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CONCRETE QUARTERLY

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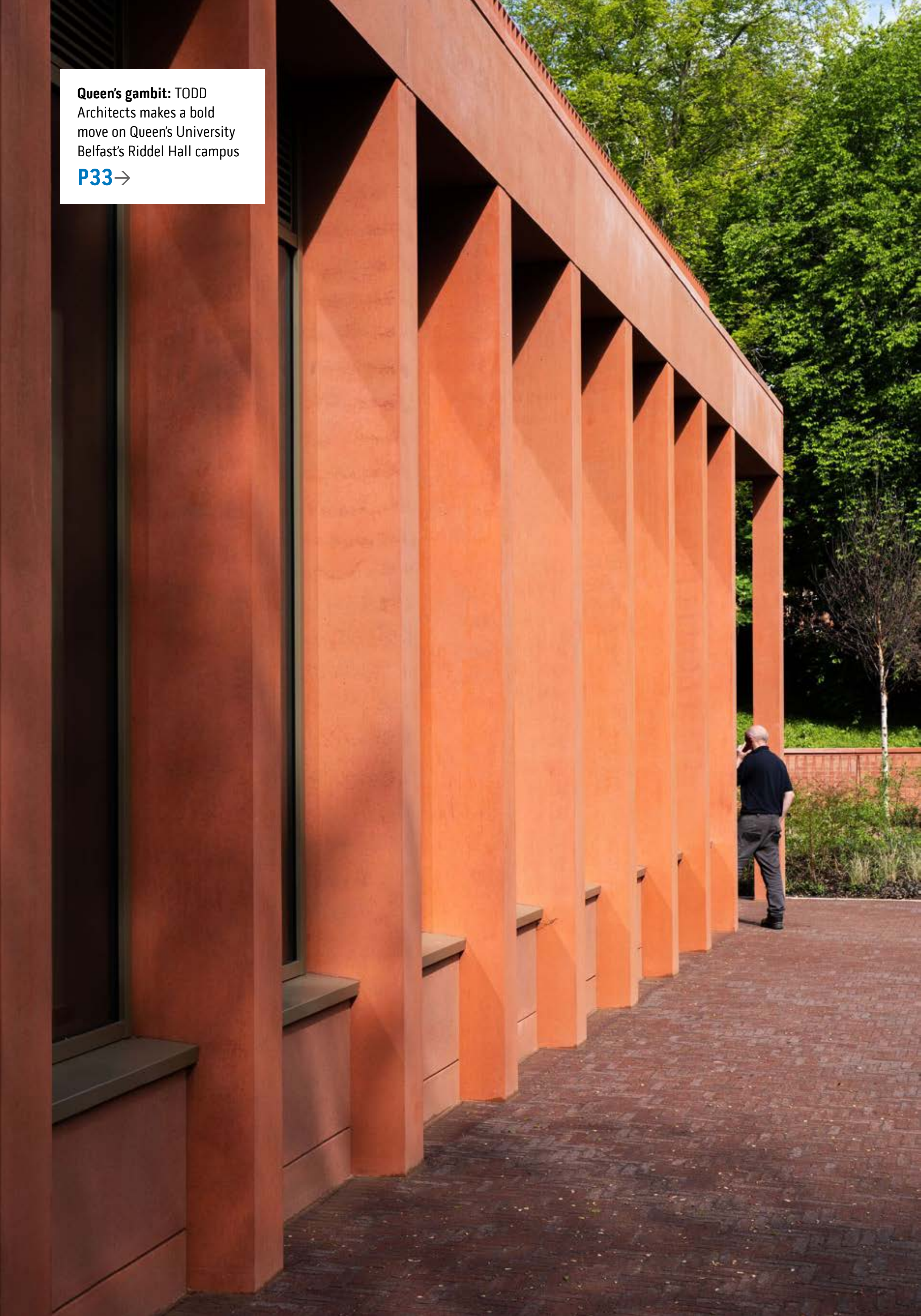

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CASTING OFF

INSPIRATION

APPLICATION

Elaine Toogood
Director, architecture and sustainable design, The Concrete Centre

Bigger, better data

“What’s the embodied carbon?” That’s a very important question for specifiers to ask about building materials and products – even if it’s far from a simple one to answer. Producing an environmental product declaration (EPD), for example, involves exploring a spider’s web of supply chain connections, investigating travel distances and energy sources all along the way. As another illustration of this complexity, just look at the 2nd edition of the RICS Whole life carbon assessment, which has just come into force – 220 pages, compared to just 41 for the 1st edition published back in 2015.

There will always be assumptions involved in any calculation of the embodied carbon of a material or product – and therefore of a building. So it’s equally important that specifiers have some understanding of how carbon calculations are put together, in order to obtain an answer that is meaningful and comparable.

The good news is that there are a lot of people hard at work in this space. The updated RICS guidance aims to provide a structure to support more informed and comparable data, while the new tool from the Future Homes Hub makes it easier for housebuilders to measure carbon in a consistent way. Work is also under way to expand the amount of carbon data available, including a range of EPDs, at both an industry average level and for individual products (page 34).

It’s fantastic that specifiers and clients are asking for this data – the first step to managing anything is to measure it. But the next is to ensure they understand how to use the data appropriately.

Location is a big factor, especially for a product like concrete, which is overwhelmingly local and seldom imported – around 92% of the concrete used in the UK is produced here, from locally sourced materials. So while the international manufacturer-specific EPDs held in many carbon databases would seem to give the most accurate measurement of as-built environmental impact, this is not necessarily the case. UK sector EPDs, produced by pooling data from a number of manufacturers, may better reflect the latest local progress in decarbonisation. These collective EPDs are also really useful for early-stage design decisions, and can be considered a benchmark for what is achievable.

> THE FIRST STEP TO MANAGING ANYTHING IS TO MEASURE IT. BUT THE NEXT IS TO ENSURE WE UNDERSTAND HOW TO USE THE DATA APPROPRIATELY

Guidance will likely continue to evolve with the more we measure and understand embodied carbon. Default wastage rates are another good example. Historically, the accepted wastage rate for concrete blocks was 20%, so if 100 were delivered to site, it was assumed that only 80 would be used. But when the MPA commissioned research to produce more up-to-date figures, we found that on today's sites, the actual rate was closer to 5%.

