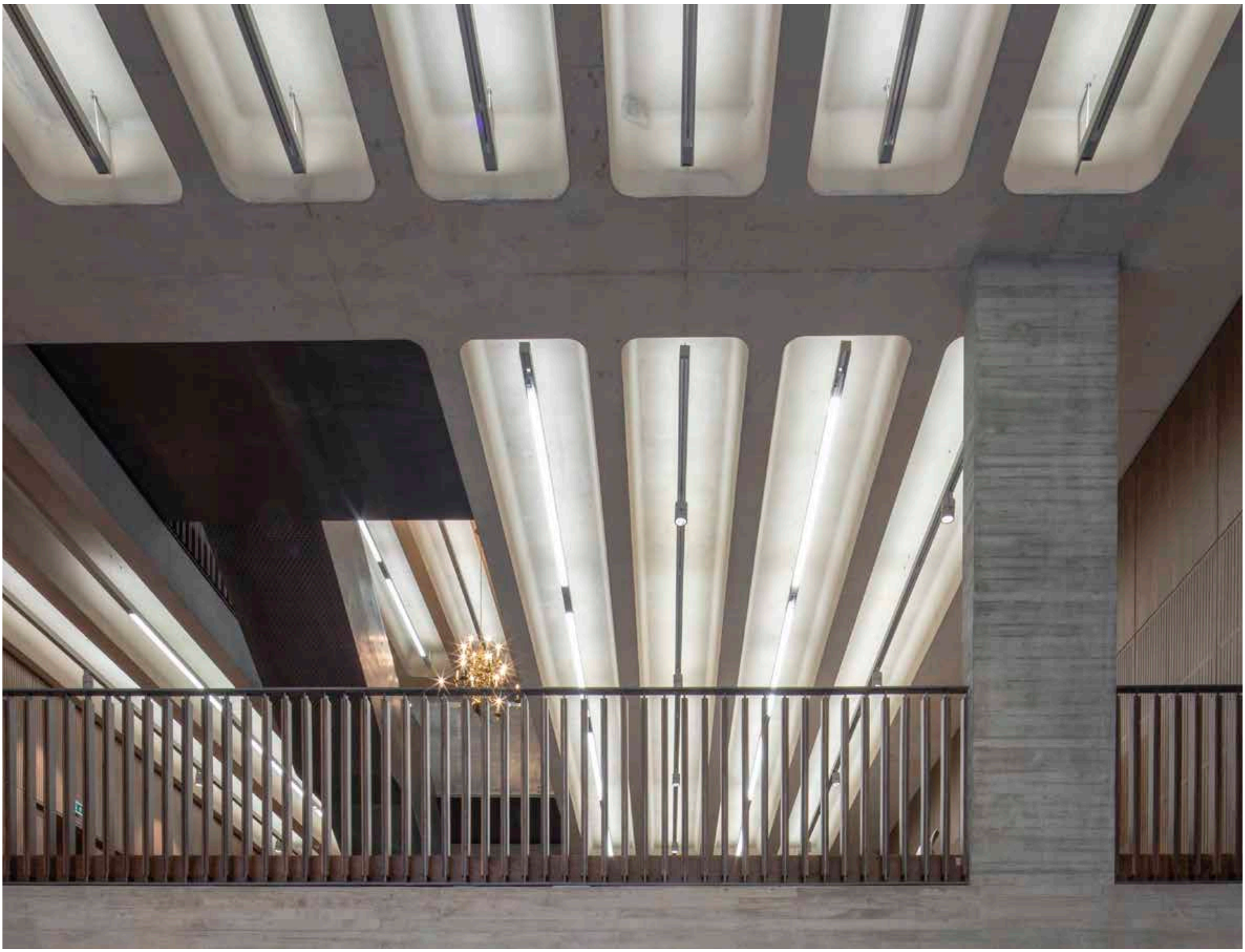
CONCRETE QUARTERLY

mpa The Concrete Centre

SPRING 2019 | ISSUE NUMBER 267



PATHOLOGICAL LAIR
Bennetts Associates builds a life-enhancing new home for the Royal College of Pathologists

GET STRATA
Inspired by nature, built by hand: Peter Zumthor brings rammed concrete to the Devon moors

AFTER GRENFELL
Building Regs have changed: your essential guide to the new rules on cladding tall buildings

CONTENTS

INSPIRATION

FOCUS

STRUCTURES

RETRO CONCRETE

DON'T MISS AN ISSUE

Read the online version of Concrete Quarterly at **concretecentre.com/cq**. If you have a UK postal address, you can also subscribe to receive a free print copy at **concretecentre.com/cqsubscription**

AGENDA

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

A lesson in less

Climate change, geopolitical turmoil, Brexit – complex problems call for ingenious solutions. So it's cheering to see so much ingenuity on display in this issue, on the part of designers, manufacturers and delivery teams.

The Royal College of Pathologists (pages 4-7) is a perfect example of how a coordinated, bespoke approach to a very specific challenge can fulfil a client's brief on aesthetics and performance, while also pushing the boundaries of material efficiency. Its deeply coffered ceiling has been precisely designed to maximise the availability of thermal mass for passive cooling, and at the same time minimise the weight of the structure and the materials required, enabling reuse of an old basement slab and retaining walls.

Material efficiency may sound simple on paper – "doing more with less" – but it is always a delicate calculation. Take the use of recycled or secondary aggregates, for example. There is often an opportunity to reuse materials from other projects or incorporate by-products from other industries, but this will not necessarily be the optimal solution on every project. Likewise with cement replacements, some of which may not always be readily available or technically advantageous. Rather, design teams must weigh up the potential resource efficiency benefits against local availability and the carbon emissions from transportation, and the implications for mix design and performance. Concrete is a fundamentally local product, and a mix will always be a carefully calibrated balance of structural performance, aesthetics, availability, cost and carbon. It is also a constantly evolving one, with many innovative forms of the material currently in development, holding the potential to transform the way we build over the coming decades.

MATERIAL EFFICIENCY MAY SOUND SIMPLE ON PAPER, BUT IT IS ALWAYS A DELICATE CALCULATION

Developing robust standards and regulations for new products is a necessarily slow process, involving a great deal of careful testing to ensure that they will deliver long-term performance and safety. This too is a complex balancing act – the rules must be prescriptive enough to prevent failure but not so rigid that skilled professionals are unable to deploy their judgement to assess their suitability in individual cases. Here, the recent update to the concrete specification standard BS 8500 is to be welcomed. It includes new composite cements for the first time, offering designers another set of tools with which to meet the many challenges that society faces, without depriving them of tried-and-tested options or oversimplifying the process.

