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Perfecting finishes with precast

Roehampton University Library, Creagh Concrete. Image credit: Hufton Crow.

A vast arrange of design options are available using architectural precast. Here, we look at the different finishes available, and the best practice steps to follow to ensure the highest quality and most cost-effective outcome.

Architectural precast is enjoying a welcome renaissance. Advances in mixes, more sophisticated moulding and a greater variety of finishing techniques mean that exposed precast concrete can offer many aesthetic possibilities – as well as its other acknowledged benefits such as thermal mass, fire protection, low maintenance. durability, quality, safety and speed of installation of site.

High profile recent projects which have embraced architectural precast – external and internal – include Cornish Concrete's new Student Centre at University College London, Creagh's University of Roehampton's library, Techrete's John Lewis in Leeds, while FP McCann has employed a wide range of finishes across its hotel, housing and education portfolio.

There is a huge range of possibilities for designers and constructors looking to use architectural precast, but key to success, as The Concrete Centre's senior architect Elaine Toogood explains, is "starting the conversation with the precast specialist as early as possible".

An important early consideration is the aesthetic quality of the surface. The expertise and knowledge of the manufacturer is essential to help navigate the potential combinations of aggregate type and sizes and surface finishing techniques and therefore the final aesthetic quality of the concrete. "Precast suppliers will have a back catalogue of mixes and picking one they've already used before will likely save time," says Toogood. "A new 'recipe' will require new samples, and not all aggregates can be finished in the same way."

The heritage-based approach to development in the UK has led to many architectural precast examples used as a cost-effective alternative to stone – hence it's common name of 'reconstituted stone' or 'recon'. Natural sands provide the colour, with a matrix of white cement. "The colour of the concrete can be changed through finishing techniques which take off the outer surface, revealing more or less of the aggregates," explains Toogood.

Pigments can also be added depending on the requirement. "Natural, earthy colours are most commonly used," says Toogood, "Greens and blues are also available but tend to be more expensive."

Moulds are an important factor in terms of cost. "Making the mould is potentially one of most expensive parts of the process, so precast firms have developed manufacturing techniques to keep costs down, often by optimising their reuse," says Toogood.

"Since most architectural precast concrete receives a post finishing treatment to change the surface of the concrete, the form facing material for the mould has little impact on the final aesthetic and is left to the precaster to suit their preferred manufacturing technique."

Adjustable steel moulds for stairs and flat panels can be reused hundreds of times over, simply adapted in the factory to suit project requirements. Alternatively, fully bespoke moulds can also be created, often for more complicated, three-dimensional shapes.

"There are lots of ways to create some wonderful forms," she adds, pointing to the Dover Esplanade scheme, where Thorp Precast created the wave-themed ramps, stairs and retaining walls using a variety of techniques.

"For well designed and constructed architectural precast, thought will have been given to where the joints between the elements are located," notes Toogood.

"With flat façades, it's practically impossible to conceal them and so should be embraced as part of the architecture. Alternatively, the surface pattern can help. At Fish Island Village in Hackney, London, the architect worked a 'Herringbone' pattern into the design of Cornish Concrete's precast sections, the unusual angle effectively hiding the angled joints.

Fish Island Village, Hackney Wick. Image credits: Cornish Concrete Products.

"Dusting the sealant in the joint can also help," she adds.

Architectural precast is usually cast into moulds horizontally, and the underside is always the best surface because of gravity. "Remember that architectural precast is designed to be seen, so the design and construction planning should consider which surfaces will be visual in the completed building," says Toogood. "The unformed face is usually the one that is hidden."

Beyond conventional moulds, it is also possible to use formwork liners to create more varied textures and patterns [see on pages 4-5]. "The surface relief that can be achieved is extraordinary," says Toogood.

Acid etching is a common post finishing technique for architectural precast. [see on pages 4-5]. Mechanical abrasion, such as grit or shot blasting is also used in post finishing, says Toogood.

"As well as changing the texture, or creating patterns, it should be remembered that these techniques also change the light reflection and colour of the precast unit," notes Toogood. "The more you remove fine particles from the surface, the more you change the colour, and the deeper you go, more aggregates will be revealed."

Polishing of precast units can involve automatic machines. A 'bridge polisher', for example runs systematically over the large surface face in the factory. Techrete provided architectural precast panels with both polished and acid-etched surfaces for the complex 'diagrid' façade at the John Lewis in Victoria Gate, Leeds.