All of this highlights that, while we all have learning to do, the industry is progressing all the time. Greater understanding will lead to greater clarity – and, ultimately, greater impact in terms of carbon reduction. ■

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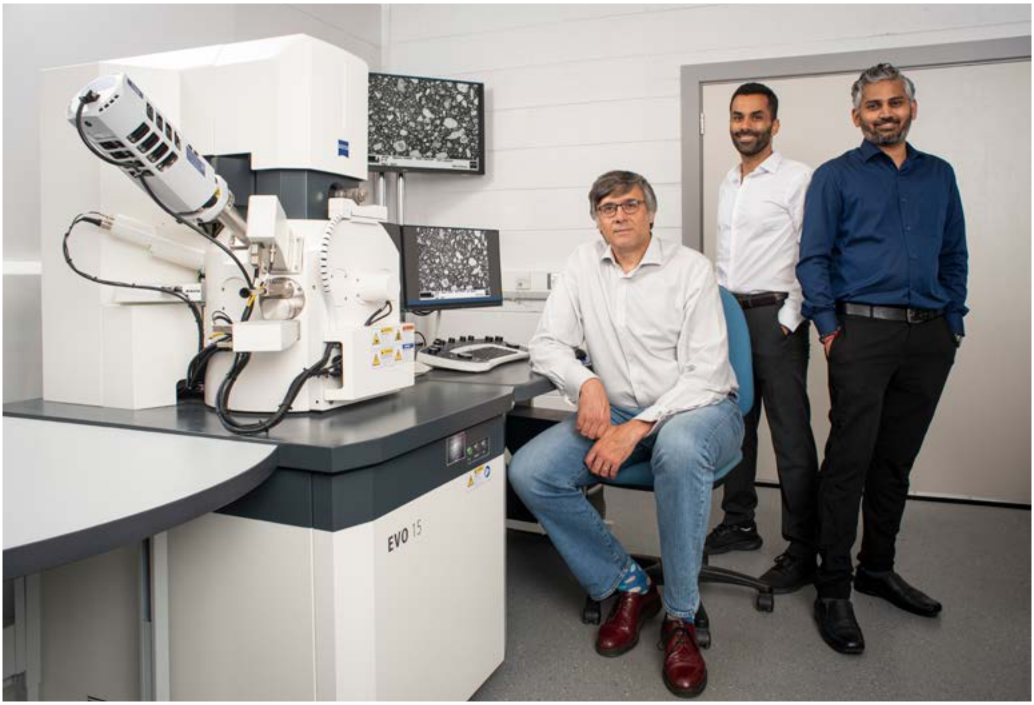


Photos: Paul Burroughs

INNOVATION

EUREKA PROJECT

THE UK HAS AN ABUNDANT SUPPLY OF CLAYS, AND SOME OF THEM COULD BE A LOW-CARBON REPLACEMENT FOR PORTLAND CEMENT. A JOINT RESEARCH PROJECT IS IDENTIFYING THE MOST PROMISING CANDIDATES, AND HOW BEST TO USE THEM

ABOVE
(Left to right) Professor Leon Black, and postdoctoral researchers Hisham Hafez and Yuvaraj Dhandapani, view a sample of calcined clay powder through an electron microscope to understand its structure and composition

Supplementary cementitious materials (SCMs) such as fly ash and GGBS are now widely used to decrease the amounts of cement used in concrete and so significantly reduce its carbon content. GGBS in particular is frequently used on major projects, usually replacing between 20-50% of cement, but as much as 95% for specialist applications.

Their time is limited, however, as Professor Leon Black of Leeds University explains: "Fly ash is a by-product of coal-fired electricity generation, and GGBS is from steel manufacture. With the decarbonisation of electricity, and UK steel manufacture shifting to electric steel recycling furnaces, these materials will become increasingly

LEFT
Samples of conventional grey-toned concrete with samples of concrete made using calcined clays, fresh from the curing room. The cubes are used to test compressive strength; the cylindrical blocks to test durability

THERE ARE HARDLY ANY DIRECT CARBON EMISSIONS FROM HEATING CLAY. YOU END UP WITH AN SCM WITH A CARBON FOOTPRINT ROUGHLY HALF THAT OF PORTLAND CEMENT

scarce here, so we are going to need other options."

Working with Professor Hong Wong at Imperial College London, Clive Mitchell at the British Geological Survey (BGS) and others (see page 9), Black is part of a team researching the extent to which UK clays can be processed and used as alternative SCMs. Their work is funded by the EPSRC, and known as the Eureka Project.

"Engineers have long used metakaolin clay as an SCM. It produces high-end, chloride-resistant concrete," says Black. "But it mainly comes from china clay, which is expensive and has other uses. So we want to establish what role lower-grade clays might have."

These naturally vary in composition, so a team led by BGS is helping to map the distribution of clays that might be suitable. "This is vital knowledge," says Black. "A lot of clay is excavated – to build roads or railways, for example. But if we know its composition, it may be usable as an SCM rather than simply landscaping."

BGS, with help from Leeds and Imperial, has already analysed some 60 clays from around the UK and is focusing on a dozen with promising characteristics. "Clay needs to be heated to around 800°C to become calcined and reactive enough to work as an SCM," says Black. "There

Photo: HS2

ABOVE
The Eureka Project is analysing the performance characteristics of clay samples along the route of HS2 from London to Birmingham, to maximise the potential use of excavation waste as a local cement substitute

is a carbon cost to this, but the temperatures are much lower than the 1,450°C needed to make cement from limestone. And, unlike limestone, there are hardly any direct carbon emissions from heating clay. You end up with an SCM with a carbon footprint roughly half that of Portland cement."

If heating clay makes it reactive, why not simply use waste bricks or tiles that have already been fired? "It's sometimes possible, but if the material is from demolition, the composition of the clays may not be consistent enough to be reliable. In addition, not all clay products will contain sufficient kaolin, and the firing process is not optimised for SCMs."

As well as identifying where in the UK suitable clays can be found, Eureka is also fine-tuning how best to use them. "After heating, the clay is milled to a fine powder," says Black. "It can cause flow issues in concrete so we are working with additives suppliers to understand how to overcome that. We expect that calcined clay SCMs can comfortably replace 20-30% of cement, but we are looking at how we might be able to increase that figure while maximising concrete performance – perhaps by blending with materials such as limestone."

"Characteristics vary, and of course certain sources are much more useful," adds postdoctoral researcher Yuvaraj Dhandapani. "But we're trying to tackle all the resources – we're looking at how to process the least promising sources too, in the most efficient way, to increase their usability."

Black stresses that Eureka is about more than proving that calcined clay works as an SCM: "It's no use this research staying in the laboratory," he says. "We need to make it usable, and ensure newly developed materials satisfy industry requirements and are adopted as widely as possible to maximise carbon reductions in our built environment. That's why we are working with industry partners right along the supply chain, from those who excavate clay, to cement and concrete suppliers, precast manufacturers and engineers and builders who will use the concrete in their projects."

Laboratory analysis of concrete containing calcined clays suggests that they perform well in terms of setting times, strength and durability. "But we need practical testing to check the clays we're looking at will work well in the real world. By the end of this year, we hope to have our first few tonnes of calcined clay ready for testing by industry." ■

Interview by Tony Whitehead

ABOVE
The colour of calcined clay concrete varies from white to red, depending on its iron content. It is also possible to obtain a more traditional grey colour by adjusting the calcining process

PROJECT TEAM
Imperial College London Prof Hong Wong, Prof Chris Cheeseman, Prof Rupert J Myers, Dr Xiaodi Dai, Dr Anusha Basavaraj
University of Leeds Prof Leon Black, Prof Susan A Bernal, Dr Yuvaraj Dhandapani, Dr Ilda Tole, Dr Hisham Hafez, Dr Alastair Marsh
British Geological Survey Dr Clive Mitchell, Dr Simon Kemp, Dr Evi Petavratzi

LASTING IMPRESSION

JUDE HARRIS

THE JESTICO + WHILES DIRECTOR EXPLORES THE MORE AFFABLE SIDE OF BRUTALISM, FROM TEENAGE LUNCHES IN ABERYSTWYTH TO CAMBRIDGE'S ORIGINAL COWORKING HUB

The Welsh architect Dale Owen probably had a strong subconscious influence on my choice of career. I went to school just up the hill from Aberystwyth Arts Centre on the university campus, which Owen designed for the Percy Thomas Partnership. My sixth-form years were spent sneaking in there for lunch every day. The centre exploits its sloping site to present a very dramatic entrance facade, with amazing picture windows that look out over the roofscape of the town towards the sea. The hard landscaped entrance terrace offers equally stunning views. There are a lot of brutalist features, such as boardmarked concrete and bold geometric forms, and a sculptural bell tower, which made it feel very modern to me. The building has been updated and added to, but Owen's Great Hall remains the centrepiece.

