CONCRETE QUARTERLY

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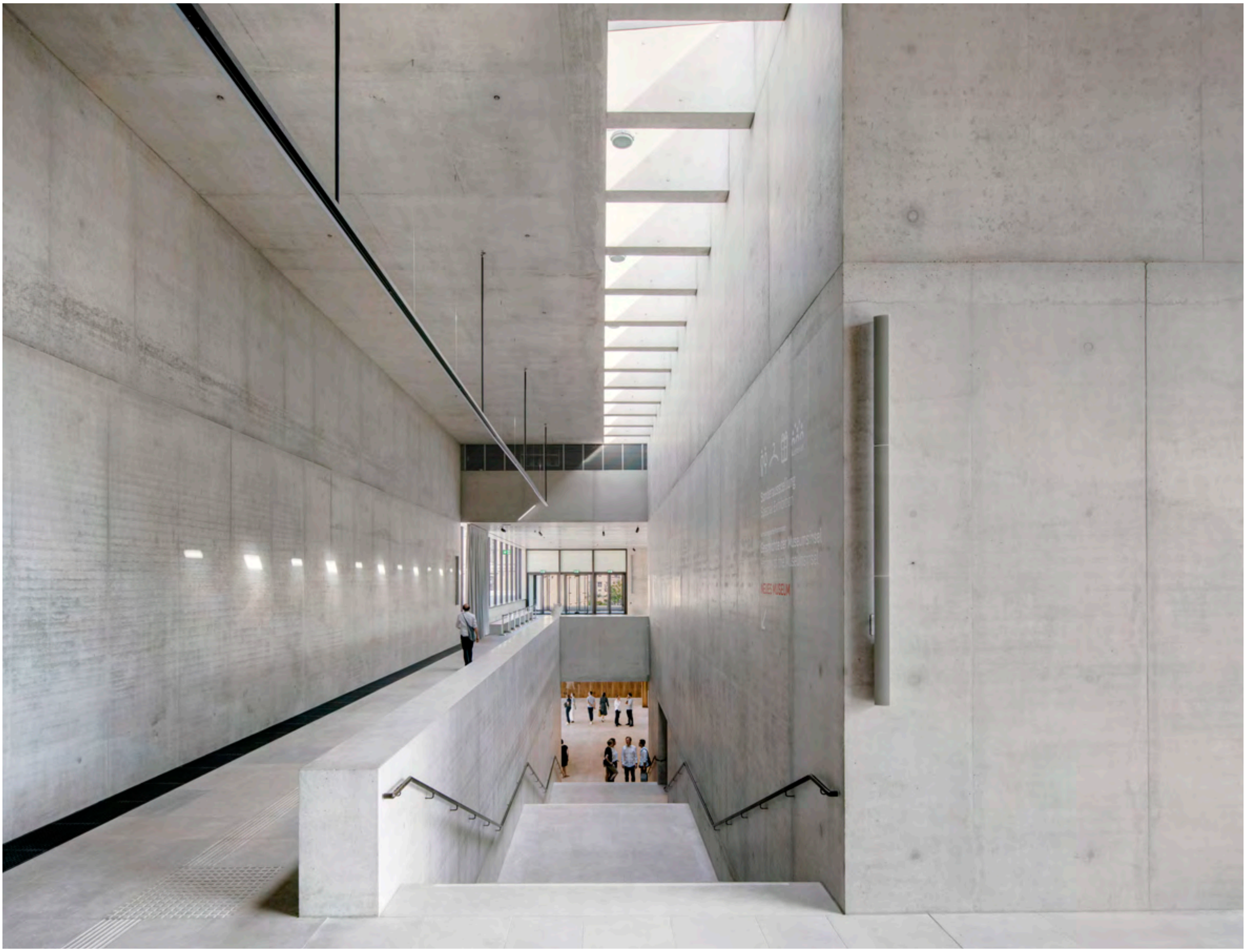

NEUES NEIGHBOUR
David Chipperfield returns to Berlin's Museum Island with a grand gateway building

ANOTHER DIMENSION
TateHindle bends space at the Tardis-like headquarters for the Institute of Physics

HOME DELIVERY
From high-rise to hexagons, the new precast systems changing the face of offsite housing

CONTENTS

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James Simon Galerie by David Chipperfield Architects
Photo by Simon Menges

DON'T MISS AN ISSUE

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AGENDA

Guy Thompson
Head of architecture, housing and sustainability, The Concrete Centre

New ways of living

Now that the UK has passed legislation to reduce its carbon emissions to a binding target of net zero, the work to meet that target can – and must – begin in earnest. The concrete sector, together with our colleagues across the mineral products industry, has been making coordinated efforts to cut its contribution to global warming for over a decade, through the Concrete Industry Sustainable Construction Strategy: the embodied carbon of UK concrete is already 29% lower against a 1990 baseline.

Net zero has always been the direction of travel. Now it becomes the next leap forward for everyone involved in the design and construction of our built environment in order to meet the needs of present and future generations. The real goal that we're striving for is for buildings and infrastructure to achieve net zero emissions over their lifetime. That is a different game, in which wider considerations of whole-life performance, longevity and efficiency come into play. The longer a structure stands, the more efficient that embodied carbon investment has been and the lower its overall footprint after each reuse.

Design efficiency is important for achieving this, but so is user efficiency – a less well-explored, but arguably more important field over the long term. Over a building's lifetime, it is the users who will have to manage it – reducing energy will still need to be the focus even when the supply is decarbonised, in order to make the best use of renewable resources and because electricity is likely to be considerably more expensive.

> NET ZERO IS THE NEXT LEAP FORWARD FOR EVERYONE IN THE BUILT ENVIRONMENT

We need to minimise energy loss from homes and ensure that energy systems continue to work as efficiently as possible. So far, so familiar. In a warming climate, there will also be a lot that is new to us. If you live in a hot country, you will already be used to following a routine to keep cool, just as you would have a different set of rules for staying warm if you lived in an igloo. Closing blinds against the summer sunshine, for example, or opening windows at night to ventilate with cooler air. In some ways, we will all have to relearn to live in our buildings, new and old.

Civilisation will not grind to a halt – we will still need new buildings and infrastructure for a growing population. But we must invest this carbon wisely, in resilient structures that keep their occupants safe, comfortable and healthy for many years to come.

EVENTS

CAFE CONCRETE @ COIN STREET

The extension and repair of George Green Library at the University of Nottingham by Hopkins Architects and Arup will be one of the projects featured at Café Concrete @ Coin Street in London on Tuesday 29 October. More details at **concretecentre.com/events**

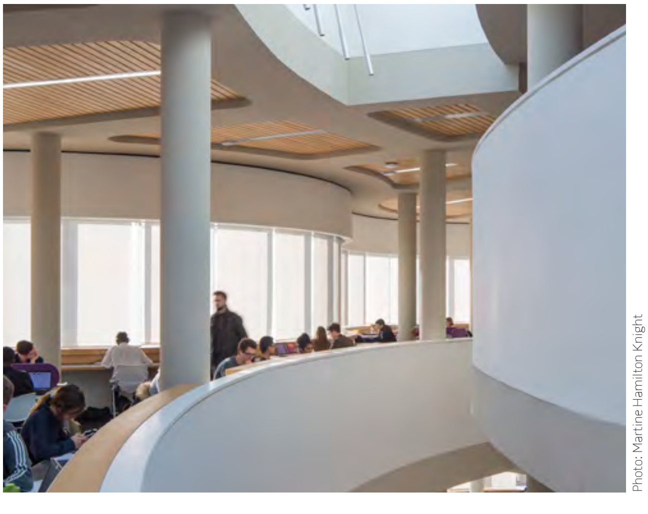


Photo: Martine Hamilton Knight

Photos: 1.Peter Cook; 2.Peter Cook/VIEW; 3.Tim Charles; 4. Pierre Metivier

NEWS: STIRLING EMBRACES ROUGH REVIVAL

Layered concrete makes its debut on the Stirling Prize shortlist: Feilden Fowles' earthy Weston Visitor Centre 1 at Yorkshire Sculpture Park is at 13/2 with the bookmakers. Concrete is shortlisted in a variety of other guises too, from the polished black surfaces of RSHP's Macallan Distillery to the graceful arches of Grimshaw's London Bridge station. A debut of a different kind for the UNESCO World Heritage List, as eight buildings by Frank Lloyd Wright, including Unity Temple 2 in Illinois, become the first examples of modern US architecture to sit alongside such icons as Niemeyer's Brasília and Le Corbusier's Ronchamp chapel. There's less good news for UK modernists Howell Killick Partridge & Amis: the Twentieth Century Society has included the Alton Estate in Roehampton on its Buildings At Risk List. Perhaps its prospective redevelopers could take a lesson from Orms Architects' revival of a brutalist office block in Camden – harnessing the retro appeal of its precast-concrete facade to give it a new life as the luxury Standard hotel 3. And finally, a more future-focused list from CEMEX – of the world's 10 most promising construction start-ups in 2019. Included is 360SmartConnect of France, which embeds contactless tags in precast concrete 4 to make components fully traceable.

