CONCRETE FUTURES

Futurebuild 2024 **Samples Exhibition**

Circular economy

The technologies exhibited here were featured in the conference: ‘Making better use of concrete demolition waste’.

Concrete made from recycled material

1. ‘Circular’ lightweight aggregate

Block pavers made using this innovative aggregate that uses by-product and waste materials.

Sample courtesy of Low Carbon Materials & Aggregate Industries

2. Recycled granite aggregate

A by-product of the china-clay industry sourced from South West England, otherwise known as stent.

Sample courtesy of Aggregate Industries

3. Carbon sequestering aggregate

An innovative lightweight aggregate created from waste material and CO_2.

Sample courtesy of O.C.O Technology Limited & Carbon8 Systems

4. Pigmented concrete using reclaimed ink toner

An innovative solution for creating coloured concrete.

Samples courtesy of University of Dundee

5. Waste plasterboard

Recycled gypsum is used in the manufacture of Portland cement.

6. Ground waste brick

A type of calcined clay being trialed for use as a lower carbon supplementary cementitious materiaSCM.

Sample courtesy of Forterra

7. Ground Granulated Blast Furnace Slag (GGBS)

A by-product of the steel and iron industry, used as a lower carbon SCM.

Sample courtesy of Heidelberg Materials

8. Fly ash (FA)

A by-product of coal fired power stations, used as a lower carbon SCM.

Sample courtesy of UK QAA

9. Recovered ash

Coal derived fuel ash (CDFA) sourced from single use stockpile or lagoon reserves in the UK and processed CDFA for potential use as a lower carbon cementitious material.

Recycling concrete

Concrete is fully recyclable, with well-established processes and supply chain in the UK

Most is used “unbound” as sub-base materials, fill and hardcore, playing an important role in the UK’s current circular economy, by reducing the demand for primary aggregates. Innovative processes are expanding the opportunities for use of recycled concrete. These include for carbon capture and storage, enhanced aggregate, new concrete products, secondary cementitious material, and manufacture of new cement.

1 Enhanced aggregate for concrete by carbonation

Recycled concrete aggregate using an innovative process to accelerate carbonation using CO_2 contained in cement plant flue gases. This process improves the quality of the aggregate for potential use in concrete.

Samples courtesy of FastCarb & Holcim

2.Crushed Concrete Aggregate (CCA)

Crushed and graded concrete from both demolition waste and repurposed returned concrete for use in concrete manufacture.

Sample courtesy of Day Aggregates

3. Recycled concrete fines

Created from concrete demolition waste with the potential for use as a supplementary cementitious material (SCM) in the manufacture of new cement.

Sample courtesy of Day

4. Recycled clinker

Innovative clinker manufactured using 100% recycled content, including recycled concrete.

Sample courtesy of Aggregate Industries/ Holcim

5. Recycled concrete paste

Created from concrete demolition waste with the potential for carbon capture and as alternative raw material in cement.

Sample courtesy of Heidelberg Materials

6. Innovative low carbon cement

Concrete manufactured using an innovative low carbon cement based on a co-product of steel recycling, using recycled concrete.

Sample courtesy of Cambridge Electric Cement

Decarbonisation through innovation

For more information see ‘Hit the road ‘ article in Concrete Futures magazine

1 Low carbon cement

This concrete is made using the same low carbon cement used to construct the Hope Sculpture in Glasgow.

Sample courtesy of ECOPACT®, Aggregate Industries

2 Low carbon cement trials

Cambridge Electric Cement, made as part of the Cement2Zero trial investigating the technical and commercial aspects of upscaling this new, potentially near-zero carbon, cement made using recycled concrete.

Sample courtesy of Cambridge Electric Cement

4 Decarbonising precast concrete with alternative reinforcement

Basalt, fibre reinforced polymer (BFRP) rods, trialled as alternative reinforcement as part of Laing O’Rourke’s Decarbonising Precast Concrete Manufacturing project.

Samples courtesy of Bostech & L’OR

5 Graphene enhanced cement trials

The largest global trials of graphene enhanced cement are underway. Trials have found compressive strength gains in concrete of around 10%, which could enable significantly less material to be used in concrete structures. Graphene was added to the cement process as a grinding aid.

5A) Graphene enhanced cement

5B) Graphene enhanced ‘functional’ grinding agent

5C) Concrete using graphene enhanced cement

Samples courtesy of First Graphene, Breedon and Morgan Sindall

6 Net zero fuel trial to make cement

A world first trial for the manufacture of cement using hydrogen and other carbon-neutral fuels.