It's very difficult to use concrete in such a crafted way while meeting current energy requirements, which is one reason why it's so important to preserve the brutalist buildings we have. They're already moments in time. Another example I've come

Photo: RIBA Collections

ABOVE
Aberystwyth Arts Centre by Percy Thomas Partnership, 1970-72

to know well is the University Centre in Cambridge by Howell Killick Partidge & Amis (HKPA). Jestico + Whiles is doing a feasibility study there, drawing on our work on the West Cambridge campus, where we are building the Ray Dolby Centre for the Cavendish Laboratory, and recently completed the West Hub – the university's first publicly open coworking space (CQ 280).

In many ways, the University Centre was a precursor to the West Hub. It provided a meeting place for people who weren't attached to colleges, such as research students and non-academic staff. There's a dining hall, a roof terrace – which we hope to re-open – and common rooms. Early photos show studious men looking out over the river while they lounge around smoking pipes.

It's a brutalist building but with a softness to it. The scale and materials are very human: the doors are timber, the stairs are finished in lead, and it has a beautiful exposed structural frame of chamfered beams and precast concrete "trees". The cladding is very expressive, and quite ahead of its time. It's Portland stone but with a porous, travertine-like texture. A grid of steel bolts clearly shows how the rainscreen cladding is fixed to the frame behind.

It will be a challenge to update to modern energy-efficiency standards – behind the stone panels there's just 25mm of insulation. But it's an extremely well-conceived building. We should treat it with the respect it deserves, while exploring how best to decarbonise it. ■

Jude Harris is a director of Jestico + Whiles

Photos: John Donat / RIBA Collections

ABOVE
University Centre, Cambridge by HKPA, 1963-67

From the archive: Winter 1971

A BRUTALIST'S BANQUET

Few architects left their mark on 1960s and 70s Oxbridge quite as indelibly as Howell, Killick, Partridge and Amis, the practice behind the University Centre in Cambridge (see previous page). In winter 1971, HKPA partner John Partridge shared with Concrete Quarterly the thinking behind one of its most celebrated projects, the Hilda Besse Building in Oxford, now grade II-listed.

This new dining hall for St Antony's College was built at around the same time as the University Centre and shared many of the same characteristics: expressed precast cladding, a dramatic roof structure over the dining area, and framed views over green space. It also wrestled with the same tensions, needing to sit within its rarefied historic context, but without "such philosophic considerations" in any way impairing the modern quest for efficiency in its day-to-day workings.

The galleried dining hall itself, which rose through the building's first and second storeys, aimed to "get the best of both worlds", Partridge explained. "Most traditional dining halls are characterised by their lack of windows, apart, that is, from clerestorey or rooflighting. They are based on medieval halls and they evoke the corporate qualities of more protected inward-looking groups. At St Antony's we set out … to design a hall that was both outward and inward looking. This meant that the view windows had to be designed so that they did not lessen the impact and strength of the walls enclosing the space."

The "splay-sided" projected concrete windows were intended to "contain" the views of the college gardens and "cut off the space so that there is no sense of the flow of landscape outside". But the faceted frames could be lit at night from outside so that the view never became dead.

The play of structure and light is a constant theme. The main hall was illuminated from within each square of the diagonal roof grid, with "pools of light thrown down to table top level". And, much like the University Centre, the cladding was set forward of the precast frame, clearly emphasising the functional distinction and, at night, allowing light to gently seep through at the seams.

St Antony's College Oxford

New hall and common-room

Architects: Howell, Killick, Partridge and Amis
Consulting engineers: Harris and Sutherland
General contractor: Norman Collisson Contractors Limited
Precast cladding units: Trent Concrete Limited

Photos: Fionn McCann

ORIGIN STORY

CHURCH OF OAK DISTILLERY

DAVID O'SHEA REVIVES A COUNTY KILDARE WHISKEY DISTILLERY WITH A FINE BLEND OF NEW AND HISTORIC BUILDINGS – AND AN ADDED SHOT OF 'ANDO' CONCRETE

There has been a distillery on the Grand Canal in Monasterevan for more than 200 years. The listed mill dates from the late 18th century, and a collection of other buildings, including a malthouse, store and furnaces, have been added over the years. But no whiskey had been made there for nearly a century and the site had been vacant since the 1990s. Our client wanted to revive the facility as a working distillery and visitor experience, while also celebrating this industrial heritage.

From the start, reusing the existing structures was central to the design. The more we dug into the fabric of the site, the more stories it revealed. Our planning consultant was brought up in a house down the road, and his dad

↓

actually remembered when some of the later additions were built. He would walk us around the site, tell us what had happened where, and even brought old photographs to some of the pre-planning meetings. It began to change from a collection of buildings into a series of episodes, and we didn't want to whitewash that history.

But at the same time, our client wanted the distillery to be of its time: contemporary and iconic. The planners were keen for there to be a distinction between the old and new elements, so we decided that all of our interventions – the cafe, the reception, the roofs and the walkways – should be in concrete or Cor-Ten steel. The clearest example is the new roof to the malthouse, where the truncated pyramidal forms contrast with the milky lime render of the restored structure below. But the play between old and new works in more subtle ways too. Where we've left ghosts of the original windows across the facade, these are in fair-faced concrete rather than render, reflecting the fact that these abstract voids are essentially a new element.

The new-build structures include walkways around the malthouse and a single-storey extension of circular concrete spaces beneath oculus rooflights framing views of the grain silos. The aesthetic is industrial, but very much modern-industrial. The floors are polished concrete and the walls are defined by very calm, fair-faced concrete, with chamfered edges and shadow gaps. We expressed the bolt holes

ABOVE
The curving walls of the new reception area were designed to be "Andoesque" with a grid of expressed bolt holes

LEFT
The malthouse's internal concrete floors have been removed to make space for copper stills, mash tuns and other equipment

and positioned them quite close together, which makes the space feel bigger. It's part of what the client, a designer himself, referred to as "Ando" concrete. He had actually worked with the great man himself on a previous project.

There's also a new service building at the front of the site, which we used as a kind of testing facility, trialling concrete finishes from heavily aggregated to power-washed to sandblasted to boardmarked. We explored using more of a reddish tone, either through the aggregate, pigment or staining, which would have echoed the steel finishes. Some of this experimentation found its way into the exposed slabs of the public spaces, which are sandblasted and feel a bit more unfinished than the Ando walls.