INNOVATION: 3D PRINTING

"We had a crazy idea, and no idea how it could be made to work"

Photo: Paul Burroughs

In 2006 a project co-led by Loughborough University's Professor Simon Austin became one of the first in the world to research the possibility that concrete could be 3D printed. "We were starting absolutely from scratch," he recalls. "We had a million pound grant, a crazy idea, and no idea how – or even if – it could be made to work."

Some 18 months later, the team had created a 5m-tall gantry with a system of chains and drives via which a concrete delivery nozzle could be moved in three dimensions. "It was quite a thing," he says. "When sixth-formers visited on open day, they naturally tended to gather round it and wanted to know what it did."

This, says Austin, is one of the most remarkable things about the 3D printing of concrete: "It captures the imagination. I had grown accustomed to eyes glazing over when I told people I researched concrete. But 3D-printed concrete is different. People are immediately excited by its potential. Suddenly concrete is sexy."

It is certainly fascinating to watch, as the beads are laid down and the elements take shape, but getting it to work is far from simple. "You have to get the rheology exactly right," says Austin. "You're looking for the Goldilocks ideal: too thick and it won't flow; too runny and it won't stand up." This is tricky for, as Austin puts it, "concrete is one of the most complex chemical products on the planet. Even cement chemists don't fully understand it."

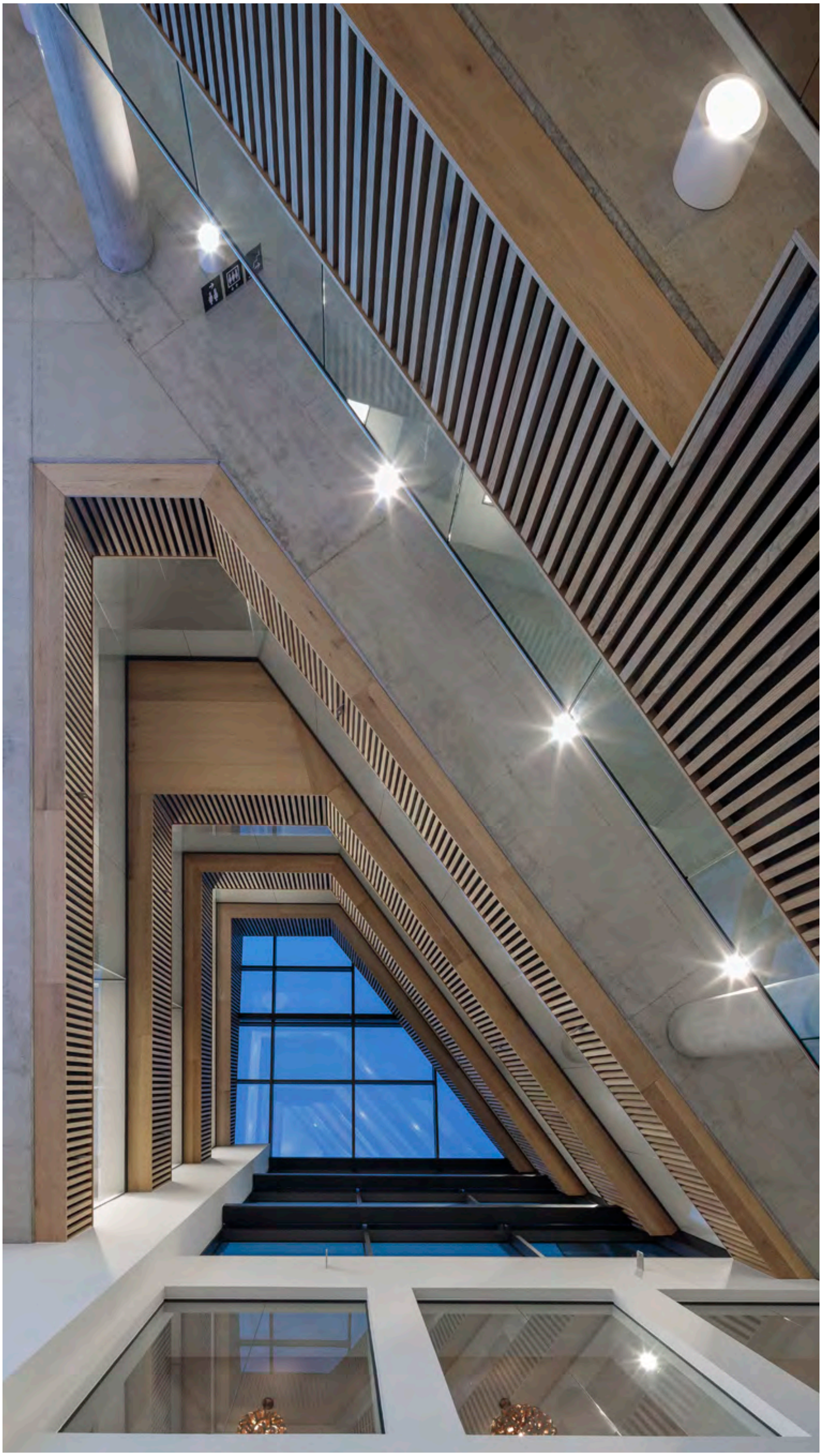
Their initial Engineering and Physical Sciences Research Council (EPSRC) project completed in 2011. By then, the idea of printing buildings had begun to attract considerable attention. Videos of houses being crudely printed in China went viral on YouTube, while Loughborough's own, featuring Austin and his colleague Professor Richard Buswell, has attracted more than 600,000 views.

Loughborough's technology has continued to progress, with the help of further EPSRC and TSB government funding and contributions from partners including Foster + Partners, Skanska, ABB, Tarmac and Hyundai. "The gantry has been replaced by a more accurate robotic arm, and concrete can now be laid down at a rate of 50cm a second. We can produce elements that curve in three planes, and that contain overhangs and voids. And although there are now more than 30 concrete printing projects globally, we remain in the forefront of world research."

Loughborough scientists have also created a start-up Concrenetics, which is partnering with Belgian precast company Urbastyle, with a view to providing commercially viable products.

Regulatory issues alone will mean that it may still be five to ten years before 3D printing becomes a commonplace solution for bespoke concrete elements. But one day it will be routine. Of that, Austin, the man who was in it from the start, has no doubt.

Words by Tony Whitehead



Photos: Dirk Lindner

A TARDIS IN KING'S CROSS

The Institute of Physics has harnessed the power of concrete to create a cavernous, slightly sci-fi space behind a row of Victorian shopfronts, writes Tony Whitehead

The new headquarters of the Institute of Physics is not an imposing building, at least not from the outside. Strolling past its frontage on Caledonian Road, King's Cross, you might miss it altogether – and that's partly the idea.

Set as it is opposite a quaint Victorian crescent, and among a busy mixture of shops and restaurants, local planners were insistent that the size and massing of the IOP's new 2,400m^2 premises should not disturb the pleasantly human scale of its locale. The IOP agreed, says Harish Ratna, project director at architect TateHindle: "The client too wanted a building that would engage with, rather than dominate, its neighbours here in the 'knowledge quarter' of King's Cross."

So the site's front facade, a row of 19th-century shops with two floors of 'living over', has been largely retained, its weathered brickwork now supported off the new in-situ concrete-framed building. The same applies to the IOP's rear facade on Balfe Street which, running at an angle to Caledonian Road, gives the building a distinctive V-shaped plan. A new fourth floor is set well back behind a balcony so as not to loom over the streetscape.

The outlines of the Victorian retail units are now framed by precast concrete elements in grey with a medium-heavy acid etch to produce a stone-like texture. The old sashes have also been replaced with full-height glazing, providing literal shop fronts for the IOP – "a showcase for its activities", as Ratna puts it.

Curious passers-by can peer into the IOP's ground-floor Accelerator Centre – not a sub-atomic particle smasher, but a science-friendly environment for physics-related start-ups. Elsewhere in the building are seminar rooms, two floors of offices, a council chamber and, in a newly excavated basement level, exhibition space and an auditorium.

Entering the building from its low-key Caledonian Road entrance, one is immediately struck by two things: the bold use of exposed concrete and the surprising amount of space. The concrete aesthetic is accentuated by grey fabrics, and prominently positioned metallic lift doors lend an almost retro, science-fiction feel to the interior. Meanwhile, thanks to the V-shaped plan, the building widens out unexpectedly to a full-height atrium where a wow-factor internal balcony overlooks the large basement-level exhibition space. "The scale is not what you might expect after the impression you get from the street," agrees Ratna. "It is like a Tardis – which I guess is quite appropriate."

The Doctor would no doubt feel at home here: the roof is fitted with a cosmic ray detector and the building is trialling Li-Fi – a light-based version of Wifi with up to 1,000 times the bandwidth. A large interactive screen in reception is dwarfed by an even larger one in the exhibition space which has been used to teleconference with the International Space Station. Today it is showing dramatic video of our boiling sun.