THE WHOLE STORY

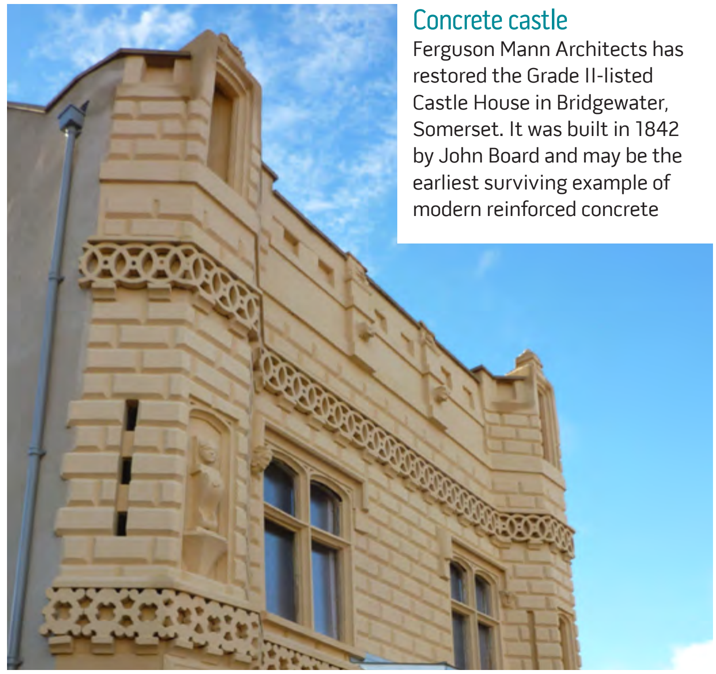
Reducing waste and using recycled content are just two components of material efficiency, writes This is Concrete blogger Guy Thompson. "Just as embodied CO_2 does not by itself represent a true carbon footprint, material efficiency should not be limited to a single life-cycle stage," he says. Without a holistic approach, opportunities may be lost on related criteria such as whole-life carbon and cost, climate change mitigation and adaptation, fire resistance and the move to a circular economy. "As with so many aspects of sustainable development, the most effective solutions require a holistic, joined-up whole-life approach."
www.thisisconcrete.co.uk

On the cover: Royal College of Pathologists HQ by Bennetts Associates
Photo: Peter Cook
Produced by: Wordmule
Designed by: Nick Watts Design

The Concrete Centre is part of the Mineral Products Association, the trade association for the aggregates, asphalt, cement, concrete, dimension stone, lime, mortar and silica sand industries.
www.mineralproducts.org

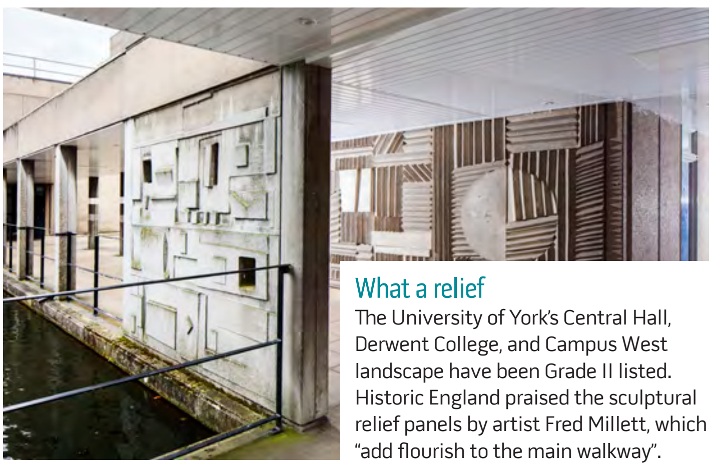
Serenading the City

The first concept designs have been revealed for the £288m Centre for Music on the site of the Museum of London. Designed by Diller Scofidio + Renfro, the building will provide a new gateway for the Barbican Centre.



Concrete castle

Ferguson Mann Architects has restored the Grade II-listed Castle House in Bridgewater, Somerset. It was built in 1842 by John Board and may be the earliest surviving example of modern reinforced concrete



What a relief

The University of York's Central Hall, Derwent College, and Campus West landscape have been Grade II listed. Historic England praised the sculptural relief panels by artist Fred Millett, which "add flourish to the main walkway".

70% carbon cut

Solidia Technologies says its reformulated cement cuts CO_2 emissions from concrete by 70%. It has less calcium, is non-hydraulic and manufactured at lower temperatures, and the concrete is cured using waste CO_2. It has been produced as precast blocks at Lafarge-Holcim's plant in Leighton Buzzard.

Images: Diller Scorfidio + Renfro, Ferguson Mann Architects, Solidia Technologies, Historic England

A CLASS ABOVE

Spring's Concrete Elegance lecture shares the learning from two exemplars of sustainable education. UCL Student Centre by Nicholas Hare Architects is designed for longevity and flexibility, while the high-rise Bobby Moore Academy (see page 8) fits an incredible amount on a tiny site – including space to play. Concrete is integral to structure and low-carbon cooling in both projects.
The lecture takes place on Tuesday 19 March at the Building Centre in London. concretecentre.com/events

Photos: Alan Williams Photography, Dennis Gilbert/VIEW Pictures

Photos: Peter Cook

ADVANCED ANATOMY

For the Royal College of Pathologists, Bennetts Associates has created an HQ with an elegant and highly efficient skeleton – and given it every chance of a long and healthy life. By Tony Whitehead

The Royal College of Pathologists is not the sort of organisation to up sticks every five or six years. It is very much an institution, and for the past 50 years it has inhabited a grand Georgian terrace near Buckingham Palace. So when the College finally decided to move on and get a place of its own (Carlton Terrace was rented) – it was with a view to staying put for the next century or so.

"This was a key reason we went for concrete at the RCP's new building in Aldgate," says Hannah Fothergill, project architect with Bennetts Associates. "It looks and feels long-lasting – and concrete has a weight, a gravitas, which we felt was appropriate for our client."

Early interviews with college members revealed a liking for the solidity of their old John Nash-designed building. "What came across was an affection for the sense of permanence inspired by exposed finishes, like the brickwork in the vaults, and this strongly influenced our approach to the design of the new building."

There are no dead bodies in the RCP's new place. It has no clinical functions, but rather is a 3,100m^2 headquarters, with office space, a lecture theatre, conference facilities and accommodation for senior members. Including the basement, it is seven storeys in all, and comprises an in-situ concrete frame all the way up to the top storey, which is set back from the rest of the building and built around a steel frame.

Entering the college from North Tenter Street, the sought-after air of built-to-last sturdiness is immediately evident. One passes through a facade of hefty, in-situ concrete wall-columns which are angled to control solar gain, and clad on the exterior with brick. Inside, the concrete walls have a highly textured, board-marked finish, which aligns neatly with the courses of exterior brickwork. Above, dramatic ceilings feature deep concrete coffers.

This is clearly not a building that is going anywhere any time soon – which is ironic given the fate of the site's previous occupant. As Fothergill explains, this too was a concrete-framed office building. "Our first instinct was to refurbish rather than rebuild, as the building was only built in 1987. For that reason we really didn't want to demolish. The problem was, it had an absolute horror of a column grid. We needed to fit in atrium space and a column-free lecture theatre and it couldn't be done without adding substantial transfer structures."

Bennetts was determined that its building would not suffer the same fate as its predecessors. "So we also wanted minimum columns to help our building stay flexible long-term," says Fothergill. "The new building has a hierarchy if you like: an enduring concrete skeleton which cannot easily be changed, floors and staircases which can be, and then easily

IT LOOKS AND FEELS LONG-LASTING – AND CONCRETE HAS A WEIGHT, A GRAVITAS, WHICH WE FELT WAS APPROPRIATE movable partitions." The moral of the story is that while concrete has the robustness to last and the structural strength to allow for future alterations, it is still absolutely necessary to design with this in mind.

But, seeking to minimise waste, the team did manage to keep the original building's 1.2m-deep basement slab, together with the basement's retaining walls. This saved hugely on cost and programme time, but did raise issues. "Obviously we didn't want to overload it – so we did consider a steel frame, which would have been lighter," says Fothergill. "But we realised we really wanted concrete for its aesthetics and also to use its thermal mass as part of the building's heating and cooling strategy. So we did our research and made it work."

This involved looking at original documentation in Building Control archives, and carrying out tests on the slab to check that it could support the weight of a new concrete frame. Once the thumbs-up was received from the structural engineer, the challenge was to create thermal mass together with column-free space, but without using heavy beams and slabs that could overload the original foundations.

