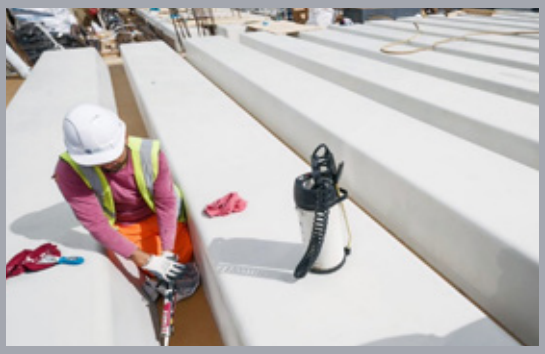
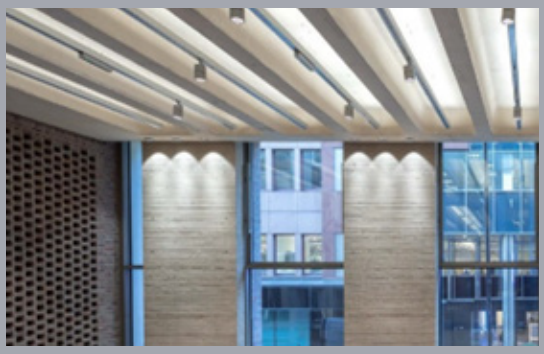
BESPOKE SOLUTIONS