It's no surprise that the building design should actively seek to exploit the physics of concrete. "The IOP's ambition is to put physics into action," says Ratna. "It wanted to reflect this in the building, and this is one reason we went for concrete. Exposed concrete helps with sustainability, in that it reduces the need for other finishing materials such as plasterboard. But in particular, we wanted to exploit its thermal mass to reduce the load on the building's heating and cooling systems."

To facilitate this, almost all the ceiling soffits in the building are formed from the exposed underside of the concrete slabs. The columns are also exposed in-situ concrete, as are the majority of the walls. Having so much concrete in direct contact with the air allows it to absorb heat produced by sunshine, people and electronics, releasing it overnight when the building is vented. Alternatively, in winter, heat can be retained to reduce active heating requirements the following day.

"What the thermal mass gives us," explains Ratna, "is a useful time lag. So in summer, cooling does not need to be switched on until later in the day,

THE IOP'S AMBITION IS TO PUT PHYSICS INTO ACTION … THIS IS ONE REASON WE WENT FOR CONCRETE

Solid steps

The IOP has two staircases: one "back-of-house" which was completed early and used as contractors' access, and one that, while more of a "designer" staircase, still exhibits the IOP's distinctively industrial style.

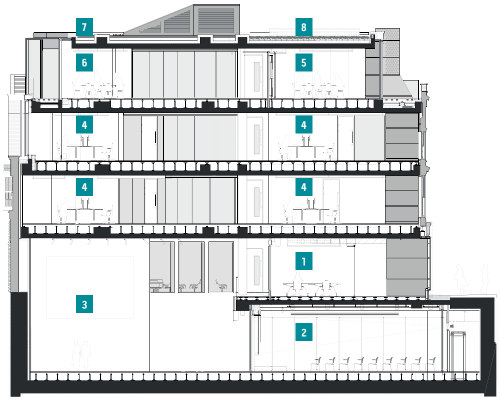
The latter (above) is made from steel stringers but features precast concrete treads. "We originally conceived the treads as steel, but were concerned about noise and slip resistance," says TateHindle's Chinedu Soronnadi. "The concrete gives a safer, more solid feel. To reduce weight, each tread has a polystyrene former inside. At first we left the treads unfinished, but found the bare concrete, though smooth, was prone to marking, so in the end we did apply a sealant."

The stairs appear to be hung from stylish vertical steel rods, though they are mainly cleated to the walls of the stairwell. "The rods, apart from looking good, actually stop the stairs from swaying," says Soronnadi.

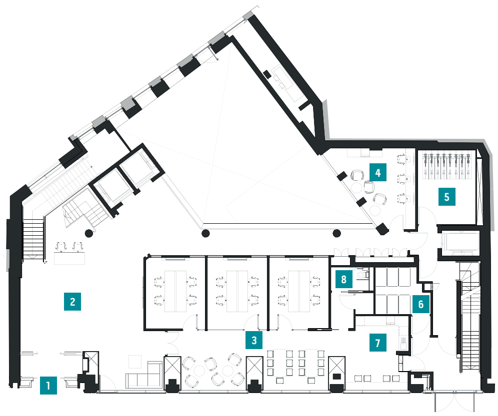
Having considered ready-made precast units for the other staircase, the decision was made to make it from in-situ concrete. "After discussion with the contractor we felt that there was so much in-situ concrete being made in the area, we might as well add this," says Soronnadi. "It also meant that we could fit it more efficiently into the exact shape of the site at this point."

Again the concrete is smooth and consistent: "It came out beautifully, all except the tops of the treads which, being at the top of the mould, are always the hardest bit to get right," admits Soronnadi. "We ground down any lumps and then painted these to prevent marking or dust issues."

SECTION AND GROUND-FLOOR PLAN



1 Accelerator centre
2 Lecture theatre
3 Exhibition and event space
4 Office
5 Seminar room
6 Council chamber
7 Green and blue roof
8 Photovoltaic panels



1 Entrance
2 Reception
3 Accelerator centre
4 Members' room
5 Cycle store
6 Bin store
7 Tea point
8 WCs

if at all. Similarly, in winter heating is kept to a minimum. The building has just a small boiler to help on the very coldest days."

The thermal mass effect works in tandem with a low-energy M&E system featuring GeoKOAX geothermal heat pumps – the first-ever UK deployment of this technology. These work like normal heat pumps, sending water down boreholes to allow the near-constant temperature of the ground to heat or cool it as required. This is used to moderate the temperature of air being drawn into the building via playfully designed zinc-clad "chimneys" on the roof. The air is then circulated through voids under the raised floor of each level where it interacts with the temperature of the concrete before filtering out into occupied spaces via floor-mounted diffusers.

"We sank the boreholes and then cast the basement slab around them," says project architect Chinedu Soronnadi. "Usually these boreholes would need to be something like 150m deep, but the GeoKOAX technology uses wider bores and swirls the water around to increase the exchange of heat. As a result, our boreholes need only be 75m deep."

Both logistically and in terms of the programme, says Soronnadi, the shallower bore holes proved convenient, especially for such a restricted site.

Standing in the basement exhibition area, and looking up through the full-height atrium, the building's structure is clear to see. On the lift core, the lines of the 1,220mm x 2,440mm phenolic film-faced birch ply sheets that formed it are clearly visible, and have been carefully centred around the two lift doors. Tie-bolt holes are symmetrical, aligned and plugged with recessed biscuits made in Germany to match the in-situ concrete.

The board markings on the concrete soffits of the upper floors are also visible, and run in two directions, reflecting the 37° angle of the V-shaped plan. The exact position of each board was specified in the drawings to avoid an unseemly mish-mash where the two courses connect. The result is a final neat triangle at the centre of the V.

Perhaps surprisingly, given the smooth, pale finish of the walls and soffits, standard C40-50 visual concrete was used throughout. The mix sourced from a nearby Hanson batching plant was naturally pale in colour, allowing the building to make the most of natural light spreading throughout the floors via the atrium. The mix also came with an Excellent rating under the BES 6001 certification for sustainable sourcing.

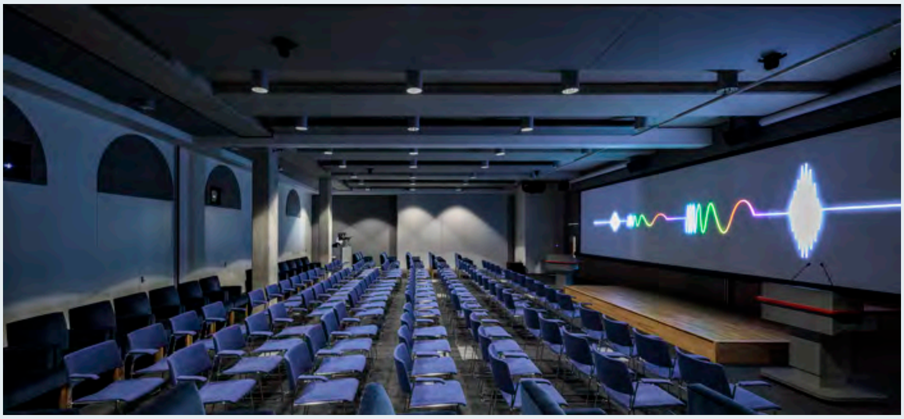
"Getting concrete from only two miles away was obviously better environmentally, but also helped reliability," says Sorrandi. "We knew exactly when deliveries would arrive, which helped the contractor to organise pours efficiently. We didn't need trucks queuing outside – not that there was room for that anyway." Close coordination of deliveries also helped reduce day joints, with fresh concrete ready to be poured as soon as the first batch had been vibrated.

The high quality of the concrete work can be seen on the round columns. These were made using phenolic film-lined cardboard forms encased with stainless steel outer covers. The result is desirably smooth and neat, though here and there the odd blow hole is visible. "We filled a few on the ground floor," admits Soronnadi, "but a few small neat holes on the upper floors have been left as they give a sense of how the building has been made."

The 500mm-diameter columns are few and far between – only three per floor – and while this does provide for enviably open, flexible spaces, it also means that the slabs have to span up to 12m. "To enable them to do this we have concealed [in-situ] upstand beams in the floor voids," says Sorranadi. "So while the slab is only 250mm thick, there are additional upstands of another 450mm where needed."

Cast-in conduits had to be designed into the slabs at an early stage to allow for lighting cables: "While the ground floor has exposed services in places, elsewhere we wanted clutter-free soffits. Some services could be concealed behind the acoustic rafts, but the lighting is a special feature so the cable routes were cast in."

While he is speaking, design director Ratna has wandered over to play with the interactive touch screen in reception. The IOP, it seems, has got what it wanted: a stylish, sustainable building that is also engaging and fun.



Downstand solution

The exposed concrete soffit of the basement-located auditorium in the IOP is unique in that it features downstand beams to enable the slabs to span more than 11m.

