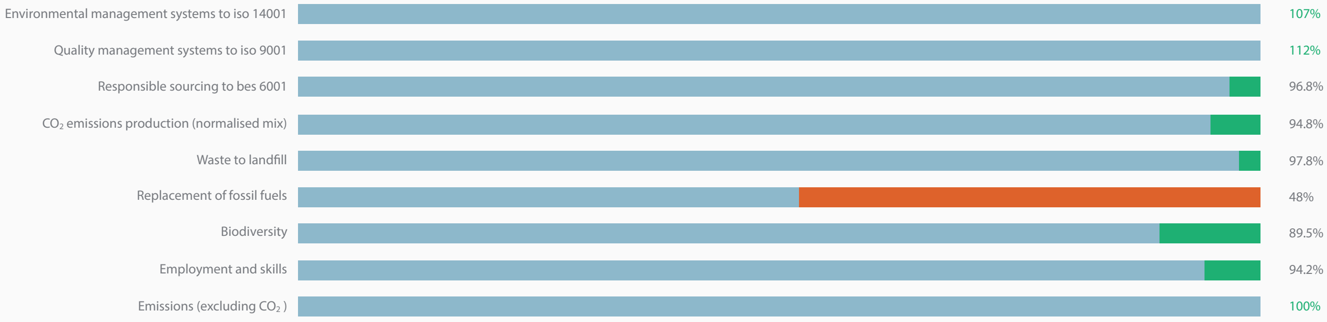
The inclusion of recycled and secondary aggregates in concrete is a balance of resource efficiency, CO_2 emissions from transportation, and the implications for mix design and performance, so they should only be used where it is technically and environmentally beneficial to do so. In 2017, 8.3% of aggregates used in concrete were from recycled or secondary sources. Approximately a third of all aggregates used in the UK for concrete and other applications are either recycled or secondary.

Recycled concrete, as well as being used as an aggregate, is often used at the source of demolition, in new substructures and external landscaping. There are a range of established uses for recovered concrete, with no evidence of any material being sent to landfill.

Cementitious materials

There are significant volumes of by-product materials such as ground granulated blast-furnace slag (GGBS) and fly ash that can act as part of the cementitious binder in concrete. These materials have a lower embodied carbon than cement and can also influence

Progress to 2020 targets based on 2017 performance from a 2008 baseline

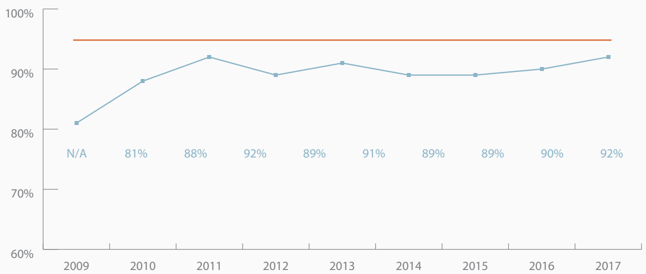


Concrete Industry Sustainable Construction Strategy: **progress on key indicators**

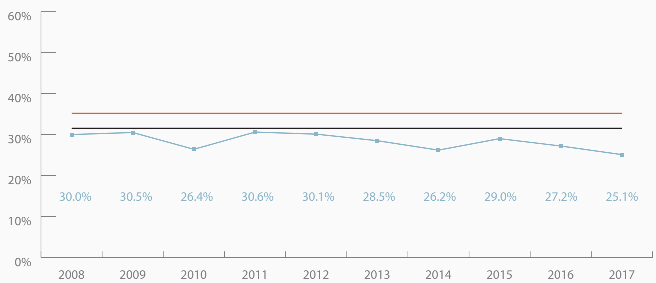
Key

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

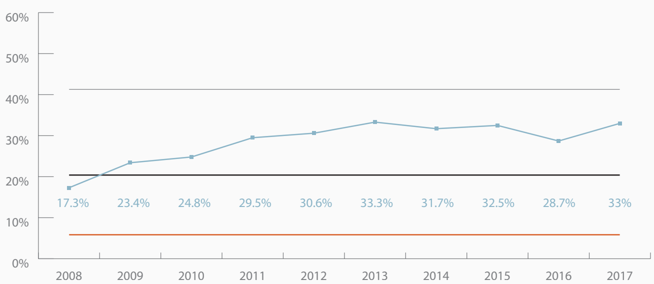
% of production certified to responsible sourcing standard BES 6001