"It was this that drove the integrated solution of the coffered ceiling," explains Fothergill. "It both minimises weight, which is good for carbon and easier on the original slab, and makes full use of the concrete's thermal mass by maximising the surface area in contact with air."

The result is a ceiling featuring coffers that are 425mm deep, 950mm wide and set at intervals of 1.2m. The ribs between are 250mm wide and span the whole 13m depth of the building – from Alie Street on the north facade to North Tenter Street on the south.

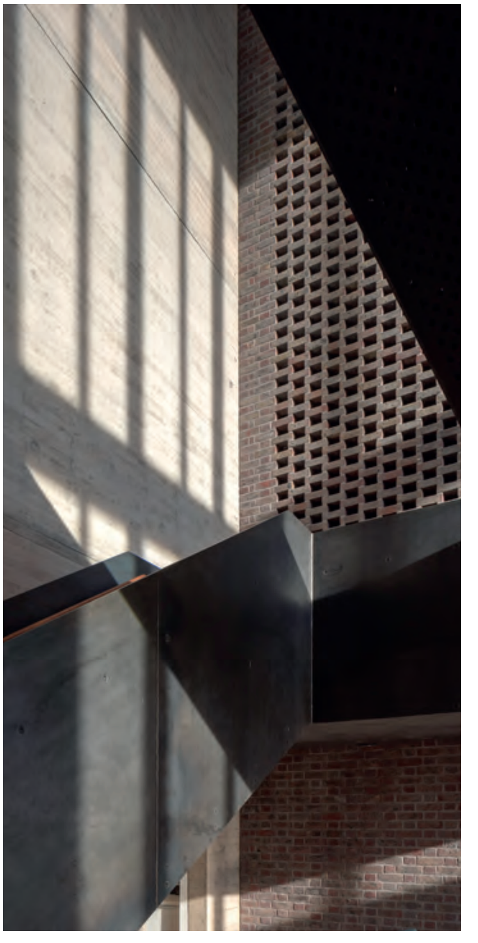
"The slab above the coffers is just 125mm deep," says Fothergill. This slab depth performs well for thermal mass and "was very light and an efficient use of concrete. To go any thinner would risk exposing reinforcement."

She adds that the early designs for the coffers were rectilinear, but the eventual result has a 10° angle to the side and slightly rounded corners. "The angle makes it easier to demould. We analysed angles between 5° and 35° but found that 10° was the sweet spot in terms of volume and thermal mass. The rounded corners help to prevent weird shadows forming and result in a pleasing, jelly-mould-like appearance."

Because the coffers produce such a large area of exposed concrete, most of the building can be passively cooled most of the time. Air is pumped into the building via large 400mm voids beneath raised floors, and extracted at ceiling level having been naturally cooled by the coffered soffit.

"In some highly populated areas we have added chilled beams suspended within the coffers," says Fothergill. "These areas, like the lecture theatre, can quickly go from zero population to hundreds and the thermal mass cannot respond quickly enough. We used external chilled beams as there was no room to place them within the slim slab."

The smoothness of the coffered ceiling is impressive and Fothergill explains that the choice of mix played a key role in helping to achieve the



New face of the RCP

Though essentially constructed from brick-clad in-situ-concrete wall-columns, the North Tenter Street face of the Royal College of Pathologists also features some of the building's few precast-concrete elements.

The facade is defined by a portal frame of precast concrete panels, and the in-situ structure is expressed on the outside by precast-concrete spandrels at the level of each slab. "Using precast concrete fixed back to the frame was a way to incorporate the thermal break," says Hannah Fothergill at Bennetts Associates.

The spandrels sit in the triangles created by the distinctive zigzag of the facade. Each is 220mm thick at the slab, tapering slightly to 200mm to create a slight fall to aid drainage. The spandrels are also sealed, and feature a rebated aluminium drip to push water away from the front edge to prevent rainwater staining the concrete over time. "The zigzag is quite deep, around 1.5m," says Fothergill, "and we are using the structure here to create solar shade on this south-facing elevation, rather than having to add things onto the building."

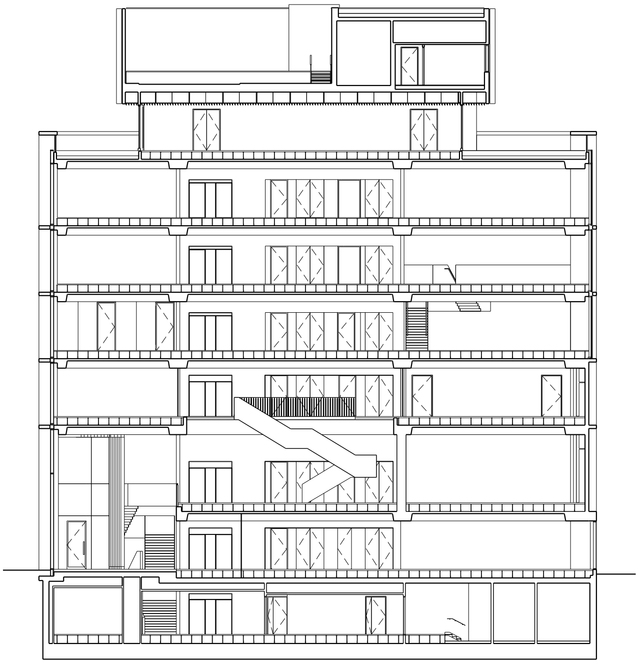
PREVIOUS SPREAD The 12m coffers were created using GRP formers. The slab above is just 125mm deep

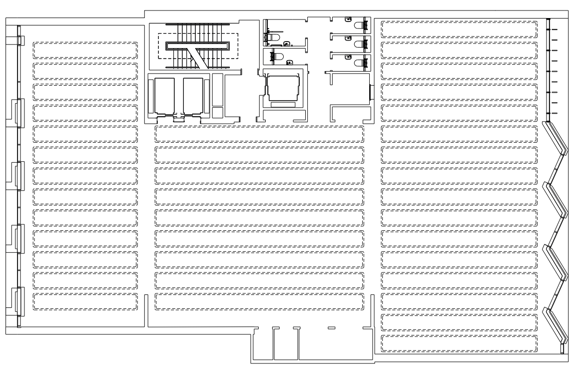
LEFT The board-marked walls were formed from 75mm-wide, rough-sawn pine planks nailed to Peri formwork

BELOW LEFT A mix with 30% GGBS gives a light finish to the exposed concrete

RIGHT A section through the seven-storey building, which includes office space, a lecture theatre and conference facilities

BELOW RIGHT Ceiling plan showing the arrangement of coffers





PROJECT TEAM

Architect Bennetts Associates
Structural engineer Waterman Group
Contractor Gilbert-Ash
Concrete contractor Oliver Connell
Precast concrete supplier Cornish Concrete
GRP coffer supplier Cordek

silky matt finish: "We have C40/50 concrete for the slab and C50/60 for the columns with 30% GGBS throughout," she says. "We felt this was the right balance between reducing embodied carbon and achieving the desired visual quality. We hoped to use 50% GGBS but the concrete contractor [Oliver Connell] advised that as well as longer strike times, a 50% mix could result in lumpiness, which is more challenging with deep-trough construction."

Ed Bourke, operations director with Oliver Connell, adds: "You might think you need small aggregate and a wet mix to achieve a smooth finish like this, but it isn't always so. We used a 20mm aggregate with a 120mm slump. It actually gives a finer finish than a 10mm aggregate with 200mm slump."