To use the same kind of upstand beams as in the upper floors would have resulted either in the ground floor being above pavement level, or the auditorium ceiling being too low, explains project architect Soronnadi: "So to achieve the desired 3.6m ceiling height down here, we have used wider, shallower and heavily reinforced beams."

He originally thought of this as a problem, he says, "but in fact, these 1,000mm x 200mm downstands are ideal for an auditorium as they help break up acoustic reflections. The grey fabric acoustic rafts fit neatly between the downstands and they've ended up looking really good."

A peculiarity of the auditorium is that it extends beyond the ground-level footprint of the building and borrows space from under the pavement outside. This meant that the load of the building's front facade lands some way inside the auditorium and so four substantial concrete columns have been positioned to deal with this. These rectangular, 500mm x 350mm columns were constructed with regular ply shuttering and, being located towards the back of the auditorium, do not obstruct the audience's view.

ABOVE LEFT All of the columns and most of the soffits in the building are exposed in-situ concrete

LEFT The Victorian former retail units on the main facade are now framed by precast concrete elements with a medium-heavy acid etch

PROJECT TEAM
Architect TateHindle
Structural and M&E engineer AECOM
Main contractor J Murphy & Sons
Concrete frame contractor Addingtons
Precast concrete supplier Evans Concrete Products

DOOR TO THE PAST

David Chipperfield's precast concrete colonnade makes a majestic gateway to Berlin's Museum Island, writes Nick Jones

Berlin's Museum Island has been welcoming visitors for almost 200 years, lured by an unrivalled collection of arts and antiquities from every corner of the world. The one thing the complex has always conspicuously lacked was an entrance.

Its first great hall of antiquities, the Altes Museum, opened in 1830. Over the following century, four more monumental museums – the Neues, the Alte Nationalgalerie, the Bode and, its biggest draw, the Pergamon – were added to this spit of land between the Spree river and the Kupfergraben canal. But, as architect David Chipperfield points out, there was no central square, and its five museums all faced in different directions. "People would come to the Pergamon Museum, and then go straight back out."

Chipperfield's James Simon Galerie is the sixth museum on the island – the first in nearly a century – but perhaps just as importantly, it finally gives the complex a front door. Facing out across Berlin's most famous street, Unter den Linden, the Galerie rises temple-like from the canal on a stone plinth. A sweeping three-flighted staircase invites visitors up to a refined, precast-concrete colonnade, and on into an imposing entrance hall.

The colonnade is a dramatic statement in the heart of a modern city. Elevated above the traffic on its plinth, it is both classical in origin, echoing its stately neighbours, and strikingly contemporary in execution. "The idea was to build a stone-like building and at the same time an obviously modern building," says project architect Urs Vogt. "The concrete was our way to express modernity."

At 9m high and 28cm^2 in plan, the columns are as slender as staircase balustrades – precise, factory forms but with a natural, textured finish. They were precast in single units using steel formwork; the outer 3mm was then sandblasted off by hand, exposing a pale marble aggregate sourced from the nearby Erzgebirge mountains. "We were looking for this slight roughness to give it more

CLOCKWISE FROM BOTTOM LEFT A new entrance to the island on Unter den Linden; walls and soffits are left unfinished, with bolt holes filled but visible; staggered walls reflect sound towards the centre of the auditorium; the colonnade opens out into a public terrace

PROJECT TEAM
Architect David Chipperfield Architects
Structural engineer IGB Ingenieurgruppe Bauen
In-situ concrete contractor Hentschke Bau
Precast concrete contractor Dreßler Bau

of a natural stone quality, and to tone with the pre-existing stone buildings," explains Vogt. The finish also provides a visual link to Chipperfield's transformative work on the neighbouring Neues Museum, where the practice used the same aggregate and light cement to memorable effect as a counterpoint to the structure's bomb-damaged brickwork.

It was during the Neues Museum restoration that Chipperfield identified the need for a separate entrance to the island. But as the new project progressed, it began to assume a wider role, reflecting the changing nature of museums in the 21st century. "The museums that had been built on this island were closed boxes," says Chipperfield. "They emphasised the static nature of the institution, the retention of objects and the showing of objects." In contrast, the James Simon Galerie would be a fluid space, stretching out into the city and drawing it in as a place to meet and socialise. So while the colonnade echoes the classical motifs of the other museums – its ratio of column to void is identical to the street facade of the Neues Museum – it also plays a more civic role, opening into a public terrace overlooking the water.

WE REALISED WE COULD LIBERATE THE MAIN BODY OF THE BUILDING TO A SORT OF PURPOSELESSNESS

Likewise, Chipperfield has chosen to leave the main level of the gallery almost empty, with just the ticket desk tucked to one side, while relegating the key programmatic elements – an auditorium, shop and gallery for temporary exhibitions – to the lower level. "We realised we could liberate the main body of the building to a sort of purposelessness, or a bigger purpose: a place to congregate or meet," he explains. Again, this is a repurposed classical motif, echoing the piano nobile of a Roman temple, as well as offering a nod to another celebrated Berlin museum, Mies van der Rohe's pavilion-like Neue Nationalgalerie, which Chipperfield is in the process of restoring.

The in-situ concrete structure of this main entrance hall has been left exposed, and this seems to be another riposte to the "static" nature of traditional museums. In-situ concrete, Vogt points out, bears the history of its former fluid state. "It's a lively material – you can see by its shade if it was poured in summer or winter. There are elements that tell you the story about how it was cast, who poured it, who vibrated it." For this reason, the walls and soffits have been left unfinished, with the bolt holes filled but still visible. Darker horizontal lines every 20cm or so suggest the ghost of the steel rebar behind, and subtly echo the strata of the translucent marble window wall that stretches across the back of the room.

The concrete is a CEM III mix, with 30% GGBS – Vogt says they explored using fly ash as a cement replacement but preferred a lighter finish to fit with the limestone that dominates the rest of the island. The contractor made a number of test panels and explored different formwork options in the basement and lift shafts. In the end phenolic faced ply was chosen for single-use in exposed areas, but then re-used in non-exposed areas of the building.

The auditorium and gallery may have been relegated to the lower level, but they are both memorable spaces. The 300-seat auditorium combines a soffit of softly billowing walnut with sharply zigzagging concrete walls. Perhaps uniquely, the walls double as acoustic panels, reflecting sound from the stage to the centre of the room. The unusual geometry meant that the 9m-high walls had to be cast in a single pour – as opposed to the 4m pours on the floor above – to avoid the need for awkward joints. This has left a darker tone towards the bottom of the wall – but again, Vogt is happy to let the building tell its own story.

The 650m^2 gallery next door would perhaps be a fairly conventional, hermetic white space, but for the fact that it narrows towards one end, creating an intriguingly distorted perspective. The reason for this is that one side of the room is a retaining wall that follows the bank of the canal – a reminder of the constrained nature of the site (as well as the boggy, heavily piled subsoil below).

The lower level connects the building to the Neues Museum and will eventually link to all the other institutions via a walkway, dubbed the "Archaeological Promenade". Chipperfield refers to the James Simon Galerie as a "kind of subway station" for the island – another in the growing list of functions of this chameleon-like building, reiterating the dynamic nature of the modern museum. On an island of antiquities and static monuments, Chipperfield's concrete temple has brought things to life.

Photos: Ute Zscharnt

Photos: David Cadzow

SECRET SERVICES

The precast concrete structure of City Electrical Factors' HQ conceals some very clever pipework, writes Debika Ray

CLOCKWISE FROM ABOVE
The building has a stripped-back feel; material choices inside and out reference CEF's products; exposed precast concrete panels span 15m

PROJECT TEAM
Architect FaulknerBrowns
Structural engineer Curtins
Main contractor SRM
Concrete frame contractor PCE

The RIBA's North East Building of the Year for 2019, the new European headquarters for City Electrical Factors on the outskirts of Durham unites the global electrical cable wholesaler's staff under one roof for the first time. Set amid a verdant landscape, it comprises two distinctive areas: a block with workspaces intended for greater privacy and controlled, specialist work; and an L-shaped space that wraps around a glazed atrium and is designed for interaction and creativity.