Most of the construction took place during Covid, and you can see some staining on the soffits from the timber shuttering, which had to stay in place through a long winter lockdown. We feared that we might have to recast the slab, but the client said we should leave it as a memento of this part of the distillery's life. It's like a date stamp – in 100 years it will be another episode that you can read in the building fabric. ■

David O'Shea is founder and creative director of Office of David O'Shea. Interview by Nick Jones

ABOVE AND RIGHT
Another "Ando" element is the overhanging walkway in front of the restored malthouse

Photos: Simon Menges

MADE TO MEASURE

Allies and Morrison's London School of Fashion cuts a fine figure on the East Bank development, with barely a stitch of concrete out of place, writes Tony Whitehead

ABOVE
The 15-storey building sits between the V&A East, BBC Music and Sadler's Wells East on the East Bank development

Not many buildings start with an in-situ concrete structure on the lower floors and switch to precast higher up – but there's very little that's off-the-peg about the new London College of Fashion (LCF). This is highly bespoke structural tailoring, pieced together with exactly as many types of concrete component as it needs.

IT'S ABOUT USING A PALLET OF MATERIALS WHERE THEY ARE MOST APPROPRIATE. IT'S A REAL SMORGASBORD OF TECHNIQUES

ABOVE
The precast cladding consists of 900 single-skin, grit-blasted panels with horizontal patterning

Its hybrid structure is quite fascinating, featuring both post-tensioned in-situ concrete floor slabs, and pre-tensioned precast ones. It has precast cladding, and a spectacular in-situ concrete curving staircase (see box, page 28). Here and there are steel-encased-in-concrete columns (and beams), while some of the lower levels contain massive reinforced concrete transfer structures that would be more at home in a bridge. On the tenth floor, we find in-situ-filled precast shell beams.

"It's about using a pallet of materials where they are most appropriate," says Emily McDonald, project principal with engineer Buro Happold. "It's a real smorgasbord of techniques and we're using this wide range of off-the-shelf components. But I love that it doesn't read like that at all. It reads like the whole that it is."

ABOVE
The open-plan area at the heart of the building includes design studios for visual merchandising and communication

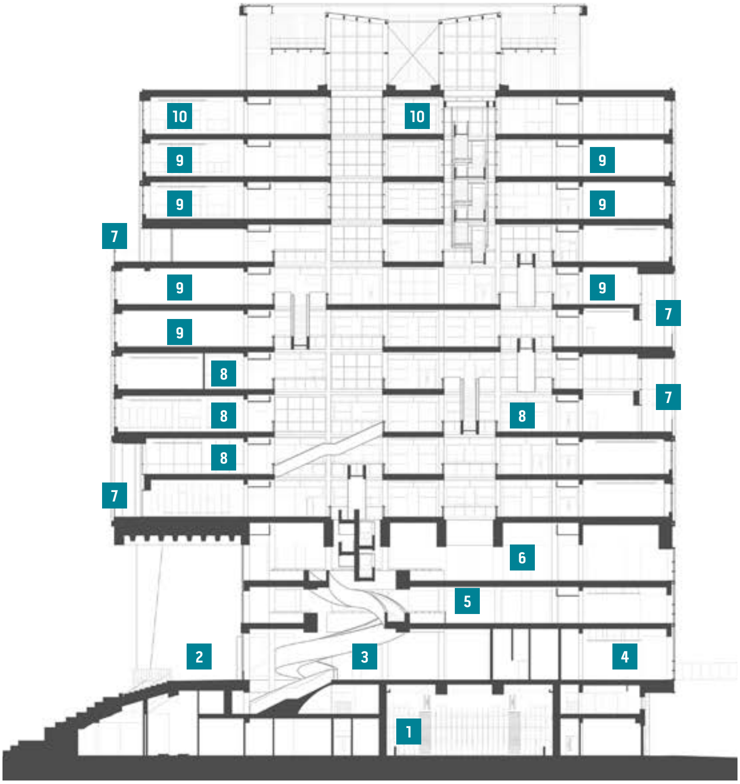
It is important that it does because, architecturally, the LCF has competition. It is just a short walk from the concrete swirls of the Zaha Hadid-designed Olympic Aquatic Centre (CQ 241) and sits between three other notable new buildings: the V&A East, BBC Music and Sadler's Wells East. All four are part of the Stratford Waterfront East Bank, a new cultural quarter rising across the river from the former Olympic stadium.

The 36,000m^2 LCF easily holds its own in this company. At 15 storeys, it is the tallest, and its precast-clad exterior presents a confident industrial aesthetic which, if hardly unusual these days, is deployed here with a very considered rationale.

The LCF comprises a number of schools that have developed over time in different locations, and this building brings them all together for the first time, explains Alex Wraight, partner with architect Allies and Morrison. "We visited the existing sites expecting to find art-school chaos, but we discovered fashion isn't like that," he says. "It was more cutting tables and serried ranks of

SECTION

1. Lecture theatre
2. Entrance colonnade
3. Public foyer
4. Exhibition space
5. Learning commons
6. Library
7. Terraces
8. Design studios
9. Specialist studios
10. Offices



sewing machines. There was a lot of making and producing going on, more like a factory. So the new LCF has something of the textile mill about it."

The building is styled this way for practical reasons too. "The client wanted a 100-year-plus lifespan, and it has to be able to adapt and easily accommodate different fit-out scenarios to stay relevant and useful. So, like a mill, we have high ceilings, plenty of natural light, and a structure that allows large areas of free space to be organised or compartmentalised in different ways."

ABOVE
The LCF's new home provides more than 40,000m^2 of space for 5,000 students, spread across 17 storeys

ABOVE
In a restrained palette, the exposed concrete frame is contrasted with maple wood and black metal

This requirement for flexibility, says Wraight, was key in the decision to use concrete: "A steel frame with linings would be much more complicated to take apart and reconfigure than the exposed concrete 'structure as finish' approach we've taken here. And of course this also cuts the costs and carbon content associated with linings."

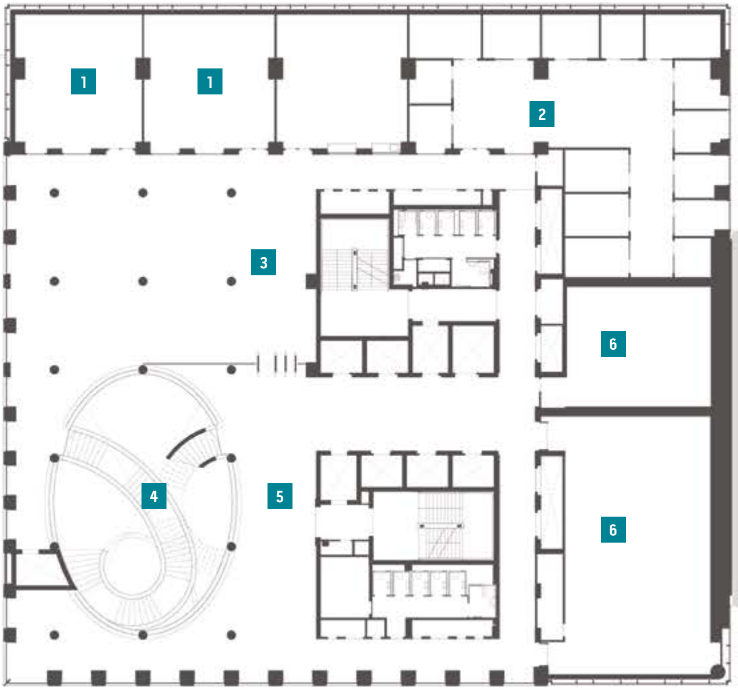
Other advantages offered by concrete include the ability of the exposed frame to conserve or absorb heat: "That helps lower heating and cooling costs over the entire life of the building."