The reliability of the mix was equally important when it came to the distinctive board-marked walls. To create a highly textured finish, these were formed from 75mm-wide, rough-sawn pine boards nailed to Peri formwork. "Because of the way the wall columns on the facade swap angles, they are quite heavily reinforced to cope with the stresses that creates," says Bourke. "But to ensure a consistent finish here you really need to use large vibrating pokers. We worked with the engineer to ensure that the reinforcement was designed in such a way that we could still get 2.5-inch pokers through it."

The quality of finish suggests such attention to detail has paid off – testimony, says Fothergill, to a great understanding between designers and contractors. "We have learnt such a lot about concrete during this project," she says, "I can't wait to do another one."

Dissecting the coffers

The coffered ceilings that are such a feature of the RCP's headquarters are the result of a meticulous design and construction process. It was originally envisaged, for example, that they would be made with the help of polystyrene formers, but, says Hannah Fothergill at Bennetts Associates, these would not have achieved the desired quality. "It would be difficult to get the rounded corners to work in polystyrene, and we also could not source formers long enough to create 12m coffers," she says. "We would have had to use two or more and have joins which would show up in the finished concrete."

The solution cost more than polystyrene but, the team agree, using two floors-worth of made-to-measure glass reinforced plastic (GRP) formers was worth it. The formers were arranged on a deck of plywood formwork with reinforcement placed between each to create, in effect, 1m-wide downstand beams.

Once the concrete had cured sufficiently, the supporting formwork was struck and the timber deck lowered from beneath to release the coffer moulds. "Because of the long spans we had to allow for deflection of the slab at the facades of up to 25mm," says Fothergill.

Following cleaning, the moulds were manoeuvred through the atrium of the building and into position to follow the same process for the construction of the floor above.

Ed Bourke, operations director with concrete contractor Oliver Connell, explains that much of the smoothness of the coffers results from the use of GRP formers. "The GRP was treated to give a smooth matt finish, so we had to match that by using Tulsa-form ply for them to sit on, rather than phenolic which would have resulted in too shiny a finish."

The connection between the formers and plywood deck was also crucial: "It was sealed with a neat bead of mastic," says Bourke. "You have to use just enough. Too much and it can spread, rubbing onto the plywood where it would affect the water absorption of the formwork and result in dark staining of the finished concrete."

SPIRIT OF 2012

Penoyre & Prasad's Bobby Moore Academy on the Olympic Park punches above its weight, writes Andy Pearson

In 2012 the Olympic Park was host to a summer of spectacular sporting achievements and, amazingly, Britain's biggest Olympic medal haul in more than 100 years. Seven years on and the giant Olympic stadium, aquatics centre, velodrome and Anish Kapoor's twisted steel Orbit sculpture still occupy the 102ha park. These days, however, the venues serve as the backdrop to a fledgling east London community.

Now renamed Queen Elizabeth Olympic Park, the metamorphosis has seen the construction of residential blocks, cafes, bars, university buildings and landscaped gardens. Its latest addition is a secondary school for 1,140 pupils, providing education and community facilities for the growing neighbourhood. Named the Bobby Moore Academy in honour of the West Ham football legend and captain of England's 1966 World Cup-winning team, the bold new building is sited on a modest triangular patch of ground in the shadow of the Olympic stadium, West Ham's new home.

In an achievement worthy of an Olympic gymnastics medal, architect Penoyre & Prasad has successfully slotted a building with an internal floor area of 9,470m^2 onto a site measuring just 3,900m^2, half the size of the grass area inside an Olympic running track. "The big design challenge was in accommodating the large number of teaching spaces on such a tiny triangular site, which is why the building has to rise up six storeys," says Anna-Lisa Pollock, senior architect at Penoyre & Prasad.

To maximise playground space to the south, the architect has positioned the £28m school tight against the site's northern boundary. The two largest rooms in the school, the double-height assembly hall and triple-height sports hall, are on the first floor where they can overhang the play space. "The sports hall and main hall allow the site to be opened up; the overhang provided by the main hall allows outdoor dining while the sports hall shelters part of the playground and the school's main entrance," says Pollock. Higher up the building, a series of south-facing roof terraces provide additional outside space, complete with views over Canary Wharf and the more distant City of London.

Internally, a central corridor bisects the building. This incorporates voids punched through the floors above to link the spaces vertically and to allow light to permeate from skylights deep into the building. Arranged either side of this central spine are the teaching spaces, organised by faculty. Large windows maximise daylight throughout and provide a sense of openness.

EXPOSING THE COLUMNS WAS IMPORTANT TO GIVE THE BUILDING A SENSE OF WEIGHT. IT ALSO WORKS FROM AN EDUCATIONAL PERSPECTIVE

Externally, the facade curves around the multistorey building, giving it a distinct aesthetic while enabling the perimeter to closely follow the profile of the adjacent road, thereby fully exploiting the plot. "Forming these sculptural curves was much easier using an in-situ concrete frame than it would have been using steel," says Pollock.

The high-rise school's concrete frame contains

Photos: Dennis Gilbert/VIEW Pictures

CLOCKWISE FROM FAR LEFT
The curved facade helps to maximise the tight site; a series of voids let light and air permeate the school; exposed structural columns support the overhang of the main hall; a triple-height glazed facade announces the main entrance

PROJECT TEAM
Architect Penoyre & Prasad
Structural engineer Terrell
Contractor Balfour Beatty

25% recycled aggregate. On the ground and first floor, where the concrete structure is exposed, the round structural columns have been given a super-smooth finish by using PVC liner on the formwork. "Exposing the columns was important to give the building a sense of weight," explains Pollock. "It also works from an educational perspective because the children can see the materials from which the school has been built."

The columns support flat, in-situ concrete floor plates – the flat soffits offering greater flexibility to alter classroom layouts over the building's lifetime. "It makes it easy to move walls to reconfigure the interior to respond to changes in teaching, when compared to the option of using a steel-framed structure with downstand beams." It also made for simpler fire and acoustic detailing.

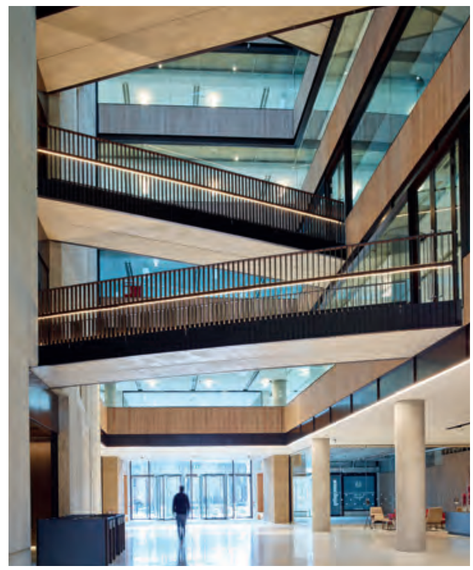
The floor plates incorporate numerous voids to let light and air permeate the school. "Having in-situ concrete floor slabs was a real benefit because it made it easier to create the cut-outs on site," Pollock says. "Because we worked with the contractor from the outset we were able to have very sensible conversations about buildability."

The concrete soffits also help to moderate the temperature inside the teaching spaces, enabling the classrooms to be ventilated naturally. However, the school's location, under the flightpath of the nearby London City Airport, prevented the inclusion of openable windows. Instead, the design team has opted for a hybrid natural ventilation solution based on a heat recovery ventilation unit fitted to an external acoustic louvre, which is incorporated into the side of the window units.

Ventilation rates are controlled based on carbon dioxide levels in the classroom, although teachers do have an override facility, and can also open a small panel beneath the hybrid units to increase ventilation. The units cool the concrete soffits at night too, maintaining the effectiveness of the thermal mass and ensuring comfortable classroom temperatures the following day.