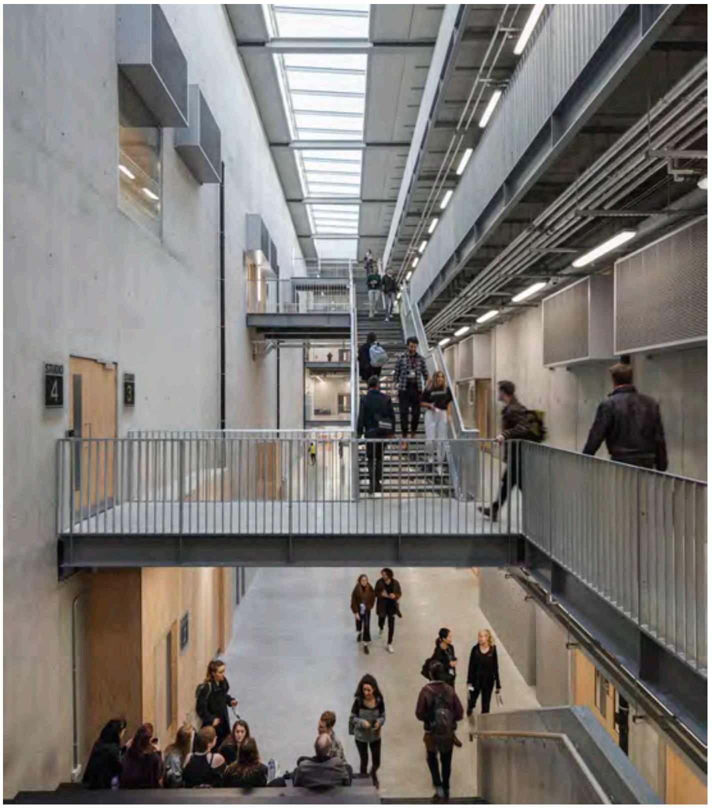
Newcastle-based architect FaulknerBrowns was briefed to devise a workplace that reflected the nature of the business and offered potential employees an attractive environment to work. "They wanted the workplace to be inspiring," says FaulknerBrowns partner Steve McIntyre. "Recruiting the best IT graduates in the North-east is really important to the business. We've got great universities here, but the best people tend to go down to London."

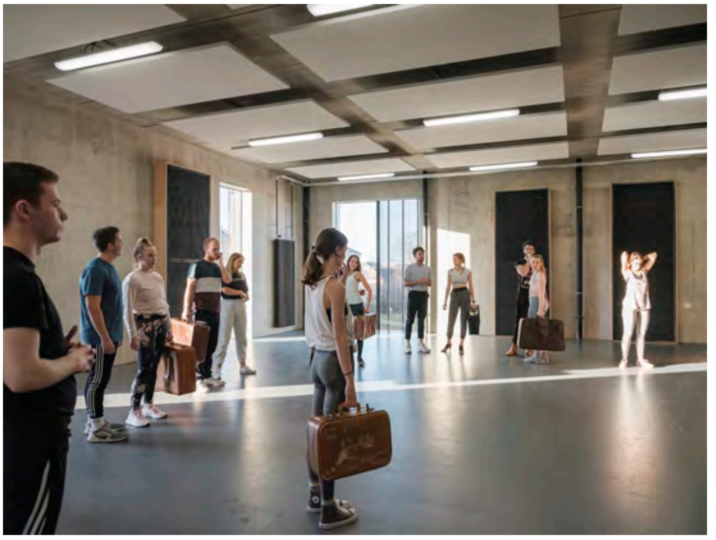
The choice of materials addresses both parts of the brief. An exposed concrete structure gave the building the stripped back, contemporary feel the client was looking for, while the use of aluminium, stainless steel, copper and translucent plastics nod to CEF's core product, and porcelain cladding panels reference the traditional use of ceramics as an electrical insulation material.

For the frame, prefabricated concrete planks were deemed the best solution, giving the desired aesthetic as well as serving more practical functions when it came to sustainability and flexibility. Cooling pipework was integrated into the concrete planks, to support a cooling strategy using the frame's thermal mass without visible pipework cluttering the surfaces. "During the night, cool water passes through the slab and that cools the workplace, and during the day the heat is absorbed into the concrete soffit, which means less energy is used to cool the building," says McIntyre. "Integrating this system into the structure gave us control over the environment, as well as the visual appearance the client was after."

This was not without its challenges: the architects had to be very precise with the design and placement of all internal elements such as risers and IT cabling, as these were cast in during the panels' manufacture: "We had to ensure all areas of penetration through the plank were drawn and agreed very early." The frame was then erected in just 11 weeks.

The architect believes this is the first precast concrete structural system with integrated cooling pipework to achieve a 15m span. The result is that, rather than needing columns in the interior, there is a large, open space that the business can adapt to suit the way it works. Already its workforce has expanded from 110 to 135, the open-plan design easily accommodating the growth. It's an office that no doubt will continue to expand and evolve.





Photos: Tim Crocker

CLOCKWISE FROM FAR LEFT
A street-like atrium connects the theatre and studio blocks; the smooth concrete of the studio walls contrasts with the rougher hollowcore planks of the soffit; the school is next door to the Stirling Prize-winning Peckham Library

SETTING THE STAGE

Concrete plays a role of raw honesty at Carl Turner's south London theatre school, reports Pamela Buxton

PROJECT TEAM
Architect Turner Works
Structural and civil engineer Eckersley O'Callaghan
Contractor Gilbert-Ash
Concrete contractors MR Concrete, Creagh Concrete Products

Situated next to Will Alsop's Stirling Prize-winning Peckham Library, theatre arts school Mountview Academy was conceived as a warehouse for the dramatic arts. This substantial 10,365m^2, six-storey building was designed by Carl Turner Architects (now Turner Works), and had a construction period of just 17 months, driven by the fixed deadline of the school year, and a tight budget of £20m.

This drove the decision to aim for "considered concrete", the term used by contractor Gilbert-Ash to describe its approach of focusing on controlling key aspects that made the biggest difference to the overall appearance. "We don't mind seeing the marks of the build process," says Turner Works associate Kyle Gudsell. "There's an honesty to it."

Mountview consists of interlocking theatre and studio buildings. After considering cross-laminated timber, a concrete structure was chosen because of its acoustic and fire performance, its reliability with regards to programme and – importantly for a naturally ventilated building – its thermal mass.

For the theatre block, the structure was formed by in-situ concrete columns and 275mm-thick reinforced concrete slabs. The studio block was built using solid, 240mm-thick in-situ concrete walls with a floor slab of pre-tensioned, hollowcore planks. This method was chosen for its speed, with one floor completed every three weeks.

Great consideration was given to the concrete walls, which are exposed in the circulation areas and studios and form a key feature of the atrium. Architect and contractor collaborated on sample panels to explore the desired finish, experimenting with both 50% and 35% GGBS. The former turned out quite light in appearance while the latter was a light mid-grey, which the architects felt worked better with the rest of the material palette. This option also had the benefit of a faster curing time.

To achieve a matt finish to the concrete, the casting method for all the exposed concrete (walls in the studio block and columns and soffits in the theatre block) used panels of WISA-Form made by UPM. This spruce plywood has a 18mm medium density overlay to give the effect required by minimising grain transfer and can be reused up to 10-15 times. The walls were cast using standard-sized 2,440 x 1,220mm panels on a steel shutter.

"We accepted they would be more industrial and raw rather than smooth," says Gudsell, adding that apart from a light sanding and a filling of holes over 10mm, the walls were left as struck, with no finish or dust sealant.

These walls contrast with the rougher soffit of the exposed slab. Measuring 10m long and 1,200mm wide, the pre-tensioned hollowcore planks varied considerably in appearance. However, much of this became background when combined with the soffit cable trays and lighting, says Gudsell.

Overall, the architects are happy with the results of the considered concrete approach. The concrete has, says Gudsell, almost a "pre-aged" appearance: "It looks worn-in a bit already, like a found structure."

TARGET ZERO

The UK has a target of net zero carbon emissions by 2050, and concrete can help designers meet it. Elaine Toogood explains the key low-carbon decisions

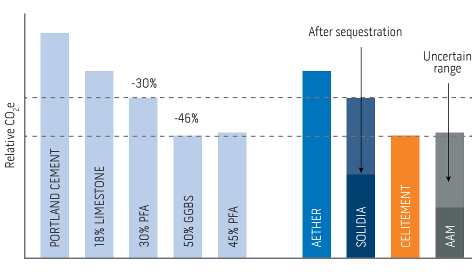
In June 2019, the government passed legislation setting a target of net zero greenhouse gas emissions by 2050. Designers are already delivering low-carbon solutions using concrete and masonry, so what needs to change for net zero carbon to become a reality? Many are not aware that the UK concrete industry has been working to a sustainable construction strategy since 2008, which includes targets to reduce embodied carbon, alongside performance indicators in a range of other areas, such as environmental management and waste minimisation. This strategy will be relaunched in 2020, to adopt a commitment to a net zero carbon built environment.

CUTTING CARBON NOW

There are many different forms and mixes of concrete, so naturally there are a range of figures for embodied carbon. On average, the carbon footprint of UK concrete has reduced by around a third since 1990 and is both comparable to and lower than other materials – a fact that is often overlooked due to the volume of concrete used.

Aggregate accounts for by far the greatest proportion by volume, and it is both low carbon and locally sourced. The component that contributes the majority of concrete's carbon footprint is cement, which is used to bind the aggregates and makes up around 10% of its volume. The UK cement industry has been decarbonising faster than the UK economy as a whole and currently contributes 1.5% to UK greenhouse gas emissions. Since 1990, it has reduced absolute emissions by 51%. In 2013, MPA Cement launched an ambitious strategy to achieve an 81% reduction in carbon emissions by 2050, and the industry is now assessing how net zero can be achieved.