FOR ON-SITE CONSTRUCTION AND OFF-SITE MANUFACTURING

SUPERSTRUCTURE FORMWORK





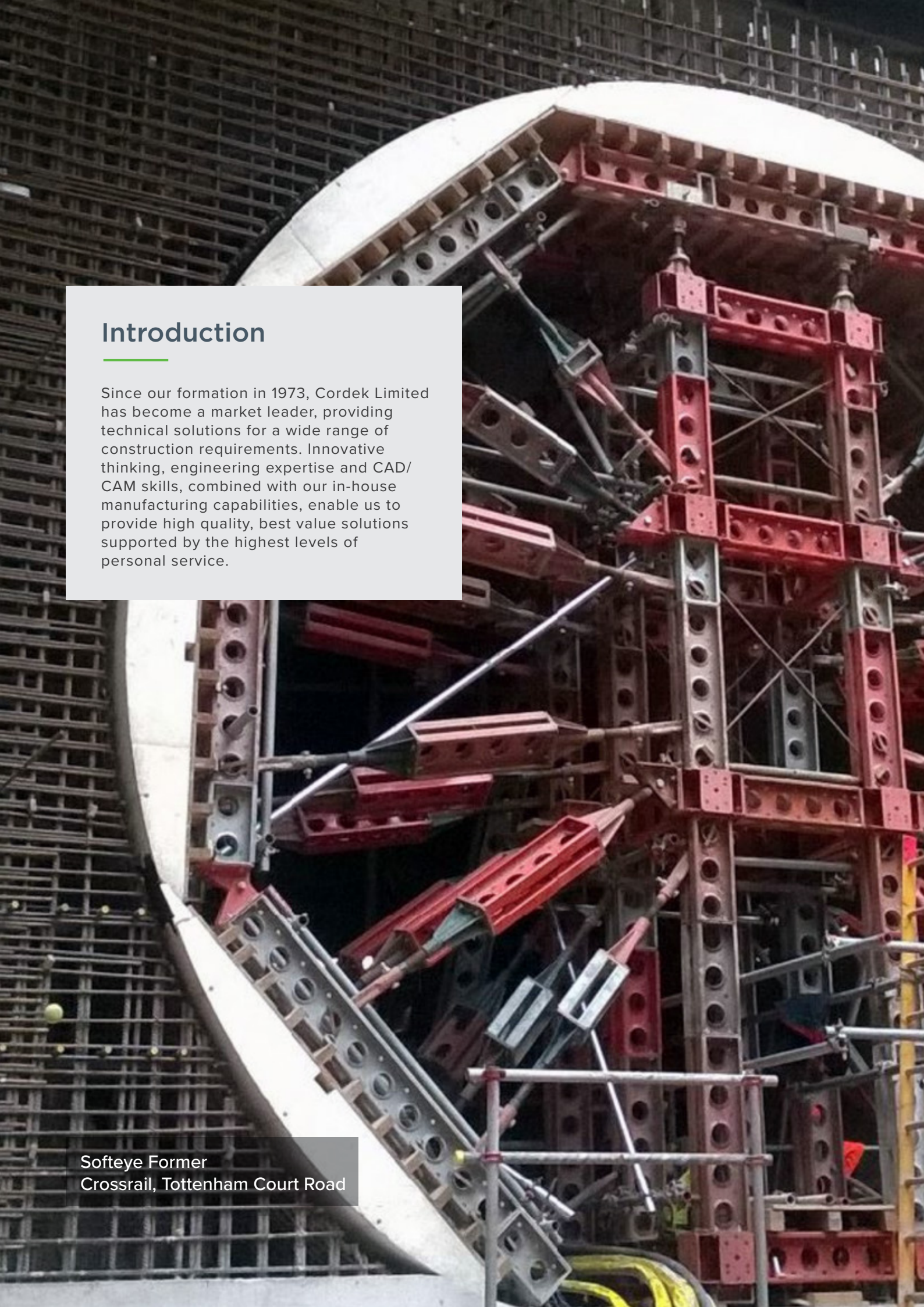
INFRASTRUCTURE FORMWORK

PATTERNS & MOULDS

cordek

Introduction

Since our formation in 1973, Cordek Limited has become a market leader, providing technical solutions for a wide range of construction requirements. Innovative thinking, engineering expertise and CAD/CAM skills, combined with our in-house manufacturing capabilities, enable us to provide high quality, best value solutions supported by the highest levels of personal service.



Softeye Former
Crossrail, Tottenham Court Road

01 THE PROCESS

5-Axis Routing

Developing Your Concept

A member of our Project Design Team will work with you to develop your concept.

- Buildability
- Surface finish
- Reuses
- Joint locations
- Programme
- Handling & access limitations
- Budgetary constraints
- Post-use recycling

Design

We provide a full design service, or the appropriate level of support to compliment your in-house capabilities: 2D/3D CAD (SolidWorks, Rhino, Auto-CAD).

- Material selection
- Calculations/FEA
- Approvals
- Mock-up/samples
- Value engineering

Manufacture

We manufacture using the latest 3D modelling and CNC machining techniques.

- Digital manufacturing
- Inspection
- Sign-off
- Delivery
- Site support
- Recycling options

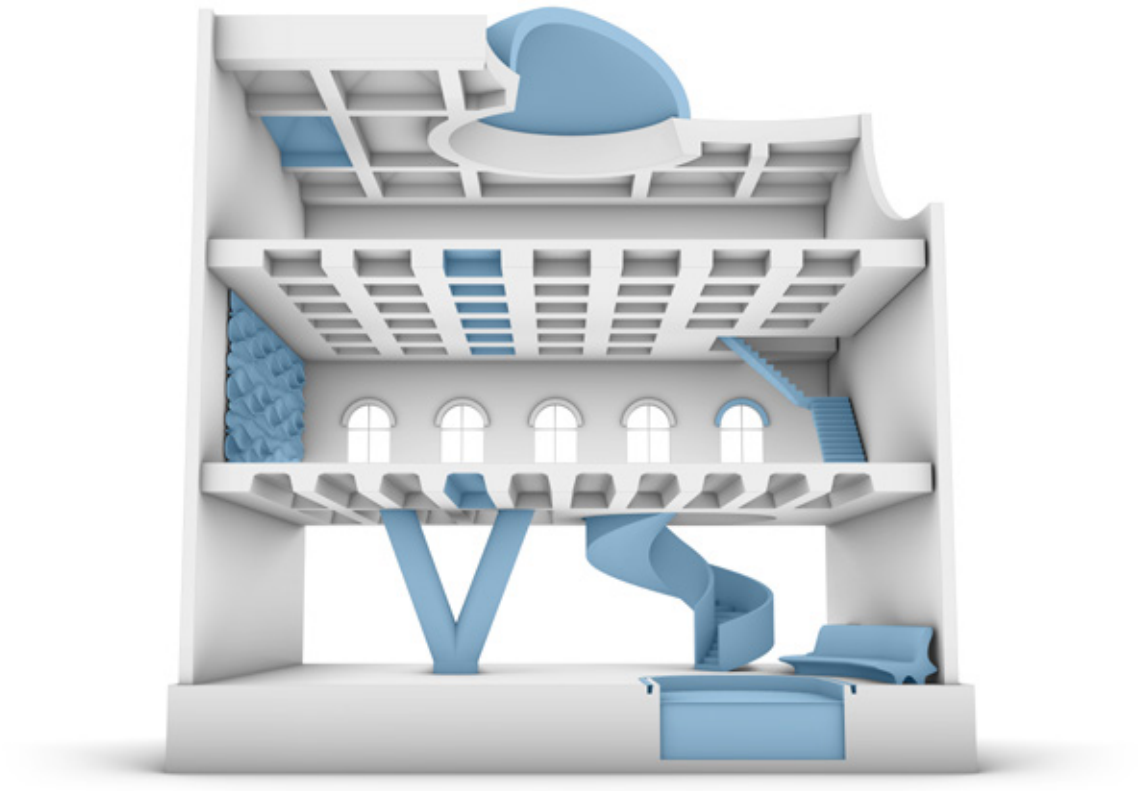
Laser Scanning

02 SUPERSTRUCTURE FORMWORK

Introduction

Cordek offers a range of bespoke and complex formwork solutions for the construction of cast in-situ architectural features, finishes and shapes in Superstructure applications. These include the construction of arches, columns, staircases, and ribbed slab soffits (trough, waffle and feature formers).