The light grey window reveals and louvres perforate the school's woven pattern of glazed and matt-finished two-tone brick slip cladding. The cladding is punctuated in places by deeper window reveals accented in bright yellow. "We designed the school to have a strong architectural presence," says Pollock, "enabling it to stand on its own against the dominant structures on the park". And enabling this theatre of glorious memories to move one step closer to being a new London community.

PROJECT TEAM
Architect Allford Hall Monaghan Morris
Structural engineer Arup
Concrete frame contractor Expanded
Precast concrete Explore Manufacturing
Post-tensioned concrete Praeter Engineering



CLOCKWISE FROM TOP LEFT
A feature wall of in-situ concrete forms one side of the atrium; the project has improved pedestrian movement through the site; the columns and bridges were prefabricated to facilitate quality control

Photos: Timothy Soar

THIS IS THE BBC

Concrete in all its forms is the new face of the corporation's former White City HQ, writes Debika Ray

Television Centre in White City, the headquarters of BBC's TV operations for more than 50 years, is one of the most recognisable buildings in Britain. Since 2013, developer Stanhope has been spearheading the redevelopment of the complex into a mix of homes, offices, studios and leisure facilities, designed by architect Allford Hall Monaghan Morris (AHMM) and engineer Arup. Among these is 2 Television Centre, a new-build structure that has made creative and innovative use of concrete in multiple ways – to ensure the project was economical and efficient and that the final building would be enjoyable to experience in its materiality and appearance.

The building comprises office space, six restaurants and a branch of the private members' club Soho House. Upon entering, you arrive in a soaring 10-storey atrium, where the core of the building is on display in the form of a massive feature wall of concrete. Above your head, a series of slender concrete bridges cut across the space, providing a dramatic description of the circulation route through the offices. As you go deeper into the structure, you encounter concrete columns and slivers of the concrete soffit. Underneath are concrete foundations, both new and reused.

For the slabs, post-tensioned concrete was chosen because it allowed these horizontal elements to be just 250mm thick. Taking advantage of this lightness, Arup and AHMM designed a grid that eliminated transfer structures, which – alongside the thinness of each floorplate – meant an extra floor could be squeezed into the original proposal.

The columns and bridges were prefabricated, adding certainty to the schedule and facilitating quality control. "We were keeping these elements exposed, so there was a higher expectation with regards to the quality," says AHMM associate director Hazel Joseph. The columns were made using one of the highest strengths of concrete available, which meant the total number could be minimised and they could be kept to no more than 600mm in diameter. As a result, the amount of open, usable space has been maximised and more light can reach the centre of the deep floorplate, which has only two sides exposed to the outside. The columns have flared heads and bottoms to reduce pressure on the slab.

Perhaps the most striking aspect of the building's concrete is its surface treatment. On full display to any member of the public who walks through the building, it has been designed with great precision using a formliner to create a board-marked effect. As Joseph says: "Rather than lining the structural elements with additional materials, we decided to expose and celebrate the raw essence and the soul of the building."

Photos: Andy Stagg

QUILT COMPLEX

Pamela Buxton admires the textile-inspired precast cladding of Centre Point's affordable housing

After Centre Point comes the counterpoint. White Lion House is the £8.75m new-build element of MICA Architects' £150m revamp of Richard Seifert's central London tower, and it provides an interesting contrast in more ways than one. Where the tower boasts a penthouse with a price-tag north of £50m, its mid-rise neighbour provides 13 units for social and affordable rent. And instead of the iconic chevroned exoskeleton that rises over Oxford Street, at White Lion House MICA has opted for something softer – a facade of patterned precast-concrete panels that it describes as "quilted".

MICA's challenge was to fit the greatest amount of housing on a triangular site constrained by a basement substation and subterranean Crossrail lines. At the same time, it had to respond to the site's rich context – as well as the tower, it faces Renzo Piano's colourful Central St Giles development and the grade I-listed St Giles Church.

The apartments are arranged in nine storeys above ground-floor retail, with an in-situ concrete frame chosen as the most efficient way of interlocking the tight stack of accommodation, which includes five different design types around a single core. A prow-like corner form maximises views of the church, with further balconies on the west side overlooking the new square outside Centre Point tower. Between the two, a glazed circulation core is revealed as a dramatic full-height slot rising the full height of the concrete facade.

The quilted facade treatment on the east and west elevations "is meant to be an antidote to the skeletal tower", says Gavin Miller, director of MICA. The architects worked with textile designer Eley Kishimoto to reimagine the tower's chevron pattern for the panels, which span floor to floor in widths of 6.8m. "We wanted to work with the language of Centre Point but we didn't want to upstage it," explains Miller.

The pattern development involved extensive prototyping. The chevrons began as a straight imprint, before the team explored a more three-dimensional recess, producing five sample panels of different depths and finishes, followed by a full-scale mock-up. In the end, a shallow relief was chosen to reduce the chance of unsightly weathering. "We were looking for the smallest recess to make the biggest impact," says Miller. "Sometimes the effect is subtle, sometimes it's pronounced." A light-coloured mix was chosen, with an acid-etched finish to tie in with the renovated brise-soleils on the adjoining Centre Point House.

The architects opted to create the pattern in precast concrete, using flexible formwork liner, as a way of controlling the detailing. The method also brought time and sequencing benefits. The 150mm-deep insulated concrete panels clip onto the ends of the main reinforced concrete slab.

White Lion House is now fully occupied, with St Giles Square due for completion in 2020.

ABOVE The shallow relief pattern on the precast panels was inspired by Centre Point's chevroned facade

ABOVE LEFT Projecting balconies overhang the southern elevation

PROJECT TEAM
Architect MICA Architects
Structural engineer Pell Frischmann
Contractor Multiplex
Precast concrete facade Grants Precast

FOR SEDIMENTAL REASONS

Elaine Toogood explores the growing trend for rammed concrete and stratified aesthetics

One of the most visually appealing characteristics of walls made of cast-in-situ concrete is the opportunity for continuous, unjointed surface and structure. Techniques for placement and compaction avoid creating cold joints between layers of fresh concrete as they are systematically built up in the formwork, minimising the impact of abrupt changes in tone or colour on the exposed surface. For high-quality visual concrete, the location of day-work and construction joints are also controlled, often hidden or otherwise expressed as a shadow gap feature.

But there are notable projects where the layering process of casting concrete has been deliberately expressed – some of which challenge the established methodology for concrete construction. In combination with earth-coloured pigments, the results echo the horizontal strata of natural rock formations and tap into a concrete aesthetic that is more natural than industrial.

Neatly executed horizontal day-work joints are clearly visible in the concrete facades of the Foro Boca concert hall in Veracruz on the Gulf of Mexico (CQ 266) by Rojkind Arquitectos, where storey-high bands of concrete of varying tones are integral to the architectural expression of the building, its form and coastal location. The layers between day-work joints are much shallower in the rammed concrete walls of the Secular Retreat in Devon – as less concrete can be placed each day using this more labour-intensive construction method (see case study, left). For the external walls of the Yorkshire Sculpture Park's new visitor centre and gallery (CQ 264), designed by Feilden Fowles, distinctive horizontal layers were also created using shallow layers of site-batched concrete with different pigment and aggregate combinations. Rather than ramming the concrete, slender walls were constructed using fluid concrete, which could therefore be reinforced. In order to provide a bond, each layer was cast before the one below was fully cured, with four layers achievable in each 1.2m lift of formwork. Various techniques were used to add surface texture, enhancing the horizontal definition and natural appearance.