"Polishing small areas, or window reveals, is likely to be done by a hand held machine," explains Toogood. "This is why it is key to have an understanding of all the processes involved in achieving the final result."

Matching architectural precast with in situ poured concrete on the same project is difficult, though not impossible, as Cornish Concrete's UCL project demonstrates. "It should be avoided ideally, but if it's absolutely necessary, match the precast sample with in situ, not the other way around," says Toogood.

Image credit: Arup.

Perfecting finishes with precast continued...

Image credit: Arup.

Transportation and site assembly

Once the unit is finished in the factory, architectural precast has to consider the logistical and construction issues in transporting the units and assembly on site.

When it comes to transportation. "This starts with moving the units into the yard, to be loaded onto the trailer," says Moses. "We make sure the exposed face doesn't sit on the bearers, but transportation is trickier with columns that will be exposed on all four sides.

Finally, there is the construction. "We always worry about site installation with any architectural precast panels, damage causes by ourselves or – more typically – other site operations," says Moses.

Image credit: Snug Architects/Graphic Concrete.

Form liners

A wide variety of textured finishes and patterns, plus ornamental and sculptural features, are possible with architectural precast, though the use of flexible formwork, form liners and other creative innovations.

Reckli designs and manufactures elastomeric polyurethane form liners and moulds for patterned concrete. It offers numerous different finishing effects, ranging from conventional wood and stone textures, bespoke ornamental features, and even 3D illustrations and photography. The form liners are supplied to precast factories to create the desired finish.

This technique was used to create the lace pattern in the façade at Nottingham Contemporary Arts Centre, where Trent Concrete supplied the architectural precast units.

The sculpted 'Parthenon' frieze of the Olympics Village in east London, is another example of the possibilities of flexible form liners. Here, Techrete replicated sections using architectural precast cast in to form liners made using a digital scan of the originals.

An alternative technique is illustrated in the new Milford-on-Sea beach huts in Hampshire, where the precast wall panels feature patterns of pebbles. These shapes were created by a form liner from Finland's Graphic Concrete, which has patented a technique for printing a pattern or image in the paper form liner using a surface retarder, resulting in a pattern – of different texture and colour – being left in the surface of the precast concrete when it is taken out of the mould.

"One advantage of architectural precast concrete is the opportunity for creativity, through a huge range of forms, textures and patterns, with the potential to be replicated again and again," says Toogood.

Motel One, Manchester. Image credit: FP McCann.


John Lewis in Victoria Gate, Leeds. Image Credit: Techrete.

Acid etching

Approaches to acid-etching vary across the BPAS membership, though there are three common methods: dipping the entire unit into an acid bath, manual application of the acid wash, or a pressure washer, the method favoured by Cornish Concrete.

"The precast unit comes out of the mould and is taken to the acid etching bay in our factory," explains Cornish Concrete director David Moses. "We regulate the ratio of hydrochloric acid to water in the washer, depending on the level we want to etch."

The etching typically varies in depth depending on what the client wants, at the UCL Student Centre a heavier etch was used to begin exposing some of the stone.

After the acid treatment, the precast section is then washed to remove all the acid, and then 'made good'.

"Most units have a few small blow holes when they come out of the mould, but acid etching exposes a few more," explains Moses. "So, we fill them, then lightly etch it again. For a large unit, this will take two to three hours in total.

Colin Richards, quality assurance materials manager at FP McCann, says that selection of the mix materials is crucial any exposed aggregate or acid-etched finish.

"Aggregates are selected for their colour, size, shape and resistance to acid attack," he says. "Where corner returns are required, you would not select a flaky or elongated aggregate as the exposed colour and texture of the aggregate on the return face will look different to the flat face of the unit.

"Aggregate size is also important. If a customer wants us to produce a flat, exposed aggregate finish, our mix design will use a 20mm coarse aggregate with a reduced sand content to allow the coarser aggregate particles to sit tightly on the bottom of the unit as cast."

Richards warns that aggregates should be selected for their hard-wearing properties for acid-etched units, which FP McCann has used recently on Motel One in Manchester, the University Locks scheme in Birmingham and the new Holiday Inn Express in Bridgewater.