Typical Applications



RIBBED SLAB FORMWORK

- Waffle – two-way spanning ribs
- Trough – one-way spanning ribs
- Feature ribs

STAIRCASE FORMWORK

- Spiral
- Straight/angled

COLUMN FORMWORK

- V-shaped
- Elliptical
- Circular
- Multi-faceted

ARCH FORMWORK

- Semi-circular
- Gothic
- Segmental
- Parabolic
- Domes

SWIMMING POOL FORMWORK

- Lining
- Scum channels
- Seating
- Slides
- Diving boards

DETAILING FORMWORK

- Rubber liners to create features and patterns
- Lighting recesses

CASE STUDY 1

SUPERSTRUCTURE FORMWORK

Royal College of Pathologists

Aldgate, London, E1

Main Contractor: Gilbert-Ash
Sub-Contractor: Oliver Connell & Son Ltd
Architect: Bennetts Associates
Market Sector: Superstructure Formwork
Product: GRP Formwork

"Cordek's bespoke trough formers helped us to achieve a high quality and consistent concrete finish, in line with the architects' specification and delivered to a tight programme."

Seamus McFerran, Design Manager, Gilbert-Ash

The Royal College of Pathologists have relocated their London Headquarters to the rapidly changing area of Aldgate, on the eastern fringes of the city. The new, seven storey structure replaces an existing office block, providing a flexible and environmentally efficient building to house their growing needs. The building design includes major conference facilities, meeting rooms, offices, a multi-function auditorium, exhibition space, restaurant facilities and accommodation. Cordek was asked by the specialist concrete frame contractor, Oliver Connell & Son Ltd, to devise a formwork system to allow the construction of ribbed concrete floors.

Project Scope

The project architects, Bennetts Associates, wanted to showcase the visual, exposed concrete as a feature of the building, highlighting the finish that can be achieved from a material often only considered for it's structural capabilities. The concept was to construct cast in-situ concrete floor slabs, with exposed ceiling soffits, using the voids between the ribs to locate the strip lighting design on each floor. The use of a ribbed design reduced the overall depth and weight of the floor slabs, with spans that provided a space virtually uninterrupted by supporting columns. As the exposed concrete soffits would remain 'as struck', it was essential that the finished surface was impeccable and that the formwork solution proposed by Cordek produced a finish that could be replicated on each floor of the building.

The Solution

The ribbed slabs were formed using a bespoke trough formwork solution, manufactured from Glass Reinforced Plastic (GRP), the robustness of which enabled re-use (multiple times). Although the design of the ceiling soffits was reoccurring throughout each level of the building, the dimensions of the troughs within them varied between 6.0m and 12.0m long. To ensure consistency throughout, every GRP former was taken from the same original pattern. The design of the trough former incorporated rounded corners, creating the requirement to form a pattern and subsequent formers with a double curvature, presenting a complex challenge to Cordek's Project Design Team. The solution was created by 5-axis technology, to select a pattern made from epoxy paste with an expanded polystyrene core, to create the required finish and profile. Once this process was completed and dimensional accuracy was confirmed using a Faro Arm digital scanner, the GRP formers were formed from it; creating an exact impression.

The Process

Bennetts Associates supplied the 2D drawing of their design proposal, from which the Cordek Project Design Team created a 3D digital model. Following approval of the 3D model, the relevant information was extracted as CAM data and used to create the tool paths for the 5-axis CNC router that was used to shape the epoxy paste pattern. After being routed, the pattern was coated with a highly durable primer to create a smooth but matt surface finish. The moulds were then formed around the pattern using GRP, which was built up in several layers to a thickness of 18mm and strengthened with plywood stiffeners. To achieve the 'matt' concrete finish specified by the architects, the surface of each trough former required dulling down and gentle exfoliation so that when struck, a gloss or shiny surface finish to the concrete was avoided.

Due to the restrictive space on site during construction, the specialist sub-contractor Oliver Connell & Son Ltd, were only able to construct a single floor at a time. Prior to casting a floor, the trough moulds were positioned in accordance with the proposed design and secured in place by fixing to the elevated timber deck beneath. Once in position, a release agent was applied to both the trough formers and the exposed timber deck between them, to aid striking once the concrete had cured sufficiently. Steel reinforcement was then placed both above and around the trough formers, supported by spacers, to achieve the required cover before the concrete was poured to the appropriate depth.

After the concrete had achieved a sufficient cured strength, so that the supporting formwork could be struck, the timber deck was lowered from beneath, releasing the trough formers. Following cleaning, the formers were manoeuvred through the atrium of the building and into position to follow the same process for the construction of the floor above. As the troughs within the ceiling soffits were to house the light fittings for each floor, ducts were positioned accordingly prior to casting of the concrete, which allowed the project electricians to feed through the wiring needed to provide power to the building's lighting system.

Summary

When originally conceived, the primary function of forming troughs in a floor slab was to reduce the overall weight of the slab. This allowed the intermediate ribs between the troughs to span considerable distances when compared to conventional designs.