Concrete is also tough, he adds: "You need that in a building accommodating 6,000 students. You can see from the way university buildings of the 1960s have aged that concrete just gets better and develops character over time. It's got soul."

The LCF's massive cuboid proportions certainly have a mill-like aesthetic, subtly accentuated by detailing. Its precast cladding consists of 900 single-skin, grit-blasted panels covering 11,323m^2, the texture of which has been likened to needlecord. "We opted for horizontal

FIRST-FLOOR PLAN

1 Project space
2 Student services
3 Makers' square
4 Staircase
5 Learning commons
6 Seminar space



ABOVE
A makers' square and learning commons occupy the "heart space" on the first floor. This is framed by 46 rectangular columns, 1m x 0.6m, with a 6m grid of slimmer columns in areas where clear soffits are not required

patterning for these vertical elements, to suggest the warp and weft of fabric," says Wraight. "The pattern edge is visible from the inside, where the brick-sized scallops give a human-scale interest, but it also registers from 500m away."

But why the plethora of concrete types? Having started off in-situ, would it not have made sense to continue? Ellie Moore, senior structural engineer with Buro Happold, explains how the building is arranged in zones, with different construction techniques being deployed to meet the requirements of each.

"The building sits on 250 piles, 750-900mm in diameter and between 20-25m deep. The first four levels contain more special, bespoke spaces, including the entrance areas and the curving concrete staircase which rises from basement level to the fourth floor – so it made sense to construct all these from in-situ concrete to achieve the monolithic character that the architect wanted."

ABOVE
The showcase spiral stair case leads from the public foyer to the library. In keeping with the monolithic nature of the lower storeys, it has been cast in situ

But above level four, the floor plates become more repetitive: "The precast approach, with its ability to reuse moulds and produce identical elements, made it simple to replicate the structure. That helped with programme efficiency too, which was vital as the LCF is the largest building on the waterfront and was very much on the critical path for the whole East Bank development."

The in-situ floor slabs on the lower levels are post-tensioned to help lengthen spans where required, while retaining a relatively light 300mm depth: "This saves the carbon cost of thicker concrete and reduces the loading on the whole building, so saving on foundations too," says Moore. "Further carbon reductions have been made by using a 50% GGBS mix in the foundations and between 30-40% in the superstructure where setting times were more critical to the programme."

The LCF's column structure is quite unusual, again reflecting the structural needs of the different zones. While the footprint is almost 60m x 60m, the square centre of the building, known as the heart space, is a 36 x 36m area where both air and people can circulate, containing lifts, bathrooms and risers for the services. It is constructed and defined by 46 rectangular columns, 1m x 0.6m. Connected at each level by a 750mm-deep ring beam, these lend the building stiffness and stability. Within sections of the heart space is a 6m grid of slimmer columns to allow lightweight spans where clear soffits are not required.

ABOVE
Adaptable workspaces are located around the perimeter of the floorplate. They vary in depth of plan, and are capable of future reconfiguration without impacting the building's organisational diagram

ABOVE
The lower ground floor contains a public foyer and exhibition space, and leads out onto the waterfront

Outside of the heart space's inner square are the workshop and studio areas. These are created by spanning out from the rectangular columns to the perimeter. Each of the four sides has a different span (9m, 10.5m 12.9m and 13.5m) resulting in spaces that suit various activities. "It was important they had clear soffits to help them remain flexible," says Moore. "Given the spans, the most efficient way to achieve that structurally was with pre-tensioned precast hollowcore planks."

More normally seen in car parks, the hollowcore slabs proved a light, inexpensive solution that also helped facilitate the rapid programme. At the perimeter, these rest on a ring beam supported every 3m by thermally broken columns that are trapezoidal in section. The cladding hangs off the exterior face, which is wider than the inside – 1m compared to just 600mm. "The shape creates natural shading to limit solar gain, then inside, we have used the 1m depth of the columns to create deep window reveals," says Wraight.

ABOVE
Full-height glazing, set within 1m-deep window reveals, looks out over the London Stadium on the opposite bank of the Waterworks River

This feature was inspired by similarly deep reveals at one of the LCF's existing premises. "We saw how useful they were," he says. "You can sit and chat, sew in natural light, hang fabric up to dry – they were really well used, so we've imported the idea to the new building with window seats between the perimeter beams."

Such user-friendly details maintain a human scale amid some pretty sizeable chunks of concrete – such as the shell beams at level ten. Moore explains that these were needed because the building steps in at this level: "The shell beams are transferring loading from columns above. In this location, the architectural intent was for the soffit of the beams to be precast to achieve the same finish as precast slabs. But these beams are 14m long and 1m deep, and solid precast beams that size would have exceeded our crane's lifting limit of 10 tonnes."

Buro Happold's ingenious solution was to use precast shell beams, which are hollow U-shapes in section: "These were light enough to be lifted into place and then they were filled with reinforced in-situ concrete to achieve the required strength."

Even larger transfer structures in the in-situ part of the building could be more traditionally constructed. One, spanning over the basement-level auditorium, is 2.8m deep to enable it to support the loading of the 14 floors above.

The impressive colonnade at the front of the LCF is another example of how the engineers have used a multi-component approach to achieve an impressively integrated aesthetic. The columns are 15m high and trapezoidal in section and slimmer at the base than the top. "They bear the weight of the building above so have to be very strong," says Moore. "They are 1.5m deep at the base but 2.75m at the top, and each is constructed from steel `I`-sections which were erected first, a bit like a vertical truss. This then had reinforcement attached before adding the concrete, poured in several sections."