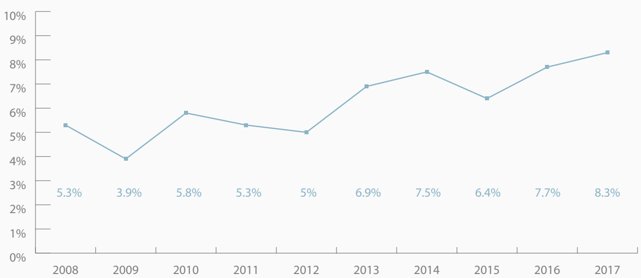
% of additional cementitious materials (GGBS, fly ash etc) as a proportion of total cementitious materials used



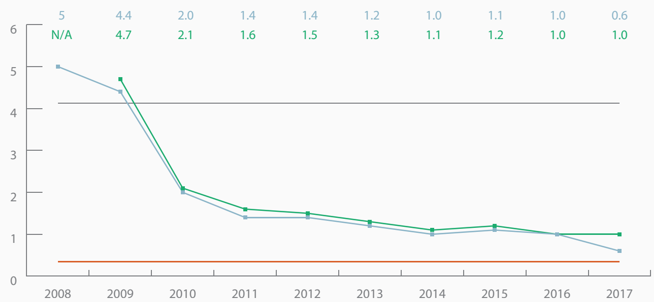
Materials diverted from the waste stream for use as a fuel source, as % of total energy use



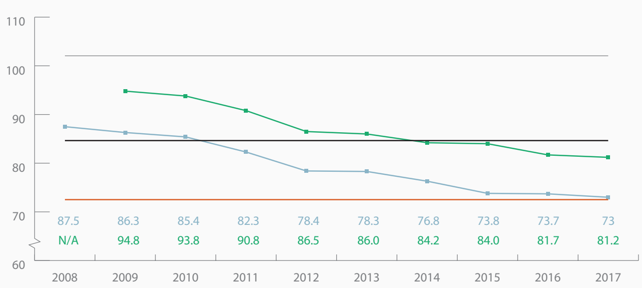
Recycled/secondary aggregates as a proportion of total concrete aggregates



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

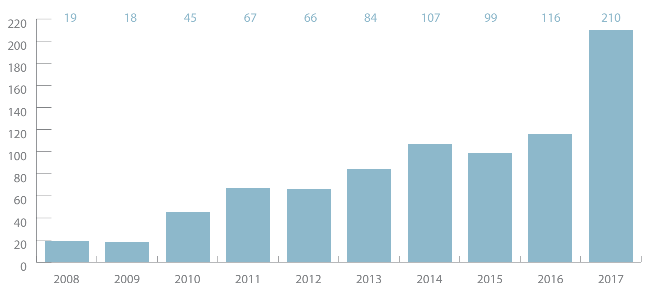


CO_2 emissions as a proportion of production output – normalised mix (kg CO_2/tonne)

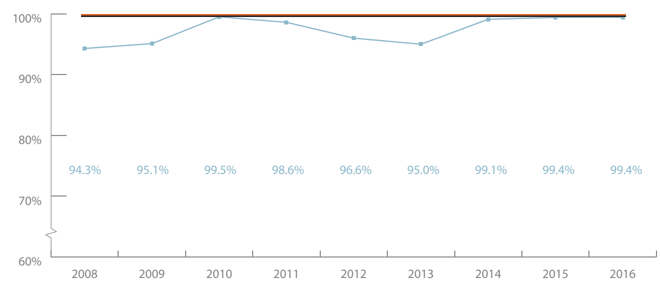


"THE CONCRETE INDUSTRY IS A NET USER OF WASTE – 210 TIMES MORE WASTE IS CONSUMED DURING THE MANUFACTURE OF CONCRETE THAN THE INDUSTRY SENDS TO LANDFILL"

Net waste consumption ratio



% of relevant production sites that have specific biodiversity action plans



the appearance and performance of concrete. In 2017, additional cementitious materials made up 25.1% of the total used.

Recycled steel reinforcement

Members of the British Association of Reinforcement (BAR) that manufacture steel reinforcement used approximately 96% recycled ferrous metal waste as raw materials in their electric arc furnaces (EAF) in 2017. BAR members that fabricate reinforcement used more than 95% EAF material in producing and supplying rebar for use in concrete.

BES 6001

During 2017, certification of concrete products to BES 6001 reached 92% of production tonnage. Over 90% of this certified tonnage achieved a performance rating of "Very Good" or "Excellent". Responsible sourcing is included when calculating credits under BREEAM assessment schemes. Under the Responsible Sourcing Certification Scheme, the majority of certified concrete production attracts a RSCS score of 7.