However, in the case of this project and many others, it is the aesthetic result of having an exposed cast in-situ concrete soffit design, which exposes the ribs and the troughs, that appealed to the project designers. The combined efforts of all those involved, starting with the identification of a cost effective and practical formwork solution, through to the finished construction, meant that the architect's original vision was realised. The reality is a good example of the high end, quality appearance that exposed, cast in-situ concrete can achieve.

CASE STUDY 2

SUPERSTRUCTURE FORMWORK

Baltimore Tower

Canary Wharf, London, E14

Engineer:	WSP Group
Contractor:	C J O'Shea
Architect:	Skidmore, Owings & Merrill
Market Sector:	Superstructure Formwork
Product:	GRP Formwork

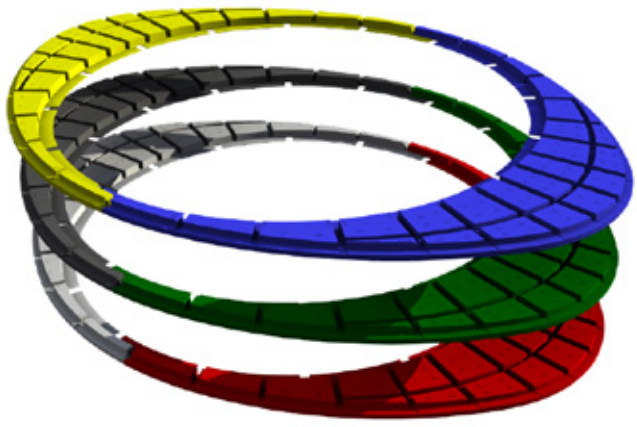
> "To attempt a traditional formwork solution would have incurred significantly increased time and cost implications. The use of Cordek's fibreglass formers has allowed us to keep to our programme."
>
> Finton Hallihan, Project Manager, O'Shea

Baltimore Tower is a £300m, 45 storey luxury residential development by Baltimore Wharf SLP, designed by Skidmore, Owings & Merrill. One of the building's key distinguishing features is that it gives the impression of twisting as it rises to its 151m height. Working with main contractor, C J O'Shea, Cordek designed and supplied a simple and cost effective formwork solution for the casting of the complex layout of radial and elliptical beams, forming the cantilevered balconies.

Project Scope

To achieve the project programme of casting a floor every two weeks, it was essential to find an alternative to traditional timber and ply formwork. Additionally, due to the beams being exposed and visible from the waterside's edge, a fair-faced finish was specified.

Figure 1



The Solution

Cordek's solution was to design a modular GRP formwork solution, with a high quality surface finish, which could be quickly fixed and struck.

Cordek began the design process by generating a 3D model of the beam layout, as shown in Figure 1 below, adding tapers and radii to facilitate striking of the formers. The formwork was then added to the model and each level divided into 50 manageable sized units. To demonstrate how the GRP formers would fit together, a section of a floor was 3D printed at a scale of 1:100 and presented to the contractor for approval.

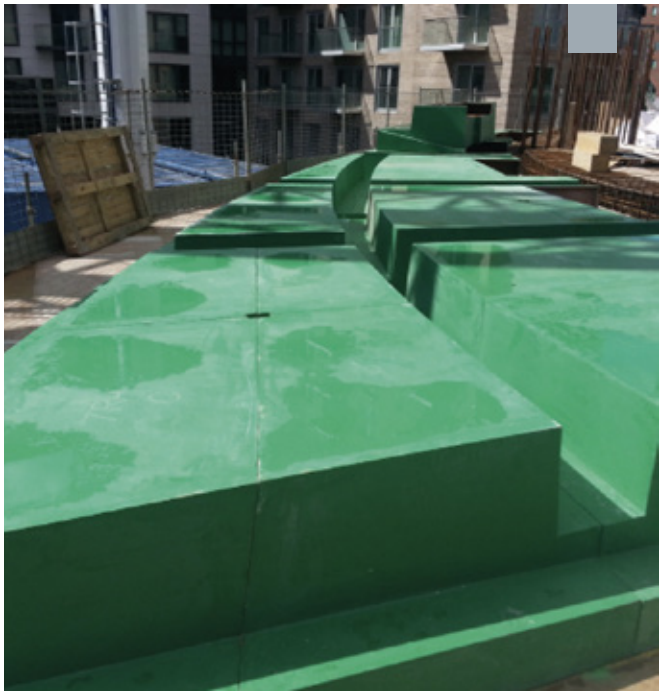
The formers were designed and manufactured to be small and light enough to be manually handled; easily cleaned and durable enough to achieve a minimum of 18 uses.

To achieve the programme, it was agreed that three complete floors of formers would be required, which equated to six sets of 25 different formers, mirror-imaged. This made it possible for construction to take place simultaneously on three floors.

The Process

Working directly from the 3D model, and using a 5-axis CNC router, a male pattern replicating the final formwork product was manufactured using a seamless epoxy tooling paste, extruded onto an expanded polystyrene core. The pattern was then used to construct the GRP production mould for the six sets of formers required.