FIGURE 1: RELATIVE CARBON DIOXIDE EQUIVALENT OF COMMON CEMENTS vs ALTERNATIVE CEMENTS



Use low-carbon concrete

GGBS, fly ash and limestone lower the carbon footprint of concrete – concrete specification alone can reduce embodied carbon by 50% (see figure 1). Cement and cement replacements are available locally, sourced from the UK and Europe. Designers should also ask concrete manufacturers for environmental product declarations (EPDs) and guidance on the footprint of their proprietary concrete, as a carbon footprint below the industry average can be achieved.

Consider the building's whole-life carbon

Most definitions of zero carbon focus on reducing a building's energy use, ie its operational carbon emissions, and this remains an important focus for designers seeking to lower carbon emissions. "Net zero", as recently defined by the UK Green Building Council, calls for a consideration of whole-life carbon, which also includes embodied carbon emissions. It is essential that both embodied and operational carbon are considered together, because decisions about one type of emissions can impact on the other. The methodology for measuring whole-life carbon is set out in BS EN 15978:2011 Sustainability of construction works. For further guidance, refer to Whole-Life Carbon and Buildings, published by The Concrete Centre.

Use thermal mass to reduce energy use

Together with insulation, ventilation and, where necessary, shading, concrete can significantly reduce the amount of energy needed to heat or cool a building. This provides operational carbon savings from day one, accumulating over the life

◀ Sevenoaks School Science & Technology Centre, Kent (2018)

This 7,200m^2 project includes 30 glass-fronted laboratories and workshops arranged on three floors around a top-lit atrium. The building's frame is in-situ concrete, in which 50% of the cement was replaced by GGBS. This not only reduces its embodied energy but lightens the colour of the concrete and increases the reflectivity of the exposed soffits, maximising the penetration of natural light into the space. The ribbed roof structure is made from precast concrete in a sawtooth design with 7m spans.

The concrete soffits not only form the backdrop to the artificial lighting strategy, they are integral to heating and cooling too, particularly in the naturally ventilated spaces. The thermally massive concrete structure absorbs heat during the day, which is released at night with the aid of a secure natural ventilation system. During the winter, it helps the building to make more efficient use of passive internal heat gains to reduce the load on the heating system. Groundwater-cooled pipes run through the structural slab above the exam space and workshop areas, chilling the slabs and providing low-energy cooling in these high-occupancy, high-gain spaces, augmenting the thermal mass.

The exposed concrete is a key part of the architecture. A "special" finish is typically used where the concrete can be seen, with a plain finish specified in back-of-house areas. Careful setting out of the MDO formwork and tie holes play a key part of the aesthetic: the formwork layouts and reinforcement detailing responded to the practical requirements of the construction sequencing, board dimensions and PERI formwork and falsework system used, while achieving a clean and simple finish. Coordination and detailing of cable sleeves with formwork and rebar allowed wireways to be built into the slabs and walls without compromising the quality of the concrete's finish.

PROJECT TEAM

Architect Tim Ronalds Architects
Structural engineer Eckersley O'Callaghan
Contractor Gilbert-Ash
Concrete contractor Oliver Connell & Son
Precast concrete contractor Moore Concrete Products

Photos: Hélène Binet

LEFT At Sevenoaks School Science & Technology Centre concrete soffits are integral to heating and cooling the naturally ventilated spaces

ABOVE In the building's in-situ concrete frame, 50% of the cement was replaced by GGBS, reducing embodied carbon and improving light reflectance

of the building. Concrete does this by acting as a thermal store, capturing free solar energy to reduce heating needs in the winter, and reducing or omitting the need for mechanical cooling by passively regulating internal temperatures.

A design collaboration with A2 Dominion homes predicted that the thermal mass of a concrete and blockwork house would provide an annual reduction of 3% in heating energy required (in kgCO_2/m^2), as well as a 3.2°C reduction in peak internal summer temperature. A survey of office buildings showed that those using thermal mass as part of a low-energy servicing strategy had a carbon usage range of 25-50 kgCO_2/m^2/year compared to 100-175 CO_2/m^2/year for a typical air-conditioned office. Furthermore, the omission of air-conditioning equipment can save 50% of embodied CO_2 per m^2 every 15 years, the approximate cycle of replacement of M&E equipment.

Efficient design of the building structure

There are multiple ways in which the structure of a building can be delivered. Optimising the amount of material used can make a significant difference to the embodied carbon, for example through consideration of span and column spacing. Double-curved structures, such as thin-shell structures, can provide extraordinary material efficiency, achieving large spans. The use of permanent void formers in concrete can also reduce the weight of the structure and the volume of material that is needed for the structure and foundations. At the recently completed Royal College of Pathologists headquarters, a ribbed floor slab was designed to lighten the structure, using less concrete while optimising its surface area to gain the benefit of thermal mass. Architect Bennetts Associates reported that this design decision saved around 40% embodied carbon compared to a more conventional flat-slab solution.

Post-tensioning is an efficient way to reduce the depth of a concrete structure. Over ten storeys, incremental savings in floor depth can add up to an entire storey height, compared to a typical steel-framed solution, potentially also removing the embodied carbon of a full storey of perimeter enclosure. Flat soffits also facilitate the installation of services and partitions.

LOW-CARBON CONCRETE OFFERS A CARBON REDUCTION OF 50%

ABOVE Sevenoaks School Science & Technology Centre has a precast concrete roof in a sawtooth design with 7m spans

Use concrete to reduce other materials

Doing more with less is a responsible approach to design and construction. Because concrete is naturally fire resistant and it provides good acoustic separation, it does not always need to be treated, coated or additionally insulated. Internal finishes account for around 12-14% of the total embodied carbon associated with office buildings. This can be avoided if the concrete is left exposed or painted – providing a dual benefit by optimising the thermal mass of the structure.

CUTTING FUTURE CARBON TODAY

It is essential that reducing carbon in the short term should not eclipse the need for buildings to continue to be fit for purpose, both now and in the future. Design decisions should consider whole-life carbon and embed energy efficiency, adaptability, durability and resilience to the impacts of climate change into the fabric of a building.

Designing for long life and reuse

Designing for longevity and adaptability maximises the initial investment, not only in carbon but financially too, and is a core principle of design for a circular economy. Concrete is in itself very durable, requiring little or no maintenance over its life, especially in comparison with other structural materials. Internal concrete structures can achieve and exceed a 60-year design life with no additional design or resource requirements. This is because the mix design and cover recommendations for reinforced or prestressed structural elements in the internal environment of a building are the same for a predicted durability of both 50 years and 100 years, as shown in Annex A, Table A.4 and A.5 of British Standard BS 8500. Choosing concrete therefore provides a material resource for the future, extending the useful life of a structure, with little or no future carbon expenditure required to ensure it is protected from fire, rot or other forms of degradation.

Climate change adaptation

Concrete is inherently resilient and is proven to be a cost-effective solution for climate change adaptation, using readily available local materials and established construction methods. Flooding is a major climate-change risk in the UK – as recent events amply illustrate. Other identified risks include overheating, drought, subsidence and high winds. Enlightened developers are testing their new developments against predicted climate-change conditions for 2030, 2050 and even 2080. Concrete has energy storing properties due to its thermal mass, which can provide cumulative carbon savings over the life of the building and provide for future passive cooling. Through early strategic planning, it is possible to significantly reduce risks with little or no additional financial and carbon expenditure, now or in the future.

Taking account of the CO_2 concrete absorbs

Carbonation refers to the process by which concrete absorbs CO_2 from the atmosphere. It is accounted for in structural engineering design, but is only beginning to be acknowledged in carbon calculations. Over the life of concrete, carbonation can absorb around a third of the embodied CO_2.

Energy use at end of life

When concrete gets to the end of its serviceable life, it can be crushed to create aggregate for reuse in construction. This processing requires comparatively little energy, compared to the spikes of carbon associated with end-of-life scenarios for other building materials.

In summary, there are many ways in which designers can make significant carbon reductions using concrete, both now and over the life of a building or structure. Responding to the climate emergency also poses many other important considerations such as climate change adaptation, resource efficiency and the transition to a circular economy, as well as pollution, water use, health and wellbeing, indoor air quality, responsible sourcing and biodiversity. It is essential that in addition to a whole-life approach to carbon, a holistic approach to design for the environment is adopted, to minimise the risk of unintended consequences. We need to act now, but with a full understanding of how today's design decisions will impact the future.
For more information on low-carbon concrete, go to concretecentre.com/publications

Next-generation cements and low-carbon concrete

Since Concrete Quarterly's article on low-carbon cements in 2016 (CQ 256), the British Standard PAS 8820 has been introduced for alkali-activated materials (AAMs) suitable for use in UK concrete products. Successful trial concrete pours for Cemfree have also provided confidence that existing plant can be used to batch, transport and place novel mixes. Calcium sulfoaluminate cements are now well-established in Europe for specialist applications, although the carbon savings are similar to existing composite cements already widely used in the UK. In the US, Solidia has completed manufacturing trials of concrete pavers formulated with carbon-cured (calcium metasilicate) cement. Celitement (calcium hydrosilicate) in Germany is at the pilot plant production stage with laboratory testing underway.