6A Clinker made using net zero fuel

6B Cement made using net zero fuel

Samples courtesy of Heidelberg Materials

8 Lower carbon concrete using Char-crete

Charcoal made from waste wood products, being investigated for use as a cement replacement in concrete manufacture.

Sample courtesy of CREST, South-West College, Enniskillen, NI

9 Concrete brick made using captured carbon

‘CarbonCure’ technology is now being rolled out for facing bricks manufactured by Marshalls in South Wales.

Sample courtesy of Marshalls Group

10 Waste derived fuels

The new production process at Cemex's Rugby cement plant has the capability to operate at 100% with alternative fuels including recycled tyres and Climafuel, a refuse derived fuel based on non-recyclable household and business waste.

10A Recycled tyre chips

10B Climafuel

11 Pushing the boundaries of material efficiency

Flexible, non-corrosive mesh reinforcement used to create a novel, thin shell vaulted concrete flooring system. The ACORN project, based at the universities of Cambridge, Bath and Dundee, is using robotic formwork and advanced structural design software to optimise concrete structures.

Sample courtesy of Solidian & Bath University

12 Fibre reinforced precast concrete for lower carbon infrastructure

Polypropylene micro-fibres and steel fibres, used in conjunction with aggregates from the manufacturer's own quarry and 40% GGBS to reduce the embodied carbon of precast concrete segments for the Silvertown tunnel.

Samples courtesy of Banagher Precast Concrete

13 Carbon mineralisation using olivine

An innovative low carbon pozzolan based on olivine, an abundant and naturally occurring magnesium silicate mineral. MagCarb is an ultra-low carbon binder co-produced in the manufacture of Seratech's SCM.

13A) Concrete made using Seratech's SCM,

13B) Concrete made using MagCarb

Samples courtesy Seratech

14 Calcined clay trials using reclaimed UK sources

A two-year MPA project is nearing completion, testing calcined clay from reclaimed UK sources for use as SCMs in concrete. Using calcined clays from these sources could divert 1.4 million tonnes of material from waste streams every year and lead to carbon savings of 20-40% compared to CEM I cement.1

14 A Reclaimed clay samples courtesy of Imerys, Heidelburg Materials and Tarmac (CRH Group)
14 B Calcined clay from ground waste brick
14C Concrete made using calcined clay as an SCM

Lower carbon concrete

Supplementary cementitious materials (SCMs)

SCMs are an established method of reducing the embodied carbon of concrete but are also used to enhance the properties of concrete.

In the UK, commonly-used SCMs are ground granulated blast-furnace slag (GGBS), fly ash (FA) and limestone fines. Other materials are also permissible in BS 8500.

SCMs have a lower embodied carbon than Portland cement (CEM I) and are used in combination with it, to varying proportions, to suit performance requirements of the concrete.

1 Ground Granulated Blast Furnace Slag (GGBS)

A by-product of the steel and iron industry, used as a cementitious material.

Samples courtesy of Heidelberg Materials

2 Fly Ash (FA)

A by-product of coal fired power stations, used as a cementitious material.

Sample courtesy of UK QAA and Cemex

3 Powdered Limestone Fines

Limestone fines are an abundant, locally sourced natural SCM in the UK.

4 Silica Fume

Also known as micro silica, this well-established SCM adds durability and strength to concrete.

Sample courtesy of Ferroglobe

5 Natural Pozzolana (volcanic material)

The concrete contains 70% SCM based on mechanically activated naturally abundant volcanic material.

Samples courtesy of EMC cement BV

Multi-component cements

The key UK standard for the specification of concrete, BS 8500, has been revised, expanding the range of options for achieving lower carbon concrete. These include the introduction of multi-component cements.

7 Concretes made using multi-component cements

A selection of some of the new lower carbon cements in BS 8500. From left to right:

CEM II/C-M (S-L) 30% GGBS, 15% limestone fines, 55% CEM I

CEM II/C-M (V-L) 30% fly ash, 15% limestone fines, 55% CEM I

CEM VI (S-L) 50% GGBS, 15% limestone fines, 35% CEM I

CEM II/B-M (S-L) 15% GGBS, 15% limestone fines, 70% CEM I

CEM II/B-M (V-L) 15% fly ash, 15% limestone fines, 70% CEM I

Samples courtesy of MPA

Alternative lower carbon concretes

The range and availability of lower carbon concretes and concrete products continues to increase, based on Portland cements or alternative binders. These include Alkali Activated Cementitious Materials (AACMs) and geopolymers.

Evolving standards

A new code of practice, BSi Flex 350, for performance-based specification is in development. This should be applicable for all cements and binders, whatever the chemistry.