To ensure the formers were installed and struck in the correct order, each former was embossed with a unique reference number and each set colour coded.



Summary

The formwork system has proven to be a success, as it met the floor cycle time, exacting finish, and re-use requirements specified by the contractor. The twisting elliptical tower has been billed as ‘an iconic new landmark for luxury living’.

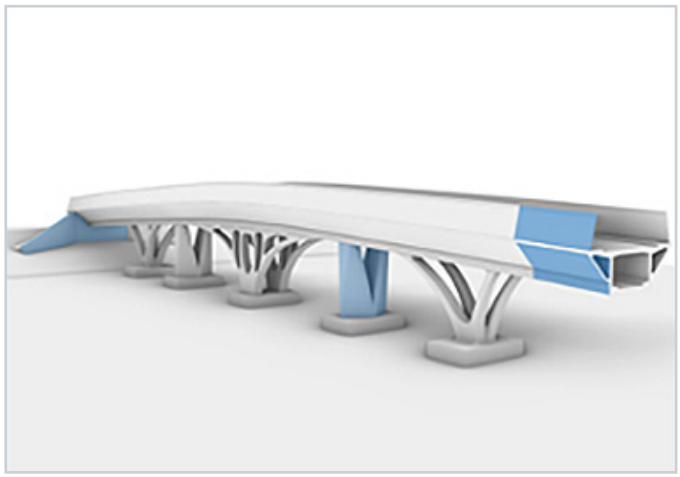
03

INFRASTRUCTURE FORMWORK

Introduction

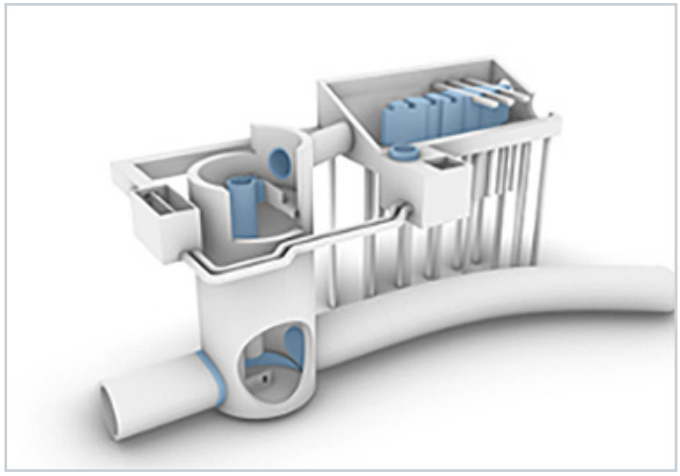
Cordek offers a range of bespoke and complex formwork solutions for the construction of cast in-situ infrastructure applications, including those relating to bridge, drainage, sewer, and tunnel construction.

Typical Applications



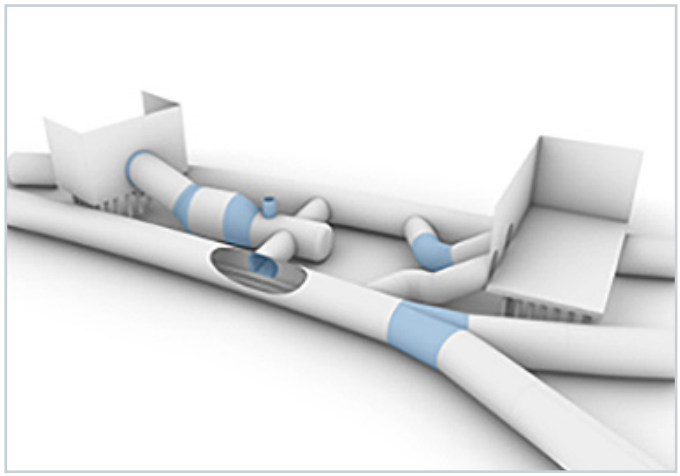
BRIDGE FORMWORK

- Abutments & wingwalls
- Parapet walls
- Piers & support columns
- Soffits



DRAINAGE & SEWER FORMWORK

- Benching
- Connection culverts
- Intakes & outfalls
- Vortex structures



TUNNEL FORMWORK

- Intersections
- Softeyes
- Transitions
- Ventilation shafts

CASE STUDY 1

INFRASTRUCTURE FORMWORK

Farringdon Station Escalator Shaft

Farringdon, London, EC1M

Engineer: Mott Macdonald
Contractor: BAM Ferrovial Kier Joint Venture
Market Sector: Infrastructure Formwork
Product: Filcor Formwork with Fibreglass Skin

As part of the Crossrail project, Farringdon Station underwent a major redevelopment to increase capacity, improve accessibility, and upgrade interchanges. It is also one of ten new stations that serve the Elizabeth Line. Cordek was tasked with providing a formwork solution to enable the main contractor to cast the 'knuckle' intersections between the escalator shaft and the levels above and below.