An alternative to inventing new cement is to save carbon through the more efficient use of cement replacement materials. Recent research has shown that materials such as GGBS, fly ash, calcined clay and powdered limestone can work better in a multi-component cement. Combinations such as cement-GGBS-limestone, cement-fly ash-limestone and cement-calcined clay-limestone potentially enable higher rates of cement replacement. In 2018 MPA initiated a project to develop new low-carbon multi-component cements for UK concrete applications, forming a consortium with Hanson, BRE and Bison Precast. The research and demonstration are part-funded by the government under the £9.2m Industrial Energy Efficiency Accelerator programme. Good progress is being made, with BRE carrying out validation testing of new concretes in which 65% cement replacement has been achieved. On completion of the technical programme, recommendations will be presented to BSI to support standardisation of low-carbon multi-component cements in BS 8500.
Colum McCague is technical manager at MPA Cement

Photos: Andy Stagg; Hufton+Crow

INTERNAL AFFAIRS

Interior designers are increasingly drawn to concrete's sculptural forms and range of textures and finishes, writes Elaine Toogood

LEFT R2 Studio's low-energy refurbishment of a Victorian terrace features a precast worktop and splashbacks

ABOVE For Stella McCartney's flagship store on Old Bond Street, MASS Concrete cast bespoke displays and fluted in-situ walls in various textures

Concrete's visual appeal is now so strong that there are numerous tiles, coatings, vinyls and wallpapers designed to look like raw concrete. There is even a carpet range inspired by the tonal variation of polished concrete floors! But there is, of course, no substitute for the real thing. For a truly unique mineral surface, solid corners, sense of permanence and coolness to the touch, concrete as an interior finish offers so much more than an aesthetic.

An internally exposed concrete structure is a recognised strategy for sustainable construction, while concrete surfaces are particularly useful in areas that require durability and low maintenance. Ideally, the concrete structure will have been designed to be of high quality when constructed, but increasingly existing spaces are being stripped back to reveal a wide range of concrete structural systems and surface variations never intended to be seen. In these instances, each part of the concrete needs to be considered to establish the most appropriate strategy. Isolated areas could be improved or covered by other finishes, for example. Shot blasting can provide an interesting texture and freshen up the surface of the concrete, but structural advice is necessary, not least to ensure that reinforcement is sufficiently covered.

For projects that require concrete to be installed retrospectively – ie as part of the interior fit-out – the design is as likely to be influenced by logistics and manoeuvrability as aesthetics, especially for potentially large features such as stairs. Concrete's ability to create fluid, sculptural shapes makes it ideal for stair design, whether as an entire flight cast as one unit, or individual treads and balustrades. (For detailed guidance on concrete stair design, see CQ 248, Summer 2014.)

Counters or worktops are a popular use of concrete for interior design. Numerous specialist suppliers offer precast elements from a defined range of colours and finishes, but bespoke designs are also possible. As with most precast concrete, the pieces are cast upside down with the unformed face, typically the less controlled surface, hidden on the underside of the counter. For jointless integrated end panels, or large cantilevers, the counter can be cast in situ, the unformed face in this case being the top surface. The choice of finish and techniques for smooth, high-quality surfaces is akin to those for in-situ polished concrete floors. Similarly, the best results will be achieved by specialist installers that have the skill and experience to match formed and unformed surfaces. (For detailed guidance on floor finishes, see CQ Visual Concrete Focus.)

Glass reinforced concrete (GRC) is often the material of choice for wall linings, fixtures and furniture, with the advantage of being thinner and therefore more lightweight. It can be created in almost any shape, texture and colour, with thickening and ribs located at the back where greater stability is required. GRC offers highly repeatable, high-quality surfaces so it requires skill to achieve the natural variations characteristic of in-situ concrete. Ultra-high-performance concrete is an innovative form that has also been used for interiors. Thin like GRC but reinforced with fibre, it can achieve greater strengths, making it suitable for elements such as stairs.

With such a range of surface finishes and sculptural forms, it is easy to understand the appeal of concrete for interior designers. For best results, the key is to bear in mind the particular manufacturing technique for your chosen effect, and marry detailing and installation accordingly.

OFFSITE HOUSING SYSTEMS

Claire Ackerman explores the latest factory systems offering high-quality, speedy solutions to the UK's housing problem

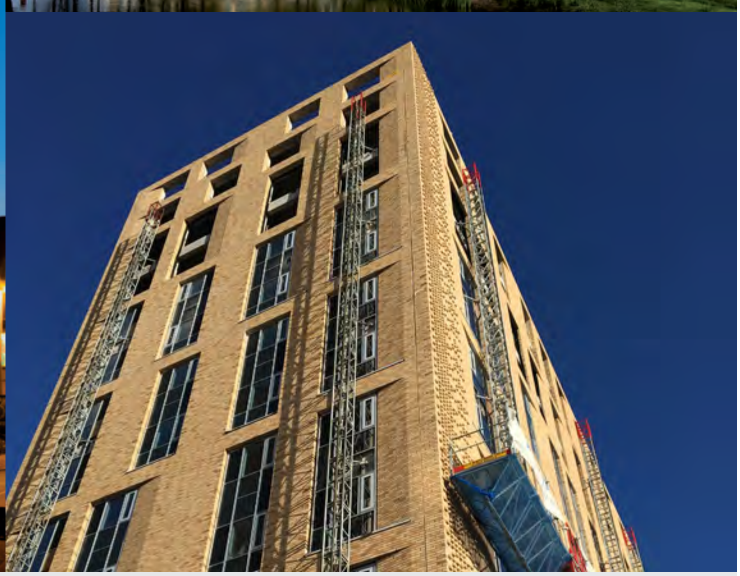
Offsite manufacture for onsite assembly is an established solution for residential buildings. The current drive for factory production and modern methods of construction (MMC) has led to greater investment in concrete manufacturing facilities in the UK, as well as the development of innovative precast systems that can be used to construct both high- and low-rise housing quickly and efficiently.

Concrete components tend to be limited by weight so modular concrete housing systems are usually based on flat panels – although volumetric stair and lift cores and bathroom pods are available. Pre-designed, factory-produced concrete structural elements are available for every component of a building. These are typically made to order with dimensions to suit project requirements, although fixing details have been standardised over the years to further improve efficiency and

High-rise solutions

Crosswall is a highly efficient modular system, where precast loadbearing concrete walls are structurally tied with concrete stairs and floors using hidden rods. It is normally associated with the cellular arrangements of hotel and student accommodation, as it provides excellent acoustic and fire performance without relying on additional finishes.

An evolution of crosswall construction was used to create the structure for 206 apartments at the Lansdowne (pictured, bottom right), a 16-storey residential building recently completed in Birmingham. It took just nine days to complete each floor. The facade comprises storey-height brick-faced (and pre-grouted in the factory) insulated concrete sandwich panels, installed without scaffolding.



An offsite system based on crosswall structural principles was used for Aston Place (left), also in Birmingham, a build-to-rent project for Dandara Living of two blocks 17 and 22 storeys high, linked by bridges at each level. The development provides 324 new homes, a mixture of studio, one-bed and two-bed apartments. The system has a standardised suite of details specifically for residential developments. Internal walls are delivered with mechanical and electrical services cast in place and a pre-sprayed mist coat of decoration. The floor incorporates a recess to receive preassembled bathroom pods to create a level threshold and precast concrete balconies have a self-finished, anti-slip surface and cast-in fixings for glazing and handrails. Here an exposed "recon" finish in two different colours was chosen for the external leaf of the insulated sandwich panels of the facade, all delivered pre-glazed to site.

A very different approach was used for the 26 and 30-storey towers of Victory Plaza (top right) in east London, designed by Lifschutz Davidson Sandilands, the first use of a "rising factory" process in the UK. A lightweight, temporary "shed" covering the entire building footprint provided enclosed working conditions for the construction of the building structure for each floor, including walls, cladding, slabs, services and bathrooms. The factory was jacked up as each floor was completed, similar to jump-form rigs used for core construction, on a cycle of 55 hours. Incremental improvements enabled the final 18 floors to be delivered at a rate of one per week. The hybrid concrete structure comprised perimeter precast concrete columns, with concrete twinwall structural panels for the core and other internal structural walls, and Omnia slabs for the floor. Contractor Mace is now using the system on a number of projects.

MorgenWonen

VolkerWessels' MorgenWonen system is made from insulated concrete sandwich panels, manufactured using a hydraulic steel mould. Houses can be erected and made watertight in less than a day by a crew of four people. In order to avoid double handling, the panels are loaded onto the lorry in the correct sequence and craned straight into place on-site. Windows, doors and most building services are installed in the factory. The only site activity is the installation of roofing over the water-tight membrane, guttering and downpipes. The house is typically ready for occupation just 10 days later, after decorating, kitchen fit-out and flooring installation.