"You would not use a material that is likely to be dissolved by the acid," he says. "The mix design is also crucial, because if there is not enough fine material in the mix, you can undercut the coarser aggregate particles and they may fall out after removal of the retarder.

"For a deep acid etched finish, you only want to see the tips of the coarser aggregate particles, and on a fine acid etched finish, just the fine aggregate particles."

At FP McCann, the etching process is carried out manually. "We take the unit into the acid washing area as soon as practical after de-moulding," says Richards. "Then, we firstly spray the unit with water, this controls the depth of etching with the acid.

"We then systematically apply the acid to the unit with a watering can, washing with clean water between coats. This ensures a nice even etch. After the final wash, the unit is removed to a finishing area.

"A bespoke finishing material is then used on any surface defects such as blow holes and allowed to harden for a few days. The unit is then brought back into the acid bay for a final etch, which removes any excess material from the face. Finally, it is washed thoroughly again and then removed to a stacking area."

Concrete graduates with honours at UCL

Setting new standards for sustainability

UCL Student Centre, London. Image credits: Cornish Concrete Products.

UCL's new student centre is dominated by exposed concrete, which meant the mixes and finishes had to be specified with great care by the design team, precast supplier Cornish Concrete and in situ concrete contractor J Coffey.

In the heart of the Bloomsbury conservation area, a new modern building for University College London (UCL) students is setting new standards for sustainability.

The Student Centre is expected to achieve a BREEAM Outstanding rating, with concrete playing a central role in the design and construction. Extensive areas of exposed concrete contribute to the thermal mass properties of the building, while recycled material has been used widely in both precast and in situ elements. Concrete also provides acoustic benefits, given the building's hemmed-in location, and the elevations are largely constructed from architectural precast.

With a varying combination of exposed precast and insitu concrete, matching all the different mixes posed considerable aesthetic challenges.

"Concrete was key to our 'fabric first' environmental strategy," explains David Tompson, associate and project architect with Nicholas Hare. "Thermal mass is very important to the building, which has to operate 24/7, every day of the year."

"But as more than half of the concrete in the building is visual, our approach to specification was crucial."

The Student Centre is part of UCL's transformation of its Bloomsbury estate, and forms a focal point for student life, with 1,000 study places. Mace was appointed from Stage 4 design to act as the main contractor and designer.

The centre has been built between listed buildings, connecting Gordon Street – the east elevation – with UCL's recently-opened Japanese garden, to the west. It is spread across eight floors, six above ground, and centred around an atrium, which is dominated by exposed concrete columns and soffits, while the stair stringer beams and balustrades span 10m across this interior space.

The structural frame is a hybrid. "An early design decision was to switch the columns from in situ to structural precast," explains structural engineer Jeffrey Blaylock from Curtins. "3D modelling was used to plan the junctions between precast and in situ. The heads of the columns interface with the top of the slab to a depth of about 10mm."

The concrete used on the project splits into roughly equal thirds: the piled foundations, the precast elements and the floor slabs.

Broadly, the precast structural elements are vertical, including circular and blade columns – some double height in the atrium – plus there are twin wall panels, stairs and sandwich panels where the Student Centre meets neighbouring buildings to north and south. The 'blade' columns in the atrium have been aligned east-west, "to provide a sense of direction through the building", says Tompson. There are two in situ stair cores, one in the north and one to the south.

To achieve the desired aesthetic outcome, the architect, engineer, Mace, plus concrete contractor J Coffey and precast specialist Cornish Concrete met to agree on a consistent approach.

"We discussed the materials to use, the formwork, trial panels, and our approach to 'making good'," explains Tompson. "The challenge was deciding the mix and finish to achieve consistency and colour match. In total, four different concrete mixes are visible in the central atrium space, although the untrained eye would find it hard to tell them apart.

"Coffey created two large sample panels and Cornish Concrete developed the same mix and brought samples to site. Full credit to Cornish and Coffey for the colour match."

Cornish Concrete director David Moses explains the process: "I took a sample of the insitu concrete away from site – prior to the main pour – and then created four precast patch samples in our factory. I returned to the site with these, and the designers picked the one they liked most. But it was a gloomy day. So we waited for a sunny day and then returned with the samples and the results were different.

"Light is everything with colour matching."