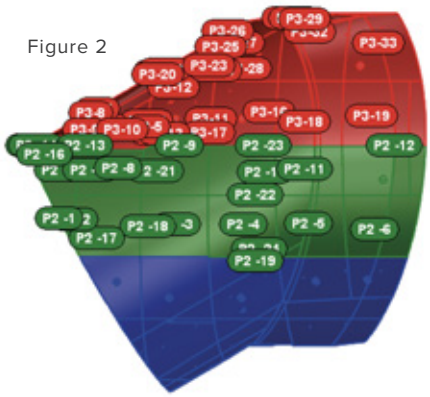
Project Scope

Unlike the straight part of the tunnel which could be formed using traditional formwork, the complex geometry of the top and bottom intersections required a unique formwork solution to form the secondary tunnel lining. The design had to accommodate the restricted access to the project and recognise that the formers needed to be suitable for manual handling.

The Solution

Cordek worked closely with the main contractor, BAM Ferrovial Kier Joint Venture, to develop a formwork solution that could be installed in stages to suit the preferred concrete pour sequence required for this complex structure. From the Engineer's 2D drawings, Cordek were able to generate a 3D model of the surface of the tunnel lining. Using this model, the surface was then subdivided into manageable individual formwork units, that were lightweight enough to handle but also able to withstand the concrete pressure during casting. Designed into the model were a network of tie bolts that could be used to accurately locate and secure the units into position. The units were designed using a Filcor 70 Flame Retardant EPS (expanded polystyrene) core, with a fibreglass coating on the forming face to ensure easy striking. A plywood backing was also included for strength and support.

Figure 2



The Process

The units were manufactured to tight tolerances at Cordek's digital engineering facility. Firstly, the complex forming surface was machined and the tie bolt holes formed, then threaded anchor plates were embedded into the Filcor EPS. The holes for the anchor plates were then filled and faired before the fibreglass coating was applied, and finally the plywood backing bonded into position. The formers were manufactured and delivered in three stages, over an eight week period to suit the contractor's programme. The first stage of the installation was to position the blue and green units, as shown in Figure 2 below. This allowed the lower section of the tunnel lining to cast before a temporary deck was installed to support the units shown in red. With these in position the contractor was then able to cast the crown of the tunnel lining.

Summary

The success of this formwork solution was a combination of the initial detailed collaboration between Cordek and BAM Ferrovial Kier Joint Venture, coupled with Cordek's expertise in designing and manufacturing complex formwork. Working within the restrictions of the tunnel's access points and the resources available to fix and strike the units, the design kept the overall number of units to a minimum.

CASE STUDY 2

INFRASTRUCTURE FORMWORK

Ely Southern Bypass

Ely, Cambridgeshire

Main Contractor:	VolkerFitzpatrick
Sub-Contractor:	Sword Construction UK Ltd
Architect:	Knight Architects
Market Sector:	Infrastructure Formwork
Product:	Filcor with ABS Skin Formwork

The Ely southern bypass is a new road connecting the A142 at Angel Drove to the Stuntney Causeway. It is hoped that the bypass will help to ease congestion in and around Ely by providing a new link to the south of the city. The 1.7km long single carriage way road includes a 300m long viaduct crossing the Great Ouse River, for which Cordek was called upon to supply a bespoke formwork solution for the construction of the complex geometrical details of the supporting piers.

Project Scope

The design of the 300m long viaduct deck included three bidirectionally, tapered supporting piers. Skewed in plan, these three 16 metres long, ‘V-shape’ piers, varied in height across the water and supported the viaduct deck whilst also providing an aesthetical feature to the reinforced concrete structure.

The specialist civil engineering sub-contractor, Sword Construction UK Ltd, approached the Cordek Project Design Team to assist them in designing a formwork solution to form the radius chamfers spanning four metres in length, along with shadow gaps used to break up the edge of the concrete and add an interesting visual element to the twin trapezoidal box girders.

The Solution

The lead designers for the project had decided upon reinforced concrete to construct the piers, due to its flexibility in form and shape, combined with the ability to achieve a F3/F4 finish. The double curving, complex geometry of the chamfers and shadow gaps meant that it would have been difficult to utilise a traditional formwork material or system and therefore a bespoke solution was required.

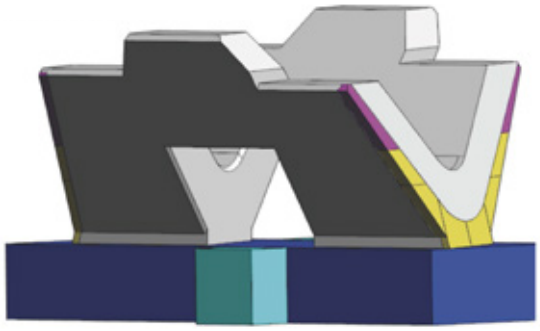
A pair of formers was proposed to construct each of the piers and, where possible, the formwork was manufactured from profiled Filcor 70 Expanded Polystyrene (EPS) with an ABS skin, to produce the required surface finish. Due to the overall length of the double curving aspect of the radius chamfers necessary to create the ‘V-shape’ design feature, in certain locations there was the additional requirement for a flexible rubber profile to be used in conjunction with the main formwork system.