Facades reminiscent of geological layers are on show on a larger scale at the Forum :terra nova exhibition venue near Elsdorf, Germany by Lüderwaldt Architekten. Ready-mixed concrete using different pigments was supplied, placed and compacted to create reinforced walls two storeys high, the order and location of colours carefully pre-planned. Each layer had to be firm enough before the next was placed to prevent them from fully blending, but still fluid enough so that vibration could be used to avoid discontinuity between the layers. The whole surface was "ground" to further blur the junctions.

Varying the surface texture was used to give the impression of sedimentary layering in the sloping walls of Snøhetta's Lascaux IV visitor centre in south-west France (CQ 260). Long, horizontal strips of rough concrete were created by sand-blasting the smooth as-struck surface using a stencil – a more precise and controllable process than layering during construction. At the Islamic cemetery in Altach, Austria, by Bernardo Bader, varying depths of timber boarding were used as formwork, the natural variation between timber planks creating horizontal tonal variation in the resulting surface.

As the following projects demonstrate, the logistics of designing pigmented mixes, orchestrating their placement and predicting curing times is quite a challenge, requiring commitment from supplier and contractor. Carefully controlled trials in advance are essential, but it will never be possible to exactly predict the final outcome. After all, concrete's free-flowing nature and its inherent tonal variations are an integral part of its appeal – and so they are to be embraced.

LEFT At Bernardo Bader's Islamic cemetery in Altach, Austria, varying depths of timber boarding were used as formwork

◀ Secular Retreat, Devon

Living Architecture, the holiday property company set up by writer and philosopher Alain de Botton, has always invited daring design. It has teetered a barn by Dutch architect MMVRDV hair-raisingly over a Suffolk hillside, with a child's swing dangling from the overhang; it has built a fantastical cottage in an Essex meadow, a shrine to a fictional character dreamed up by Grayson Perry and FAT Architects. But in some ways its most recent project, Secular Retreat in south Devon, is the most adventurous of the lot. After all, none of the others involved two years of trialling just to work out how to build the walls.

Designed by legendary Swiss architect Peter Zumthor, Secular Retreat stands on a hilltop surrounded by Monterey pines. In many respects, it is the essence of a modern villa: a flat roof slab projects over glazed walls, revealing open-plan interiors of bespoke furniture. What holds it all together is something surprisingly monumental, and almost geological: a structure of 700mm-thick rammed-concrete walls that, like layers of prehistoric rock, bear the history of their making.

Despite the technique never having been used at this scale in the UK, it was integral to the design almost from the start. Zumthor, for whom this is a rare foray into houses and his first permanent UK project, had initially turned down Living Architecture's entreaties but was persuaded by the possibilities of the site. "That was the thing that excited him," says Mark Robinson, director of Living Architecture. "He had a very strong idea from the start based on the hilltop, and inspired by the stony outcrops on Devon's moors. His early concepts involved literally piling stones, and that then manifested itself in the idea of layered concrete."

While Zumthor had used rammed concrete before, notably on the Bruder Klaus Field Chapel in Germany (CQ 264), it was a voyage into the unknown for the local contracting team. "It took nearly two years of development and hundreds of samples," says Robinson. "We built a full-scale mock-up of part of the house, to examine details such as where the rammed walls meet the poured roof slab. It was a laboured process but that's what we had to do to make sure that the guys were confident and

ZUMTHOR HAD A VERY STRONG IDEA FROM THE START, INSPIRED BY THE STONY OUTCROPS ON DEVON'S MOORS

Photos: Jack Hobhouse/Living Architecture, Adolf Bereuter, Mole Architects that Peter was happy with the approach." It is easy to see why this project was 10 years in the making.

The walls were built up in 500mm layers. A dry, loose concrete mix – white cement, sand from the south-west coast and local limestone aggregate – was shovelled into the formwork in 150mm layers and tamped down to about 100mm, a process that was carried out five times. The concrete was left to dry overnight before the sliding phenolic ply formwork was struck, raised and the next layer added.

It was important, Robinson says, that the shuttering was 600mm high, as this meant that the site team couldn't just level the concrete off at 500mm. "Most contractors think concrete has to look perfect, so it was about changing the mentality and saying, this is handmade, just tamp it down, and if it's uneven that's fine. You make rammed concrete by not thinking too hard about it, not trying to be too precious." If that makes it all sound a bit easy, he adds: "At the same time, you can't make it deliberately uneven. You can't be random about it."

As the long development period suggests, the rudimentary construction technique belies some extremely careful detailing. The uppermost layers of concrete are more compacted, with slightly more water in the mix, so that they act as an aesthetic bridge to the poured-concrete roof slab. Likewise, because the structure was built as two unreinforced 300mm walls around 150mm of insulation, the team could use a slightly wetter mix to give a softer, more refined finish to the inner surface. The outer wall is rougher and more porous, effectively acting as an extremely thick rainscreen to the waterproof insulation behind.

For Robinson, one of the most appealing things about rammed concrete is that it brings its own narrative. "We can read our building by the concrete," he says. "Because we used a dry mix, it was always affected by whatever the weather was doing. If it was a dry day or a wet day, or if it started dry and then got wet, you can read it in a 500mm lift. What Peter wanted was that unpredictability. The guys can probably point to the walls they did because everybody had a slightly different way of doing it. It's a testament to them – they've handcrafted a building."

IT WAS ABOUT CHANGING THE MENTALITY AND SAYING, THIS IS HANDMADE, JUST TAMP IT DOWN, AND IF IT'S UNEVEN THAT'S FINE

ABOVE The rammed-concrete walls at Secular Retreat are 750mm thick: two 300mm layers of concrete encase 150mm of insulation

LEFT On the inside walls, a slightly wetter mix was used to create a more refined finish

RIGHT The ramming process was carried out by hand

Photos: Maxime Delvaux

▲ Plot A3 building, Lyon

Lyon's Presqu'île is both its historic heart and home to some of its most interesting new architecture. This spit of land between two of France's mightiest rivers is now graced by the Herzog & de Meuron-masterplanned Confluence quarter, as well as Coop Himmelb(l)au's eye-popping, crystalline Musée des Confluences at its southern tip. In this company, an eight-storey office block that doesn't even have a name wouldn't usually be of much interest – were it not for its intriguing concrete structure.

The first three storeys of the building on Plot A3, designed by Swiss architect Christian Kerez, are dominated by a series of 90cm-diameter columns that stretch from the exterior all the way through the curtain-walled interiors. What makes these elements so striking is their layered, almost geological aesthetic – a product of the *béton estampé* casting method.

The columns were cast in situ using formwork of thin vertical timber boards. The concrete was placed from above and tamped down by hand to create layers of 10-20cm. A smaller tool was required to tamp around the columns' inner ring of reinforcement. Each layer was left to cure for up to two days before the next was added. The only variation in the mix was the grade of the aggregate, which was all sourced from a local limestone quarry.

The use of the columns as such a prominent feature was inspired by the neoclassical architecture of the Presqu'île's Cours Charlemagne, the western border of the Confluence quarter. "In classical buildings you always have the pedestal at the bottom, which is often heavy, with enormous brickwork elements," says Kerez. The idea was to embrace this heaviness by using a structural system that relied on hefty masonry elements. "Because [*béton estampé*] is less dense and can only be densified by applying pressure from the top, not from all sides, the dimensions have to be much bigger."

Kerez was happy to let the architecture be led by the engineering, with testing of the concrete focused solely on the structural performance. The result was a grid of columns with an unusually monumental scale: "When we did a mock-up at 1:1, it was really striking how differently a human body relates to the scale of 90cm-diameter columns."