The concrete mixes also had to consider the BREEAM Outstanding requirements, which meant replacing 50% of the cement with GGBS (ground-granulated blast-furnace slag). The exception was the 10-tonne

UCL Student Centre

Client:	University College London
Main contractor:	Mace
Architect:	Nicholas Hare
Engineer:	Curtins
In situ concrete contractor:	J Coffey
Precast supplier:	Cornish Concrete
Programme:	October 2015 – February 2019
Construction cost:	£38.5m

> The precast columns were poured flat as the finish isn't as good when poured vertically.

stringer beams. "It was such a vast exposed area that we didn't think we could achieve a good enough finish with the hand trowelled finish to the inner string due to the time taken to achieve a setting point with such large quantities of GGBS," says Moses.

Additionally, Cornish Concrete could source china clay waste locally in the Duchy and achieve 100% recycled aggregate in the structural precast. "The 50% GGBS content coupled with 100% secondary content aggregates meant that each cubic metre of precast was 90% secondary sourced material," says Moses.

The finishes to the exposed concrete are 'plain', with some areas trowelled. Cornish Concrete used a mixture of formwork, with steel being used as the primary form, with edges in plywood held in place with magnetic falsework. The joints between the plywood sheets were filled and sanded down, before being coated in polyurethane so that the joint lines were no longer visible. "The precast columns were poured flat as the finish isn't as good when poured vertically," explains Moses.

The design team decided on a 'light touch' approach to making good, which mostly involved just a light rub down with sand paper, says Tompson.

Lifting 'eyes' on the precast stairs and stringer beams were filled with preformed, factory-made concrete discs then grouted in.

"The columns were propped by J Coffey using "soft collars" thus negating the need for cast in propping sockets," adds Moses.

One aesthetic problem during construction was the appearance of an orange stain on the soffits. "This was caused by rain, with rust dripping off the rebar and sitting on the shuttering," explains Tompson. "Coffey used a light sander and that was enough to remove that surface stain.

The environmental considerations meant the services design had to be coordinated with the structural design from an early stage, says Blaylock. "Most of the services are exposed but there are cast-in cooling pipes which circulate water and go down 120m via boreholes into the aquifer," he explains. "These sit within the 300mm thick floor slabs and required their own mesh to sit on."

The stairs include concealed lighting in handrails, so conduits were cast in to the balustrades at Cornish Concrete's factory before transporting to site.

Concrete also provides an important acoustic role on the north and south ends of the Student Centre, which are effectively party walls though detached from the neighbouring structures. "The building interfaces with the Bloomsbury Theatre and Georgian town houses on the other side, so we fitted precast sandwich panels on both sides," explains Blaylock. "This also provided advantages of no formwork and reduced site labour."

Architectural precast cladding sections, along with brick-faced panels, have been used on both the front Gordon Street elevation and at the rear.

The front façade comprises white acid etched precast columns and spandrel panels, along with 12.5m, three-storey high precast brick-faced columns. This required creation of a bespoke mould in Cornish Concrete's factory, with the bricks set out according to the desired mortar beds and perpends.

The handmade Petersen Kolomba bricks were picked to fit in with the conservation area requirements. "The bricks at the edges of the building were laid in situ, and Swift Brickwork flush-pointed all brickwork to achieve consistency across the façade," adds Tompson.

The acid etch finishing took place in Cornish Concrete's factory, using what Moses describes as "a giant pressure washer". The level of etching – medium in the case of the Student Centre – is regulated by the ratio of acid to water in the wash.

The Japanese Garden elevation also features acid etched precast columns and spandrel panels, with a colonnade effect on the top floor, which also provides solar shading. "Given the complexities of the temporary works required to hold the fins in place, we carried out a full-scale trial panel," explains Moses. "The result was four fins made with one cill and one head in one piece. This meant a quicker, simpler and safer installation on site."

The new Student Centre at UCL opened to students in February.

FP McCann

Acid test for Somerset hotel

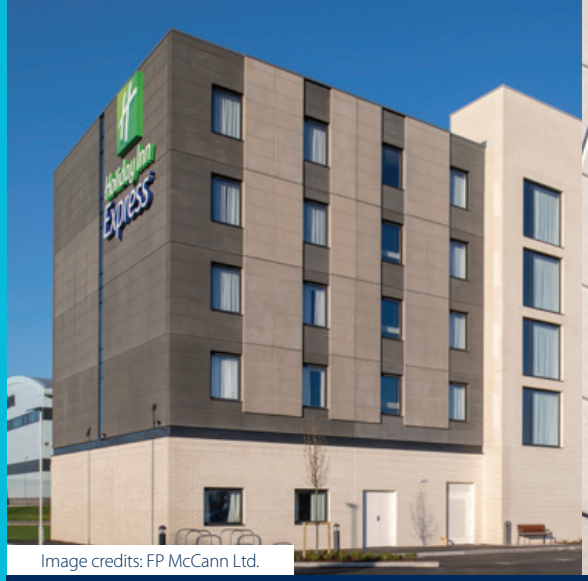

Image credits: FP McCann Ltd.