Waste consumption

Concrete is manufactured using efficient, low-waste processes and can be supplied in the precise quantities required, limiting waste. The concrete industry is a net user of waste – 210 times more waste is consumed during the manufacture of concrete and its constituent materials than the industry sends to landfill.

Waste to landfill

The indicator for waste minimisation relates to landfill disposal per tonne of concrete production and includes waste related to the constituent materials. During 2017, the value was 0.6kg/tonne of concrete produced. This represents significant progress towards the 2020 target of a 90% reduction from the 2008 baseline, equivalent to 0.5kg/tonne. Our longer-term aspiration is for zero waste to landfill.

Replacement of fossil fuel

The industry requires high temperatures for production, primarily in cement manufacture, and this is an opportunity to safely use alternative combustible materials instead of fossil fuels. Where fuels used are recognised as carbon neutral under the EU Emissions Trading Scheme, this has the added benefit of reducing the embodied carbon of cement.

The concrete industry indicator shows the proportion of energy derived from materials diverted from the waste stream as a percentage of total energy use. In 2017, 33% of total energy use was from waste-derived fuels, the highest value recorded since the strategy was launched in 2008. For cement production alone, this increases to 44%.

Design

The use of all construction materials can be optimised through structural design and the selection of construction systems that cut waste on site. Designers can also adopt a strategic design approach to optimise concrete's performance and reduce the need for other materials.

Concrete alone can often meet the performance requirements of structure, fire and acoustic separation, without the need for other finishing materials. A range of design solutions enable designers to improve material efficiency, such as post-tensioned concrete or void formers. Exposed concrete also optimises thermal mass, enabling considerable savings on energy and carbon over a building's life.

The durable finish of concrete offers further lifecycle cost savings through a reduction in maintenance (and replacement) that would be required for other "wearing" finishes. Designing for long-life in most cases is the most efficient investment in resources.

Considering a building's performance in a changing climate is an essential part of designing for the future. Concrete and masonry can be used to provide resilience to overheating, flooding, strong winds and extreme weather events.

The long service life and robust nature of concrete facilitates the reuse of existing concrete frames and foundations, extending a building's life still further. Designers can use space-planning and adaptation strategies to accommodate changes of use and extend the life of a structure.

At end of life, concrete is 100% recyclable. Demolished concrete can be relatively simply segregated and crushed for reuse as a cost-effective material for hard core, fill or in landscaping or used as recycled aggregate in new concrete. Crushed concrete aggregate absorbs up to 20% of the original embodied carbon.

Reusing recovered materials can avoid the use of primary resources, preferably where it is more carbon-efficient to do so.

The graphs here provide a snapshot of the UK concrete sector's performance to date, and the table opposite summarises progress towards all the targets. The full performance report can be downloaded from **sustainableconcrete.org.uk**

Summary of performance indicators

The concrete industry publishes performance data annually. Reports are available at sustainableconcrete.org.uk.
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	2017	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%	96.6%	95.0%
% of production sites covered by a UKAS-certified ISO 9001 quality management system (QMS)	2008	84.2%	96.3%	95.0%
% of additional cementitious materials (GGBS, fly ash etc) as a proportion of total cementitious materials used	2008	30.0%	25.1%	35.0%
Recycled/secondary aggregates as a proportion of total concrete aggregates	2008	5.3%	8.3%	No targets set*
% of production certified to responsible sourcing standard BES 6001	2008	n/a	92.0%	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	154.1	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	122.3	
CO_2 emissions as a proportion of production output – normalised mix (kg CO_2/tonne)	1990	102.6	73.0	Reduce by 30% from 1990 baseline (72.2)
	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	8.6	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%	33.0%	50.0%
Waste to landfill as a proportion of production output (kg/tonne)	2008	5.0	0.6	90% reduction from 2008 baseline (0.5)
Net waste consumption ratio	2008	19	210	
Mains water consumption as a proportion of production output (litres/tonne)	2008	86.0	69.7	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	656	
Lost time injuries (LTI) frequency rate for direct employee per 1,000,000 hours worked	2010	6.5	4.0	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%	99.1%	100%
Number of convictions for air and water emissions per annum	2008	6	0	0
% of relevant sites that have community liaison activities	2008	85.9%	90.3%	100%

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

This data is published on behalf of the Sustainable Concrete Forum, and sourced from the following sector associations: British Association of Reinforcement, British Precast, British Ready-Mixed Concrete Association, Cement Admixtures Association, Cementitious Slag Makers Association, Mineral Products Association, MPA Cement, UK Quality Ash Association.