When it came to the finish, Kerez was again happy to let the architecture be guided by the production process. The columns were left as-struck. "We don't find it interesting to work from a picture," he says. "The finish is the aesthetic consequence of a change in fabrication method. We were just hoping to make it look natural and that it would fit with the buildings from previous times."

When the formwork was removed, Kerez was delighted to find that the concrete had a stone-like quality that echoed the Presqu'île's traditional buildings. "The pressure from the process is so big that the aggregate is pushed to the outside and it begins to look like a terrazzo. We were quite amazed to see this surface."

THE FUTURE OF FIRE SAFETY IN TALL BUILDINGS

Following the Grenfell Tower tragedy, the government has banned combustible materials from the external walls of buildings over 18m high. Tony Jones gives the lowdown on the updated fire regulations

On 29 November 2018, the UK government published details of previously announced changes to the Building Regulations banning the use of combustible materials in the external walls of certain types of building. The intention of these changes is shown in table 1. In addition, a revision to Approved Document B has been issued to reflect the ban.

Scope

The ban applies to any building with a storey 18m above the ground that either contains a dwelling, a room for residential purposes or an institutional use such as student accommodation, care homes, dormitories in boarding schools, and hospitals. Hotel type uses are not included. The ban applies to the whole height of the "relevant buildings". The new regulations came into force on 21 December 2018 although there is some leeway for buildings already in the planning process, providing construction started within two months of the ban.

Clarification of items covered

Regulation 2 deals with definitions and this has been changed to include definitions of "external walls" and "specified attachments", the items covered by the ban. Anything within the build-up of an external wall is covered – therefore structural elements within the walls of relevant buildings must not contain combustible materials. In addition, "specified attachments" include items such as balconies, sunshades and solar panels and they are also covered by the ban. Clearly, for relevant buildings, timber balconies will not be permitted.

Thermal upgrades

Regulation 4 sets out the requirements for building work. This has been changed to confirm that the ban applies to work carried out to upgrade the thermal performance of relevant buildings by stating that such work must comply with regulation 7.

Change of use

The changes to regulations 5 and 6 describe how the ban will work where there is a material change of use. Any building that, through modification, becomes one of the relevant building types must comply with the updated regulations. Therefore, if the external walls contain combustible material, that material will need to be replaced. This could have significant implications for office-to-residential conversions or vertical extensions.

Banned materials

Regulation 7 covers materials and workmanship, and here the changes provide details of the ban. The revised regulation states that materials in the external walls of relevant buildings must comply with European fire classification class A2-s1, d0 or A1. Specifiers should take note that this A2 limited combustibility class differs to that required for buildings outside of the ban, as given in the existing Appendix A of Approved Document B. Regulation 7 acknowledges that a number of items used in external walls may not be readily available in a non-combustible form, and a relatively short list of items are exempted from the ban. This includes specific items such as cavity trays between two leaves of masonry, seals, gaskets, fixings, sealants and backer rods. However, there are more generic items such as window and door frames listed. It is accepted that the list will need to be regularly reviewed.

TABLE 1: AMENDMENTS TO PART B OF THE BUILDING REGULATIONS

Regulation	Intention of change
2	To provide a definition of "external wall" and "specified attachment"
4	To require thermal upgrade work to comply with regulation 7
5	To confirm that if changing the purpose of a building to one covered by regulation 7(4), this is considered a material change of use
6	To confirm that any building undergoing a material change of use due to the additional clause in regulation 5 is required to have "external wall" and "specified attachments" containing non-combustible materials only
7(2)	To define in detail the materials that may be used in "external walls" and "specified attachments"
7(3)	To define specific items to which the ban on combustible materials does not apply
7(4)	To define the relevant buildings to which the requirements apply

Photo: Ian Stewart / Shutterstock

ANYTHING WITHIN THE BUILD-UP OF AN EXTERNAL WALL IS COVERED. STRUCTURAL ELEMENTS WITHIN EXTERNAL WALLS MUST NOT CONTAIN COMBUSTIBLE MATERIAL

ABOVE Relevant buildings include apartment blocks, student accommodation, care homes, school dormitories and hospitals

Approved Document B

Approved Document B was also revised in November 2018 and implements the change predominantly by modifying section 12. In addition to regulation B4 (surface spread of fire) the relevant part of regulation 7 (materials and workmanship) is included.

The introduction has been significantly shortened, stating that the purpose of the section is to reduce the risk of vertical fire in tall buildings and the risk of ignition from adjacent buildings.

Additional requirements for fire resistance are highlighted, but rather than simply referring to Appendix A (which provides a table of resistances for different members), the text now refers to the relevant sections in the approved document.

For buildings other than those defined in regulation 7(4), requirements for the combustibility of external walls are largely unchanged. This means that insulation materials for buildings that have a storey above 18m but which fall outside of regulation 7(4) in terms of use must still either meet an acceptable standard of performance in the BS 8414:2015 system fire test or be of limited combustibility. The definition of limited combustibility remains as per the previous version. Therefore, testing to BS 476-11 is acceptable. The equivalent BS EN 13501 criteria is A1 or A2-s3, d2 or better. The difference in classification for these buildings and those in regulation 7(2) is not helpful, particularly the fact that different A2 classes apply to buildings above 18m depending on whether they are required to comply with regulation 7(2) or not. It is not clear at present why these requirements have not been harmonised.

Masonry cavity wall construction in buildings that do not fall under regulation 7(4) remain exempt from the insulation requirement using the existing diagram 34 of the approved document.

The requirements for external surfaces remain defined via reference to diagram 40 of the approved document, though the requirements of regulation 7(2) take precedence for relevant buildings. Under the new Approved Document B, it is now stated that the internal faces of cavities should also comply with diagram 40.

The revised Approved Document B then contains an additional section dealing with regulation 7. In addition to restating much of the regulation as presented above, it confirms that the ban includes student accommodation, care homes, sheltered housing, hospitals and dormitories in boarding schools. It is clarified that regulation 7 applies in addition to the requirements of B4.

On this basis, Approved Document B notes the requirement to consider the impact of any products incorporated into the walls (including exempt items), and provides performance criteria for some exempt items. There is a requirement to consider the impact of other attachments to the wall which could affect risk – so even if the item is not a "specified attachment", both the regulations and Approved Document B require that its potential to spread fire across the wall is considered.

It should be noted that Approved Document B was revised again on 18 December 2018 to restrict the use of assessment in lieu of tests.

Summary

Overall, the regulatory changes have delivered a ban with significant implications. The practical impact on change of use of existing structures will need to be considered. In addition, the completeness of the list of excluded items will be challenged. As these areas are written into the regulations there is no "legal" way around the requirements. The changes result in no change to the materials used in buildings that fall outside of the ban. This leads to subtle differences in requirements particularly with regard to the definition of limited combustibility. Care should be taken to ensure that the appropriate rules are chosen – although given the rules on material change of use, it may be pragmatic to use the more onerous requirements for all new buildings over 18m.

OPINION: TOO MUCH AND NOT ENOUGH

Tony Jones argues that while the ban lets combustible structures off the hook, it may inadvertently outlaw safe forms of construction

Photo: John Gomez / Shutterstock

ABOVE The changes to the regulations were prompted by the Grenfell Tower tragedy in London – the worst UK residential fire since the Second World War. The rapid spread of fire was blamed on the building's exterior cladding

The government's decision to detail the ban on combustible materials in external walls within the Building Regulations may have unintended consequences for demonstrably safe forms of construction. In addition, restricting the ban to cladding does not address concerns about combustible structure.