Holiday Inn Express, Bridgewater

Client:	Intercontinental Hotels Group	**Main contractor:**	Midas Construction
Project manager/ cost consultant:	Zeal Projects	**Architectural and structural precast:**	FP McCann
Architect:	Aros	**Precast frame build:**	S4J
Structural engineer:	Clegg Associates	**Project value:**	£10m
Façade design:	Practech Design Studio	**Programme:**	March 2018 – Spring 2019

FP McCann has supplied acid-etched and brick-faced precast cladding, plus numerous structural components, to create an impressive impact on a new Holiday Inn Express in Bridgewater.

A new £10m hotel in Somerset, which will house many of the workers on the nearby Hinkley Point nuclear project when complete, is using a range of architectural precast concrete finishes for its facades, supplied by FP McCann.

The company is also supplying structural precast components for the four-storey Holiday Inn Express near Bridgewater, working for main contractor Midas Construction. FP McCann's sub-contracting partner S4J is undertaking the precast frame build.

Work on the four-storey building commenced in March 2018. In total, some 509 individual precast structural and architectural units are being manufactured by FP McCann for the project.

The façade incorporates both brick-faced and acid-etched finishes. The 30 brick-faced panels, up to 440mm thick, are faced with half bricks and manufactured at FP McCann's Grantham factory in Lincolnshire.

The 84 acid-etched panels, supplied by FP McCann's Littleport plant in Cambridgeshire, are 410mm thick, with two different colour shades – one 'buff' white, one charcoal – to match the architectural design requirements.

"The mix for the white concrete used white aggregates with white cement, while the charcoal concrete was grey cement, pigment and black aggregates," explains Colin Richards, FP McCann's quality assurance materials manager.

"As on all our projects, we manufactured a series of samples for our customer, until an agreement was reached as to the colour and level of etching required by the designers. Once they chose the etching level required, a sample was given to our acid etching team as a reference."

The acid etching process was carried out by FP McCann's specialist operatives in the factory. "We vary the concentration of the acid to get the depth necessary – it was 16% strength hydrochloric acid for the Bridgewater hotel units," says Richards.

The brick-faced sandwich panels include the heaviest units on the project, weighing up to 15.26 tonnes, and measuring 8.335m across and 2.975m high.

The structural design uses a steel frame at ground floor level, to allow open plan areas for the reception and dining rooms, with precast sections for the three storeys above. There are 394 precast structural units in all, consisting of solid reinforced concrete floor slabs, internal walls, stair flights and cores, plus lift shafts, manufactured at the Grantham facility.

"The internal faces to these walls were fair-faced, ready for minor filling and decoration, and floors were ready for latex and carpet," explains Daniel Westgate, FP McCann's commercial manager for structures.

"The precast wall and floor sections have been designed for ease of build, linking together with hidden tie rods. Joints are finished with a high-strength non-shrink grout."

As part of the contract, S4J also installed 130 pre-formed bathroom pods supplied by Somerset-based Off Site Solutions (RT). "FP McCann provided a recess for the pods to sit into and the pods were dropped in as works progressed," says Westgate.

Grant Millar, operations manager for Midas Construction, was pleased with the decision to use FP McCann's precast expertise on the project.

"This method of modular precast construction demonstrates a number of efficiencies compared with practices associated with a traditional build," he says. "The remote manufacturing of the building components offers significant advantages in terms of product quality and integrity. On site, speed of construction, minimising waste and the ability to work uninterrupted in all weather conditions are all major benefits.

"Additionally, the sandwich panel external facade system removes the need for scaffolding, reducing the health and safety risk factors associated with people working at height."

The installation of the precast units took just 12 weeks, using a 130t crawler crane. with 10 operatives on site.

The Holiday Inn Express project is scheduled to complete in spring 2019.