The five columns are each connected to the building by beams made from more steel sections

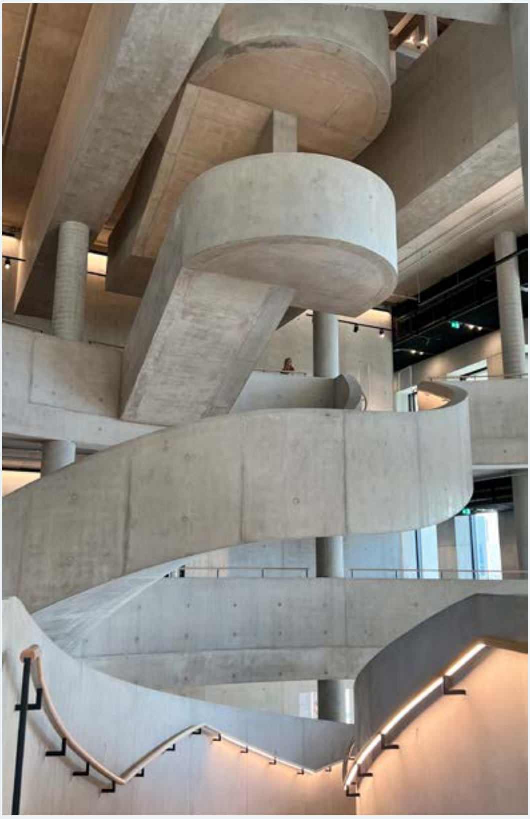


Photo: Tony Lall-Chopra

Concrete on the catwalk

The LCF's spectacular curving concrete staircase rises from its basement level to the fourth floor and is the stand-out feature of the building's interior. "It's designed as an invitation, an unfurling, experiential journey," says Alex Wraight, partner with Allies and Morrison. "As the sculptural focus, it represents quite an investment – but it was never on the value-engineering list."

The without-compromise approach has paid off: "It's brilliant to see the students using it as a catwalk and featuring it along with their designs encased in reinforced concrete. Spanning between these beams to make the ceiling of the colonnade are the same kind of pre-tensioned hollow-core precast planks used within the upper floors of the building interior.

The LCF exceeds the London Legacy Development Corporation's target of reducing embodied carbon (compared to Stage 2 baseline) by 15%, and has also achieved BREEAM Outstanding – facts that Wraight believes might surprise some. "Questions have been raised about the embodied carbon content, but with the structural approaches we have taken, together with the use of GGBS, we have been able to reduce that quite a bit."

Perhaps more importantly, he adds, it really does matter how well the building will last – both physically and in terms of its usability. This mirrors a broader sea-change in the fashion industry, which is turning against cheap, wear-and-throw-away "fast fashion". "The LCF itself champions the idea of slow fashion – that it is better, environmentally, to invest in long-lasting materials and designs to create clothes that will last," says Wraight. "The new LCF is just that: slow fashion." ■

PROJECT TEAM

Architect Allies and Morrison
Structural engineer Buro Happold
Concrete contractor Expanded
Precast cladding Techrete
Specialist formwork 3D Pattern and Mould Makers

on Instagram," he says. "Yes, there are less carbon-intensive ways of getting from one floor to another – but this adds so much to the experience of the building and will really last. A steel and timber staircase would need more maintenance and possible replacement after a couple of decades."

The stair was designed on Revit, but with the help of Enscape: "It's essentially a game engine that allows you to virtually walk around your model. But the result is really testimony to the craftsmen who made it. As you can imagine, the formwork was extraordinary."

Paul Greaves, director of bespoke formwork specialist 3D Pattern and Mould Makers, explains how it was done: "First of all we 3D-printed some small models of the stairs so we could think about how best to proceed. In the end, the formwork for each staircase was made in sections or pods. One of the flights, for example, had 13 pods. So we would complete the first three pods and check the assembly and fit in our factory before sending off pods one and two. We would then make pods four and five before delivering pods three and four. That way we could be sure the fit was always perfect, all the way up."

The staging and framework for each pod was CNC cut and assembled before the curving moulds for the balustrades were formed from top-grade birch-faced plywood. "We used 6mm ply as it was thin enough to bend, but three layers of it – so 18mm in total – to achieve the strength needed for the weight of concrete."

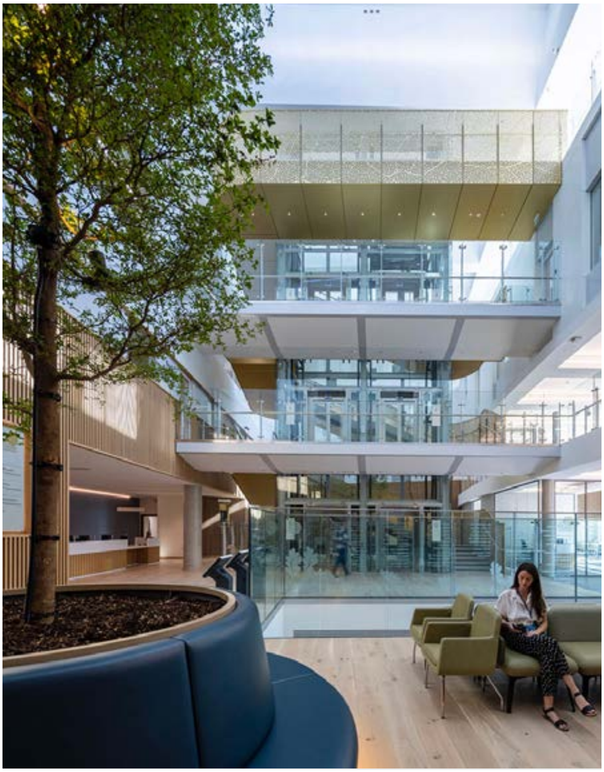
The soffits were mostly formed in a similar fashion, adds Greaves: "Though where the curve radius was particularly tight, CNC-machined MDF was used to achieve the correct gradient and curvature."

Once assembled on site, Expanded would pour the balustrades first and then remove the inner formwork before pouring the soffit. The steps were created later by fixing new formwork to the struck concrete and pouring a few steps at a time.

IN SAFE HANDS

Photos: Nick Caville/BDP

The BDP-designed £50m Oak Cancer Centre at the Royal Marsden Hospital does pretty much everything you could ask it to. Across six storeys, it hosts a rapid diagnostic centre, with mammography and endoscopy suites, an advanced treatment area including 63 chemotherapy bays, a pharmacy, consulting rooms, and – right in the heart of the building – a centre for advanced research.



The wide-ranging programme is underpinned by a reinforced-concrete frame, which is both very efficient and very hardworking. Slabs are 300mm deep and support a grid of 7.5m x 7.5m. "We try to set up as regular a grid as possible to embed future flexibility," says project architect Peter Ruffell. "You have to find a balance that works with the often conflicting needs of the programme on each floor."

Structural engineer Campbell Reith has calculated that its lean design approach reduced the total amount of reinforcement by an estimated 66 tonnes, saving 55 tonnes of CO_2e. The embodied carbon of the superstructure was 165kgCO_2e/m^2 – beating the RIBA's 2025 baseline.

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CURTAIN RAISER

Cosway Street is a 49-home development in Marylebone, central London, distinguished by a curtain-like precast facade that ripples down the length of the building.

"The idea was to craft the building as if it had been carved from brick," says Rachel Stevenson, senior architect at David Miller Architects, which delivered the scheme from an initial design by Bell Phillips. "However, the fluting means there are a lot of 'corners' and 'seams', so we opted for precast panels to ensure control over quality and a consistency of finish and details."