The Process

Following receipt of 2D CAD information, the Cordek Project Design Team created a 3D model of the 'V-shaped' piers which was used to design the formwork solution. Use of digital modelling also aided the contractor to view and understand the proposal, including the assembly, positioning, pouring and striking sequences.

The Filcor 70 EPS formwork solution was profiled using a 5-axis CNC router, producing a representation of the CAD design to within a millimetre. Due to the size of some of the units (2-3m in length), blocks of Filcor 70 EPS were bonded together, before being routed to the required profile and the ABS skin applied to the surface. For the manufacture of the rubber profiles, triangular shaped moulds were created out of model board prior to pouring the castable rubber compound. Once they had cured, the flexible pyramid shaped profiles were demoulded and positioned on the routed Filcor 70 EPS units to form the edge detail of the 'V' shape piers.

CAD model showing formwork



On site, the formwork solution was positioned and tied in to the steel reinforcement prior to placement of concrete. The concrete was poured in two stages due to the height and weight of the overall structure. The first pour was carried out before being allowed to cure, following which the formwork was struck. Additional reinforcement was tied into the exposed rebar from the first pour, with the repositioning of the formwork prior to the final concrete pour being carried out.

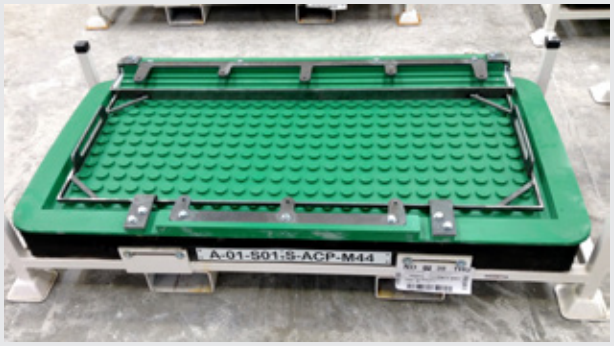
Summary

Cordek helped to design and deliver a bespoke formwork solution which aided the construction of the ‘V-shape’ piers, which provide a unique aesthetic feature to the project.