The government's decision to change Building Regulations probably reflects the need to re-establish confidence in the industry, but it does have several downsides in comparison to implementing the ban through approved documents alone. Approved documents provide an accepted means to satisfy the Building Regulations. While it is possible to demonstrate compliance without following the approved document, the onus is then on the design team to demonstrate how they meet the regulations. This means that alternative approaches that can be shown to be safe can be compliant. The relevant previous regulation was B4(1) and this remains unchanged: "The external walls of the building shall adequately resist the spread of fire over the walls and from one building to another, having regard to the height, use and position of the building."

This regulation avoids prescription and is therefore aligned with the Hackitt report "Building a Safer Future", which advocated outcome-based regulation. It would be completely compatible for the approved document to ban combustible material in cladding as the means to satisfy this regulation while accepting that other first-principles approaches could be used.

By implementing the ban primarily through the regulation, the use of combustible materials in external walls will become "illegal". This means that, for example, concrete sandwich panels that require rigid insulation for their construction will need to use less efficient insulation products, despite over 50 years of satisfactory performance from products where insulation that would not comply with the new criteria is sandwiched between two inert, fire-resistant concrete panels.

WRITING THE EXCLUSION LIST INTO LAW LEAVES NO ROOM FOR PROFESSIONALS TO APPLY THEIR JUDGEMENT

Similarly, the application of new regulations for material change of use will mean that office-to-residential conversions where insulated concrete cladding panels have been used may become less viable, as will the upward extension of such buildings to include a residential top floor. Again, given the good historic performance of these systems in fire, this seems an unnecessary restriction and requires review.

As not all components that make up an external wall are available in non-combustible forms, there is an exclusion list written into regulation 7. The list will require updating both to address omissions and presumably to remove items as non-combustible components become available. As a minimum, there will need to be further guidance on interpretation – for example, does a non-metallic wall tie count as "thermal break materials where the inclusion of the materials is necessary to meet the thermal bridging requirements of Part L of Schedule 1"? If not, its inclusion is banned in relevant buildings. Writing the exclusion list into law leaves no room for professionals to apply their judgement. It is not desirable for further clarification to be established by case law.

Overall such an approach is likely to limit innovation and may hamper the ability of cladding to improve performance in other areas such as internal comfort.

The changes to the regulations and Approved Document B do not address non-cladding combustible elements in high-rise structures. This reflects the scope of the consultation but ignores concerns about the performance of combustible structures in residential towers. In January 2018, Arup and the University of Edinburgh published a paper[1] highlighting the contribution to the fuel load of exposed cross-laminated timber (CLT) in a fire test simulating a compartment fire. In addition, they demonstrated the inadequacies of current fire encapsulation systems and the failure of timber fire design methods to capture real behaviour. Predicting charring rates was shown to be unreliable due to the delamination of the material. The points raised in this paper have not been addressed.

In a similar vein, the International Association of Fire Chiefs has raised concerns about extending the scope of the International Building Code to cover buildings constructed from CLT above five storeys tall.[2]

In fact, there are restrictions on combustible structures in some parts of the UK. The Scottish Handbook 2017 effectively prohibits the use of CLT in residential buildings above 18m unless a fire safety engineering approach is used. This is because both separating elements and elements of structure supporting them are required to be non-combustible in high-rise residential buildings.

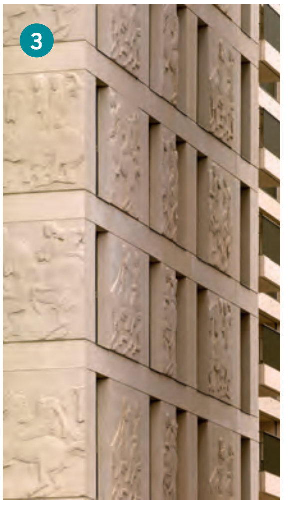
The regulations in England appear to be out of step in not considering any limitations on the use of combustible structures in high-rise buildings. These omissions also need to be addressed.

REFERENCES

[1] Deeny et al, "Fire safety design in modern timber buildings", The Structural Engineer, January 2018

[2] International Association of Fire Chiefs "The Use of Cross-Laminated Timber in the Construction of Tall Wood Buildings", 12 April 2018

LASTING IMPRESSION JE AHN



Photos: Collection Artedia/VIEW, seier+seier/Flickr, Edmund Sumner/VIEW

THE ART OF AGEING WELL

I've always been told that as an architect you have to love Le Corbusier – and I have totally failed. I love his logic and his clarity and the gusto of his writings, but when I stand inside his buildings, I think: he's right, this is a machine that people happen to live in, and I don't want to live in a machine! But there is one that really moves me – his chapel at Ronchamp, Notre Dame du Haut 1 (1954). You climb these winding streets, and there it is, standing there as if a giant had moulded it. It's like when you see a clay pot, you can almost feel the human hand, the warmth. Just walking in, you sense the atmosphere. I'm not a particularly religious person but that moment was so human, so different from the experience you get from gothic churches.

It's fascinating how religious elements are manifested in different times and places. At Ronchamp or Tadao Ando's Church of Light in Japan, you have this very sculptural expression in concrete. But then Jørn Utzon's Bagsværd church 2 in Denmark (1976) is completely different. It's so blocky outside, you think is this a crematorium or an office building? And then the inside is crazy – it bears no relation to the exterior! I don't know what he was thinking or what his brief was. I haven't visited it, but I really want to.

We're designing a social housing development in London with precast-concrete structural cladding, and I'm exploring how you can manufacture reliefs and surface patinations, in a similar way to Níall McLaughlin's athletes' housing for the London Olympics 3 (2011). I'm really interested in how they went through the process – producing the mould, creating the effect. I personally dislike how very flat surfaces age – whether it's glass or concrete, algae and dirt gather in a very uncontrolled manner. But as soon as you put folds in, and they get older and deeper, you give the process character. Look at our faces: as we get older, the creases show the essence of a human being, our nature. I like that.

Je Ahn is the founding director of Studio Weave

FROM THE ARCHIVE: WINTER 1957

THE GRAND ARCH OF LLANDAFF

"Adding to an old building is a ticklish business these days. It has not always been so: the historical conscience is a new thing," wrote CQ in 1957. The observation had been triggered by the fierce debate surrounding George Pace's restoration of the bomb-damaged Llandaff Cathedral in Cardiff. The main point of contention was the central pulpitum which, although a revival of a constructional form used in medieval times, was bracingly modern. A parabolic arch of reinforced concrete, 25ft high, spanned the nave, with a concealed platform for the organ and a sculpture by Jacob Epstein of a distorted Christ in Majesty.

"The arch has been criticized as being 'out of place'," wrote CQ. "This looks like another way of saying that concrete, used as concrete and not hiding it, has no place in a stone building." But far from destroying the cathedral atmosphere, this new layer of history had done much to restore it, CQ concluded. "With a design of today and material of today, a sense of aspiration, of movement, is established, in mood as Gothic as the arcades flanking the nave: infinite riches in a little room."

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

FINAL FRAME: LA MARSEILLAISE, PROVENCE

Jean Nouvel's 135m-high office tower in Marseille has a lightweight ultra-high-performance concrete facade painted in 27 shades of red, white and blue. The matrix of brise-soleils comprises 3,500 separate precast-concrete elements, with each panel painted in up to six colours to create an ombré effect. Nouvel has described the tower as a "new architectural anthem for the region": the blue is meant to represent the city's sky, the red its terracotta rooftops and the white the rugged coastline.

Photo: Michèle Clavel