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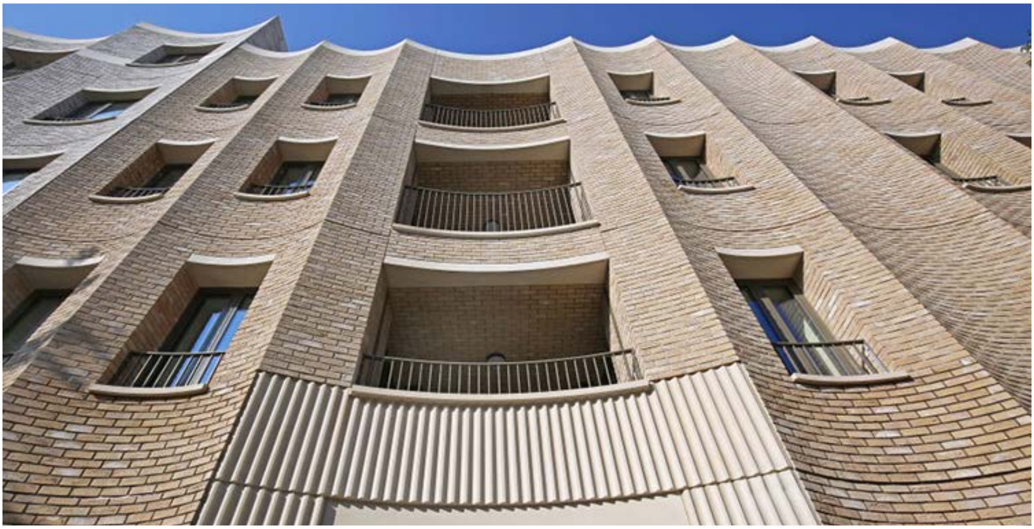

Photos: Agnese Sanvito

Photos: Donal McCann

RED QUEEN

TODD Architects has added a red-hued business school to the grade II-listed Riddel Hall campus at Queen's University Belfast. The three-storey building announces itself as a colonnaded pavilion of brick and precast concrete, with its full form only revealed as the site slopes down into woodland.

Internally, boardmarked concrete, created using a rubber formliner on steel formwork, echoes the surrounding trees.

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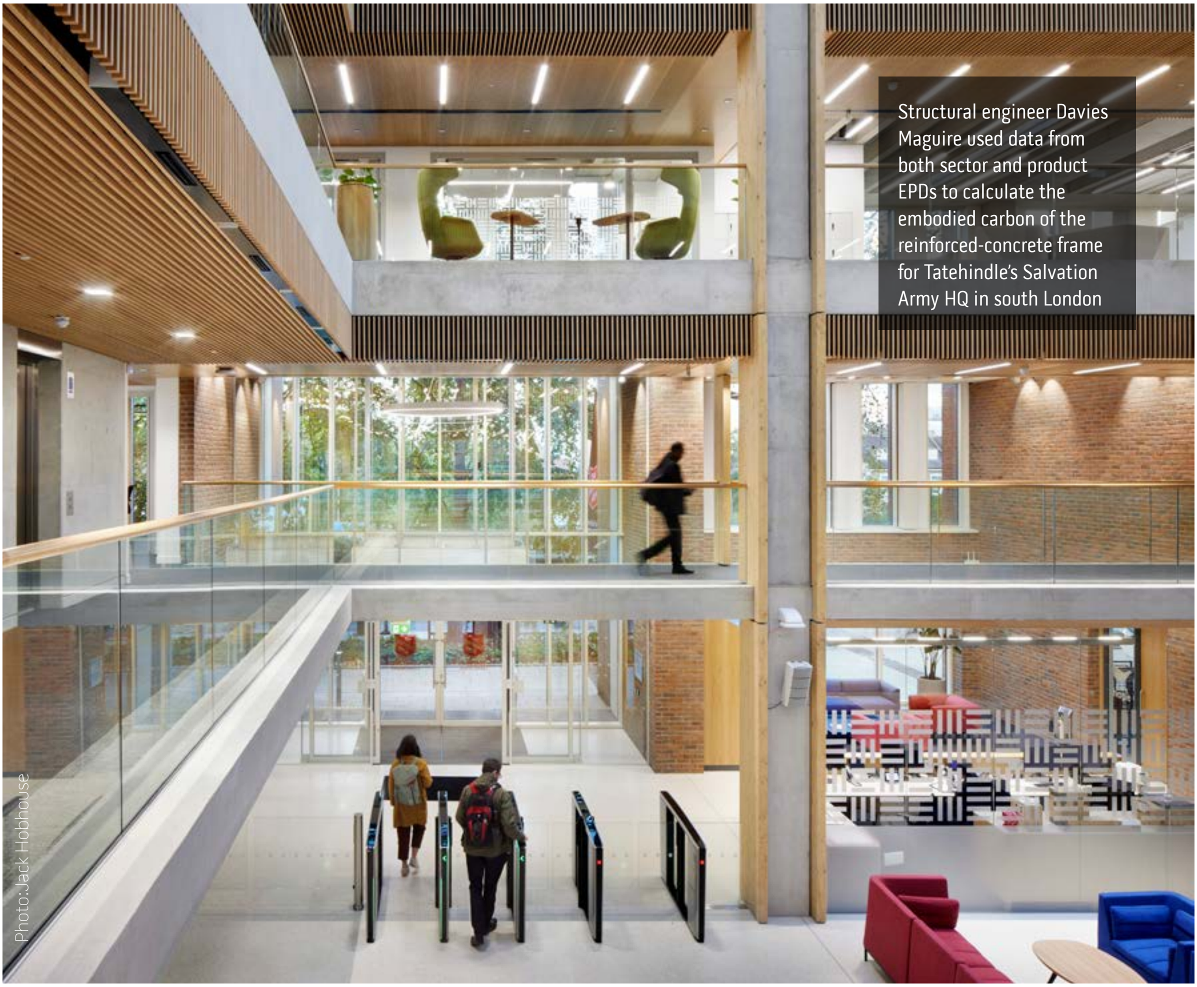

Structural engineer Davies Maguire used data from both sector and product EPDs to calculate the embodied carbon of the reinforced-concrete frame for Tatehindle's Salvation Army HQ in south London

Photo: Jack Hobhouse

Environmental product declarations for concrete

As the MPA releases a new suite of sector EPDs for ready-mixed concrete, Rachel Capon explains why these documents are becoming increasingly important and how designers can best use them to inform early-stage decisions

Environmental product declarations, or EPDs, provide transparent data on construction products to help designers choose building materials with lower environmental impacts. To ensure comparability across different products, the methodology to be used is set out by international standards such as the European standard for EPDs, EN 15804, and the complementary product category rules for concrete, EN 16757.

An EPD is based on a life cycle assessment (LCA) over the full product value chain using indicators for climate change and other environmental impacts, as well as resource use. For each indicator, the construction product life cycle is broken down into stages and sub-stages: material extraction, manufacturing and construction (modules A1-5); use (B1-7); end of life of the building (C1-4); and finally, recovery and reuse (D). The assessment and resulting EPD data must be independently verified by an accredited third-party.

EPDs are referenced in project-level carbon tools and assessments, such as the RICS Whole life carbon assessment (WLCA) standard, and the Future Homes Hub's Whole Life Carbon Conventions. They are increasingly required to achieve green building certifications, and to drive lower-carbon public procurement.

Different kinds of EPD

The most accurate measure of as-built environmental impact is given by a manufacturer-specific EPD for production of a specific product or material at the plant from which it is supplied. However, this level of detail is not always available. As an alternative, manufacturers may average data for a specific product over a number of their plants. They can also average data for different products produced at one or more plants to create an "average EPD".