1 Low carbon concrete block

Manufactured using AACMS in the concrete mix. They are available for different applications including paint grade, medium density and lightweight blocks

Sample courtesy of Greenbloc®/CCP

2 Low carbon concretes made using AACMs

A) Sample courtesy of Vertua®, CEMEX
B) Sample courtesy of Earth Friendly Concrete®, Capital Concrete
C) Sample courtesy of ECOPACT®, London Concrete/Aggregate Industries
D) Sample courtesy of CemFree®, part of DB (Holdings) Limited

Evolving SCMs

Other sources of SCMs for use with CEM I are being developed, including recovered fly ash, natural pozzolans, calcined clays and recycled concrete fines.

3 Concrete made using cement containing calcined clay and limestone (LC_3)

Sample courtesy of EPFL, Laboratory of Construction Materials (LMC)

4 Recycled concrete fines

Created from concrete demolition waste with the potential for use as an SCM.

Sample courtesy of Day Aggregates

5 Graphene admixture

Concrete made using a graphene-enhanced admixture, offering leaner concrete solutions through enhanced strength.

Sample courtesy of Concretene

Concrete Futures

Innovation

The concrete industry continues to invest significantly in research and development to improve the manufacture, performance, use and reuse of concrete.

Areas of focus include climate change mitigation and resilience; digital technology; resource efficiency and support for nature.

Growing concrete

Using bacteria to create calcium carbonate is known as microbially induced calcite precipitation (MICP). It is being developed for crack repair in self-healing concrete, and to create new cement-free concrete.

1 Bioconcrete

This material was produced by a naturally-occurring soil bacterium provided with industrial by-products, calcium chloride, and urea inputs. The bacteria rapidly precipitated calcium carbonate, binding the sand and aggregate together to produce this performant low-carbon Bioconcrete material.

Samples courtesy of Biozeroc

2 Self-healing concrete

Lower carbon concrete with a bacteria-based admixture that enhances the water tightness and reduces the maintenance of concrete in exposed conditions. The addition of an innovative corrosion-inhibiting admixture further enhances the durability of reinforced concrete. This sample is part of an Innovate UK funded research project.

Samples courtesy of University of East London & JP Concrete

Supporting nature

Intensive green roofs and nature bridges are examples of ways that concrete can help support the integration of nature in the built environment.

New products are also evolving to provide conditions suitable as a natural habitat on, or in, the concrete.

1 Enhancing river flood defences

Individually crafted, lower carbon concrete with holes and texture to encourage natural growth and habitat.

Samples courtesy of NatureBricks ™, Artecology

2 Attracting sea life to concrete

Ultra-high-performance, lower carbon concrete cast into custom made reusable moulds designed in collaboration with ecologists to encourage natural shore life and support biodiversity on marine structures.

Sample courtesy of BlueCube Marine and CubeX Industries

Permeable paving

Permeable concrete paving can be used as part of a Sustainable Drainage Systems (SuDs) to reduce the risk of surface water flooding and contribute to groundwater recharge.

1 Innovative permeable concrete

A new, draining cast insitu concrete pavement using locally sourced recycled waste shells.

Sample courtesy of University of Central Lancashire / Interreg Funded Circle Project

2 Innovative permeable paving

This new solution for permeable concrete paving uses innovative permanent formwork made from recycled plastic to facilitate water flow.

Sample courtesy of Kiacrete / Permia

3 Precast permeable paving

Permeable block paving system allowing surface water to pass between blocks.

Sample courtesy of Marshalls

Carbon storage

The natural carbonation process of concrete can be accelerated and enhanced, enabling more CO_2 to be absorbed, and permanently stored earlier in concrete's lifecycle. New technologies include carbon mineralisation of recycled concrete and waste products for use in concrete, as well as the creation of innovative binders.

1 Carbon sequestering precast concrete

Sample courtesy of Solidia

2 Carbon sequestering concrete

Sample courtesy of Concrete4Change Ltd. (C4C)

3 CO_2 utilisation in ready-mixed concrete

Sample courtesy of CarbonCure

4 Accelerated carbonation of crushed concrete aggregates

Sample courtesy of FastCarb, Holcim

5 Carbon capture and storage in recycled concrete paste

Sample courtesy of Heidelberg Materials

6 Carbon sequestering aggregate

Sample courtesy of O.C.O Technology Limited and Carbon8 Systems

7 Innovative carbon sequestering binder

Sample courtesy of MagCarb, Seratech

200mm

3D Printed concrete

This table base was printed using a low carbon, graphene-enhanced mortar.

Design: Ben Harries

Design and manufacture: Versarien PLC

Photo courtesy of: Versarien PLC