From the outside, the homes are designed to look like traditional masonry construction. The internal perimeter loadbearing walls are as-struck precast concrete, as are the walls inside the staircore, with decoration applied directly to the concrete. The other internal walls are non-loadbearing, made of a lightweight partitioning system, and therefore layouts are flexible.

The homes have a high thermal mass of 450 kJ/m^{2}K, as opposed to 125KJ/m^{2}K for lightweight construction, and air leakage of just 1.14m^3/m^2/hr. They are sold as "energy neutral", equipped with a very efficient air-source heat pump. As of July 2019, 1,510 homes had been constructed, predominantly in the Netherlands.

PRE-DESIGNED, FACTORY-PRODUCED CONCRETE STRUCTURAL ELEMENTS ARE AVAILABLE FOR EVERY COMPONENT OF A BUILDING

Visualisation: Dandara Living; Photos: Paul Riddle, FP McCann; MorgenWonen

Photos: CCP, HexxHome, Tarmac, RoofSpace Solutions

Slimcrete

Apart from the roof, the entire structure of this house by Cornish Concrete Products is made from 40 bespoke precast units and can be erected in just two days. The crosswall construction comprises a 100mm reinforced structural skin, with 150mm insulation – to achieve a 0.15W/m²K U-value – and a 50mm reinforced external skin. Internally, there are 150mm-deep hollowcore floor sections, 100mm reinforced internal partitions, while the stairs are also precast. The largest panel, a wall section, measures 7.5m x 3.1m and weighs 7.5 tonnes.

Basalt fibre reinforcement in the concrete offers greater tensile strength than polypropylene or steel fibres, which means the walls can be thinner. CCP's Thermomass connector system, meanwhile, uses non-metallic composite ties to hold the sandwich panels in place with a conductivity value of just 0.3W/m²K, preventing cold bridging.

From the outside, there is no clue that it is precast concrete: the external wall finishes are flat concrete with a 2mm-thick Parex acrylic render.

CCP has constructed eight modular homes to date, two of them using the Slimcrete system. The first Slimcrete house was constructed near Falmouth, Cornwall and the second is under construction near Wadebridge, also in Cornwall. CCP has agreed a 10-year warranty with insurer Build-Zone, and agreements with two other warranty providers are in the pipeline. There has been much interest in the system from developers of homes for private rental and shared ownership.

health and safety. The surface quality of precast concrete can be good enough for a painted finish. Bespoke architectural precast concrete can be used for uniquely shaped, sized and finished elements. Working with manufacturers, designers can create a solution for individual projects, which is then delivered just-in-time for assembly onsite.

Contemporary offsite housing solutions must meet high standards of building performance, in terms of energy efficiency, acoustic isolation and structural performance. These requirements are evolving with the increasing risk of overheating in a hotter climate, and new legislation related to non-combustibility. Here, concrete's intrinsic properties are an advantage. For example, it provides inherent acoustic damping, a key requirement of housing developments which can be difficult to meet with lightweight solutions. The thermal mass of concrete, when used properly, offers an offsite solution with in-built natural cooling and resulting energy savings, while its non-combustibility makes it a particularly appropriate material for structure, walling systems and cladding.

Innovative new systems are also being introduced, capable of delivering a range of both modern and traditional aesthetics. As the examples on these pages show, concrete continues to be able to meet the challenges our homes face, now and in the future.

ABOVE I-House, a collaboration between Saint-Gobain Roofspace and H+H, replaces the inner leaf of cavity walls, separating walls and internal partitions with storey-height Celcon Elements, made from aircrete. The system can deliver a watertight shell in a week, ready for follow-on trades. It has been used for over 500 homes
ABOVE LEFT Garenne Group's HexxHome is a flexible architectural precast system on a hexagonal plan, for one or two-storey single homes or terraces. A one-bedroom prototype has been built at Garenne's factory in Taunton, and a three-bedroom showhome is under construction at Graven Hill in Bicester
LEFT Garages by Tarmac for Barratt Homes, constructed from precast concrete panels at a speed of up to two per day. The panels are formed in rubber moulds with a recess pattern that resembles traditional masonry, sprayed with a reddish "Trufinish" pigment. When the concrete has set, the mould is peeled off and mortar trowelled into the 10mm-deep recess

LASTING IMPRESSION STEFANIE RHODES

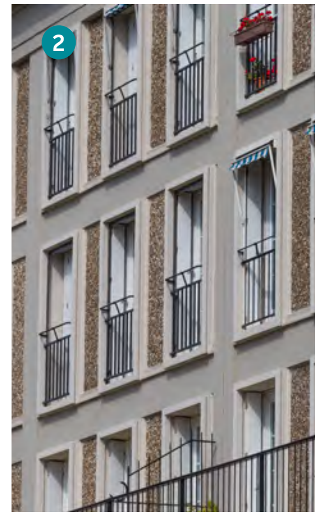
FROM CITY STREETS TO CELESTIAL STRUCTURES

I grew up near Lake Constance in southern Germany, a beautiful area full of cutesy medieval towns. So when I visited the Kunsthaus Bregenz 1 (1997) in Austria by Peter Zumthor for an Olafur Eliasson exhibition, it wasn't something I had ever seen before – concrete was something to be hidden or rendered. But here, these meticulous in-situ concrete spaces were absolutely celebrated – it's all the building is. I was about to move to Sheffield to study architecture, and seeing this beautiful concrete and the amazing synergy with the exhibition left a real impression.

In 2014, when we were working on Bethnal Green Mission Church, we visited Le Havre to see Auguste Perret's post-war reconstruction of the city centre 2 (1945-64) – this very well-considered background architecture with beautiful concrete details everywhere you look. Perret only designed a couple of buildings, while his workshop did an array under his supervision, so they're all slightly different – there are endless variations of precast concrete elements and panels. It was built as fast and as cheaply as possible, but it is a very coherent cityscape.

Sverre Fehn's Nordic Pavilion in Venice 3 (1962) is a pivotal reference point for our practice. Again, it is a celebration of structure. The roof is relatively deep, but it is made from incredibly thin concrete lamella, which have a strong material quality and modulate the light from above. We took a similar approach at Bethnal Green, as we needed a transfer slab with deep beams. We decided that if you've got a structure, you don't hide it, you make it a key part of the space. The ceiling is an important part of a space of worship – the way it emphasises the volume, the height, the sense of being immersed in that space – and Basil Spence's Coventry Cathedral 4 (1956-62) is a beautiful reinterpretation of a vaulted ceiling. Churches are incredibly traditional spaces, and Spence found a way of bridging that without simply copying from the past.

Stefanie Rhodes is a director at Gatti Routh Rhodes Architects



Photos: 1.Markus Tretter; 2.iammattdoran/Adobe Stock; 3.Hundven-Clements/VIEW; 4. maartenhoek/Adobe Stock

FROM THE ARCHIVE: SUMMER 1988

TWELVE GOOD MEN AND TRUE

Carole Vincent, who has died aged 80, was a concrete artist of rare grace and power, whose works can be seen everywhere from her native Cornwall to Singapore. In 1988, CQ explored her innovative sculptural series, Twelve Good Men and True. Originally intended as a large-scale work for the hilltop site of Truro Crown Courts, the idea evolved into 12 2ft-high maquettes based on portraits of her family and friends.

The figures were initially cast in clay, from which plaster moulds were made, in pieces "like a jigsaw", so that they could be reused. This allowed for limited editions, often with different aggregates. For the Twelve Good Men, she mixed slate aggregate and white cement, "just wet enough". After a week, the moulds were removed, and the fine surface skin sanded down under water to reveal the aggregate and restore the design's sharp lines. "Part of the attraction of Vincent's sculptures," wrote CQ editor George Perkin, "lies in her ability to exploit the natural properties of the material, achieving a simplicity of line and form well suited to concrete, coupled with imagination in the use of aggregates to vary the colour and texture."

Access the full CQ archive at concretecentre.com/cqarchive. A book, *The World Recast: 70 Buildings from 70 Years of Concrete Quarterly*, is available from www.concretecentre.com/publications

TWELVE GOOD MEN AND TRUE

More sculptures by Carole Vincent

FINAL FRAME: UNDER RESTAURANT, NORWAY

Snøhetta has completed an underwater restaurant off the coast of Lindesness, the southernmost point of Norway. The 34m-long concrete tube-like structure resembles a sunken periscope, with an 11m x 3m panoramic window at the submerged end, which rests 5m below the sea. The rough concrete shell is 0.5m-thick to help withstand tidal forces, and its deliberately rugged texture is intended to encourage algae and molluscs to grow, gradually transforming the structure into an artificial reef.

Photo: Inger Marie Grini/Bo Bedre Norge