Multiple manufacturers can pool their data to create a "collective EPD". Where a sector association, such as the Mineral Products Association (MPA), aggregates data from its members to create a collective EPD, this is known as a "sector EPD".

Sector EPDs have multiple benefits and uses. They set an industry baseline that is independently verified. They can be used by designers to inform early-stage design choices, before a specific product or manufacturer has been selected. They enable manufacturers to benchmark the environmental performance of their own products. And concrete manufacturers without their own EPDs, who have provided MPA with appropriate manufacturing data, can reference them for procurement purposes.

Previously, sector association EPDs were often called "generic EPDs", but the guidance and terminology for different EPD and data types used in environmental assessment has recently been updated. The new European data quality standard, EN 15941, says that this label should no longer be used.

Photo: Rob Parrish

ABOVE
Sector EPDs are valuable for early-stage decision-making, but EPDs from manufacturers provide the most accurate measure of as-built environmental impact. London Concrete, which supplied the ready-mixed concrete for AHMM's Tower Hamlets Town Hall, has launched product- and plant-specific EPDs for all of the mixes it produces

Validity of EPDs and standards evolution

All EPDs expire after five years. The underlying methodologies also undergo periodic review. Notably, the European standard for EPDs, EN 15804, was amended in 2019, introducing additional requirements and indicators.

One of the key changes in the new standard is that the global warming potential (GWP) indicator – which measures the climate change impact from greenhouse gas emissions and removals – is broken down into three sub-categories: fossil, biogenic, and land use and land-use change. Another change is that all EPDs – with very limited exceptions – must now cover the whole life cycle of a construction product. Specifically, for construction products containing biomass, this takes account of the CO_2 sequestered during the plant or tree growth and its re-emission to the atmosphere at the end of life.

For cement and concrete products, this also factors in CO_2 removals due to the carbonation of concrete which takes place at end of life, but also during use and, in some cases, even earlier.

MPA sector EPDs for cement

Cement is the essential ingredient in concrete and the main contributor to its GWP. In 2022, MPA published two new

Photo: Tom McNally

sector EPDs for UK manufactured cement: UK average CEM I sector EPD and UK average Portland cement sector EPD, which align with the amended EN 15804 standard. The EPDs are modelled using aggregated data from all MPA member cement production sites and cover 100% of cement produced in the UK. The UK average CEM I sector EPD is a representative CEM I cement delivered in bulk. The gross GWP, based on 2020 manufacturing data, is 839.8kgCO_2e per tonne. This can be used as an input in the calculation of EPDs for concrete mixes.

The representative UK average Portland cement sector EPD includes all UK-produced cement: CEM I and other cements sold in bulk, and bagged cements sold via builders' merchants. It has a gross GWP of 812.3kgCO_2e per tonne, again based on 2020 manufacturing data.

The "gross" value indicates that emissions from combustion of all fossil-based fuels used in the cement kiln – both virgin

ABOVE
The rebuilt Pooley Bridge in the Lake District, designed by Knight Architects. The lower span was built using Heidelberg Material's Regen GGBS concrete, which has a product-specific EPD covering modules A1-A3

fuels and waste-derived fuels – have been included. When comparing EPDs, it is important to note that “net” GWP values (that is, excluding CO_2 emissions from the combustion of waste-derived fuels) will be lower than gross GWP values.

As cement is chemically bound into concrete, and cannot be physically separated, it is one of the few exceptions to the new EN 15804 requirement to assess product impacts over the whole life cycle. Instead, the EPDs only measure the impacts for the manufacturing stage up to when the cement leaves the factory (modules A1-A3). When comparing them with cement EPDs from other countries, it is important to note that in the UK supplementary cementitious materials (SCMs) such as fly ash or GGBS are typically added after the cement has left the factory, at the concrete mixing plant. In mainland Europe, SCMs are often added at the cement plant, so the GWP at the cement factory gate is lower.

MPA sector EPDs for ready-mixed concrete

In 2018, the British Ready-Mixed Concrete Association (BRMCA) published its first EPD for UK manufactured ready-mixed concrete based on the average of all concrete mixes produced by MPA members. In 2024, MPA published five new sector EPDs for ready-mixed concrete, which update the benchmark, but also help designers understand and quantify the impacts of their mix design choices. They represent frequently specified mixes at strength class C28/35, based on representative mix designs for CEM I, CIIB-V+SR, CIIC-SL+SR, CIIIA+SR and CIIIB+SR.

The EPDs cover the whole concrete life cycle: product manufacturing, construction, use, end of life, and recovery and reuse. Technically, this is described as cradle-to-gate, with additional modules A4-A5, B1, C1–C4, and D.

↓

BELOW
The MPA sector EPDs for cement are modelled using aggregated data from all MPA member cement production sites, including Cemex’s plant in Rugby, and cover 100% of cement produced in the UK. The new sector EPDs for ready-mixed concrete are based on this data

Photo: Cemex

Each EPD uses the MPA UK average CEM I sector EPD for the CEM I component. Data for other raw materials (module A1) comes from the widely used Ecoinvent LCA database and verified EPDs. The transport of raw materials (A2), manufacturing of ready-mixed concrete (A3) and its transport to the construction site (A4) are based on data supplied by MPA members, averaged over their production sites. The later life cycle stages assume typical scenarios based on current practice. The construction (A5) and use (B1) stages are based on use of ready-mix concrete in the superstructure of a six-storey concrete frame building. The end-of-life (C) and recovery and reuse (D) stages are based on typical UK practice for demolition, recovery and reuse, as described by the National Federation of Demolition Contractors. This states that all superstructure concrete is recycled at end of life, with 95% being crushed and reused in groundworks on or off-site. Recarbonation of concrete is included in modules B1, C1, C3 and D.

This collection of five EPDs highlights the range of options available to designers to specify lower-carbon concretes, such as the new multi-component cements in BS 8500:2023.

The EPDs are published by EPD International. Machine-readable versions of these and the cement EPDs are available on Eco Platform by searching for "Mineral Products Association" as the EPD owner.

Photo: John Grandorge

ABOVE
Artist Juergen Teller's home and studio in west London by 6a Architects. MPA sector EPDs for three different densities of aggregate blocks and for aerated blocks are to be published later this year

MPA sector EPDs for precast concrete

MPA Precast and MPA Masonry were early adopters of EPDs and published seven, covering a wide range of precast products. These are now being updated. MPA sector EPDs for three different densities of aggregate blocks and for aerated blocks are to be published later this year, followed by EPDs for architectural and structural precast concrete elements and precast flooring.

Rachel Capon is UK concrete sustainability programme coordinator at the Mineral Products Association

FINAL FRAME: KUNSTSILO, NORWAY

Barcelona studios Mestres Wåge Arquitectes, BAX and Mendoza Partida have converted the shell of a 1930s grain silo into the Kunstsilo art gallery, in Kristiansand, Norway. A 21m-high atrium has been carved out of the cylinders, with 250mm-thick inner sleeves of cast concrete added to stabilise the structure.

Photo: Alan Williams