LEFT:
A storey-high, two-room wide insulated precast concrete sandwich panel with reconstructed stone headers and cast on brickwork being made ready for delivery following installation of glazing at the factory.

BELOW LEFT:
Large pre-glazed precast brick and reconstructed stone finished concrete sandwich panels arrive on-site for assembly into the structure.

ARCHITECTURAL FLEXIBILITY, STRUCTURAL AND ENVIRONMENTAL CONFIDENCE

Norman Brown of **PCE** discusses how modern design tools and processes can provide a precast architectural concrete component approach to construction.

For well over a century, the versatility of concrete construction has provided clients and their design teams with an infinite ability to influence the architectural appearance of buildings, both internally and externally. This allows outstanding visual effects to be achieved, to meet the architectural aspirations, building performance requirements and budgets available at the time.

It is important that today's use of concrete, to provide the whole or part of the architectural finish, is not compared directly with that of the late 1950s/60s, or even just 20–30 years ago. Project requirements with respect to performance specification and environmental considerations – together with changes in materials and associated technology, manufacturing methods and overall construction techniques – have developed and progressed so much.

ENGINEERED PRECAST

Concrete quite rightly often presents significant projects where the use of in-situ concrete has resulted in stunning high-quality architectural finishes; here we look more closely at the benefits of the off-site engineered precast concrete architectural façade approach.

The ever-increasing emphasis to embrace design for manufacture and assembly (DfMA) to reduce on-site construction processes and programmes and the need to improve the environmental performance of the industry, as well as continuing to ensure progress in reducing health and safety risks for all concerned, has led to a marked

RIGHT:
A large two-room-wide pre-glazed precast concrete sandwich panel with the outer leaf formed by specialised mould liners and pigmented concrete.

BELOW RIGHT:
External elevations to student accommodation buildings constructed using precast pre-glazed concrete sandwich panels to give a traditional build appearance but with all the advantages of off-site engineered construction.

resurgence in the use of concrete solutions for building façades.

As a result of this, specialist design-and-build contractor PCE has seen a large growth in the demand for precast concrete façades over the past few years for both low- and high-rise buildings within the residential, medical, research, and prison sectors, where the importance of high-quality and fast construction programmes coupled with low risk, while offering clients high value, is important.

The firm's in-house digital design processes now not only concentrate on structural and aesthetic requirements, but also include digital modelling specific to reducing the embodied carbon of precast concrete manufacture and use. This includes architectural façades, which have been developed to ensure that the embodied carbon content during manufacture, transportation and on-site assembly, as well as the whole life of the structure, can be accurately evaluated at the outset and monitored as the design concept progresses to reality.

RESEARCH PROJECT

Being a partner in the recently completed Innovate UK research project 'Decarbonising Precast Concrete – Tangible Innovation through Partnership' has further developed PCE and the industry's approach in being able to offer clients who care about the environment – and most do – greater understanding about their building construction and façade options with respect to the carbon problem.

The project consortium comprises PCE, Akerlof, Accelor, Curtins and Forterra.

The manufacturing processes of architectural precast concrete components can incorporate many types of differing finishes to the external surface of a concrete unit, including colour pigmentation, reconstructed stone surfaces, coloured aggregates, various methods of removing the as-cast surface laitance to provide differing surface textures, the casting on of brick or natural stone facings, or using rubber form liners to produce patterned variations in the cast surface.

A unique type of finish, or a combination, can be incorporated onto a discrete manufactured concrete element that can either be a single leaf or formed of two joined leaves of concrete containing thermal insulation between them, more commonly known as a 'sandwich panel'. The physical size of components is only governed by practical haulage considerations and site access. Thus, one finished component can often be more than one storey in height and/or a number of bays in width, reducing the number of component-to-component joints and attaining the benefits that occur.

MINIMISE COST

The external architectural leaf of a sandwich panel is generally non-load-bearing, with its thickness designed to satisfy the visual requirements, especially any designed surface variations in depth. This minimises the cost of what are generally more expensive

> "Off-site manufacture of an architectural precast concrete façade solution often enables all glazing to be preinstalled and sealed into the sandwich panels at the production factory prior to delivery to site."

materials and finishing techniques compared with the more standard grey concrete inner leaf that takes the structural loads required of the completed panel.

Separating both leaves is a layer of insulation, with the external leaf being tied to the internal using a carbon-fibre composite tie system passing through the insulation. Being carbon fibre, the requisite tie strength is achieved to make the two outer leaves and the insulation perform as one structural component, without any air gaps within the thickness of the component that can promote fire spread, or without the carbon-fibre ties causing thermal cold bridging from the external to internal faces.

All insulation used must be European Class A1+ fire rated, thus ensuring that the insulated façade components are non-combustible, with the thickness of the insulation determined from the thermal resistance calculations of the complete wall section. Acoustic performance requirements are calculated using the inherent mass of concrete and, if appropriate, any cast-on stone elements and brickwork that are beneficial in this respect.

Off-site manufacture of an architectural precast concrete façade solution often enables all glazing to be preinstalled and sealed into the sandwich panels at the production factory prior to delivery to site. This significant off-site construction benefit gives enhanced quality control and reduction in waste, while dramatically reducing working at height safety risks and negates the requirement for any external façade access during the construction programme.

Once constructed, the pre-glazed sandwich panels can provide a weathertight façade, enabling earlier commencement of internal trades than would otherwise be possible using more traditional on-site construction methods. Consideration of casting-in mechanical and electrical services within the internal face of the sandwich panels, together with producing a high-quality internal surface finish that can be directly decorated at the initial design stages, can reduce expensive and time-consuming following trade activity, including dry lining needs.

While the use of concrete and precast in particular to provide architecturally pleasing finished façades is far from new, the industry approach to doing so within the past few years has developed considerably. Modern digital modelling, design and control processes ensure high-quality manufacture, installation and final use, as well as the opportunity for an accurate whole-life understanding of the embodied carbon content of the façade, together with enabling the structural and architectural options to be decided upon for further reduction of embodied carbon.

Coupling the above with the ever-continuing developments in concrete and its associated materials, including insulation and structural non-thermal bridging connectors, enables clients and their design teams to continue to push forward into the 21st Century using a precast architectural concrete component approach to give them architectural flexibility and structural and environmental confidence, while ensuring enhanced value to their projects. C

LEFT:
Day two of a five-day assembly programme per floor level to construct a 14-storey aparthotel. Some 18 large pre-glazed precast sandwich panels formed the perimeter structure of each level, erected without external support/scaffolding on a tightly congested site.