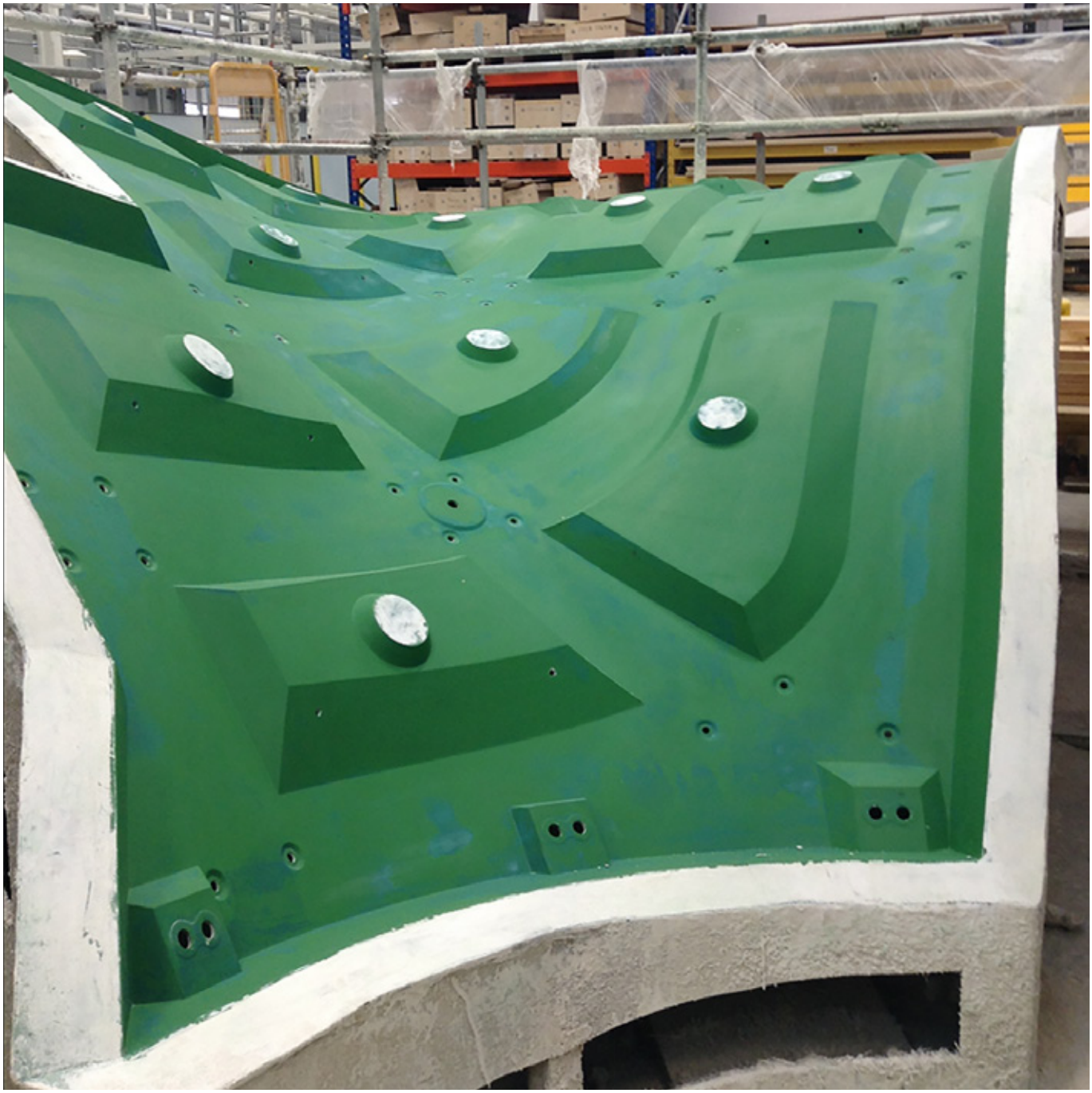
04 PATTERNS & MOULDS

Introduction

Cordek can create digitally machined patterns and moulds for a wide range of precast products in a variety of materials. Whether the mould material has already been defined or if you're looking for advice, our Project Design Team can assist you in choosing the most appropriate solution, which considers the required finish, quantity, budget and timescale.



Acoustic Panel
Crossrail, Liverpool Street Station



A ‘pattern’ is the name given to the first tooling stage of a product. Sometimes called ‘plug’ or a ‘master’, it is a high-quality representation of the required shape and is often produced in a strong material and paint finished to ensure the best possible surface finish.

A ‘mould’ is any shape that is used to create multiple finished products. It is the negative of the finished product and can be created directly, or by moulding from a pattern. A mould must be sufficiently strong to produce the required number of products and must contain no undercuts, or it will not be possible to remove the products.

Moulds are normally treated with a form of release wax or oil so the products don’t stick to them. If made in a strong material like GRP, a well-maintained mould is capable of producing dozens, or perhaps even hundreds of identical products.

The ‘product’ is the finished shape. All products from the same mould will be identical.

CASE STUDY 1

PATTERNS & MOULDS

Circus West, Battersea Power Station

Phase One, Residential Block, Circus West,
Battersea Power Station, London, SW8

Engineer: Buro Happold
Contractor: Byrne Bros
Architect: SimpsonHaugh and Partners

Staircore Design: CDC Ltd
Market Sector: Patterns & Moulds
Product: GRP Moulds

The familiar silhouette of Battersea Power Station on the London skyline has long awaited regeneration and revitalisation. Since its closure as a working power station in 1983, the riverside location has become an ideal setting for both a residential development and new community. Cordek was invited to tender for the design and supply of four, multi-use concrete moulds, for pre-casting two spiral staircases within Phase One's residential block, Circus West.

> "Cordek moulds offered a repeatedly high finish. The moulds were easy to assemble in our precast factory, helping to form elements that were easy to install on site."
>
> Graham Ward, Senior Project Manager, Byrne Bros

Project Scope

Cordek was tasked with designing a set of moulds that could produce 100 flights of stairs spanning 14 floors in each stair core. The design needed to be functional and efficient, and the manufactured moulds capable of producing 50 casts as a minimum requirement, making it essential that the formers are durable and robust.

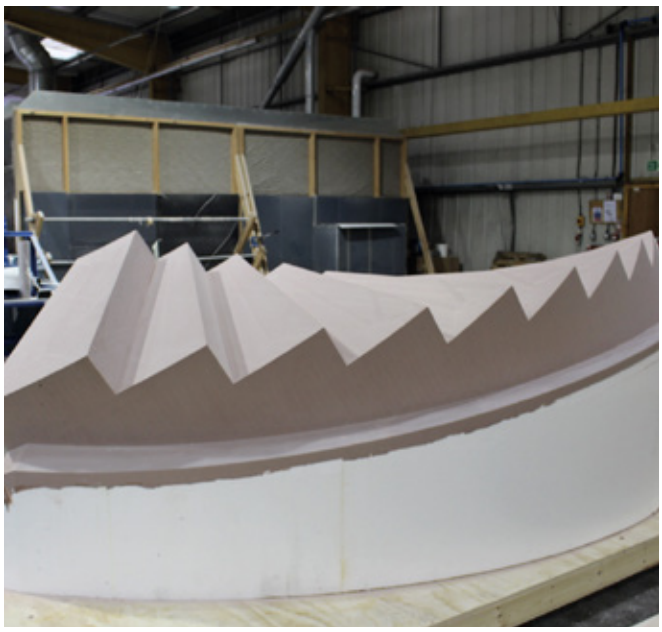
The Solution

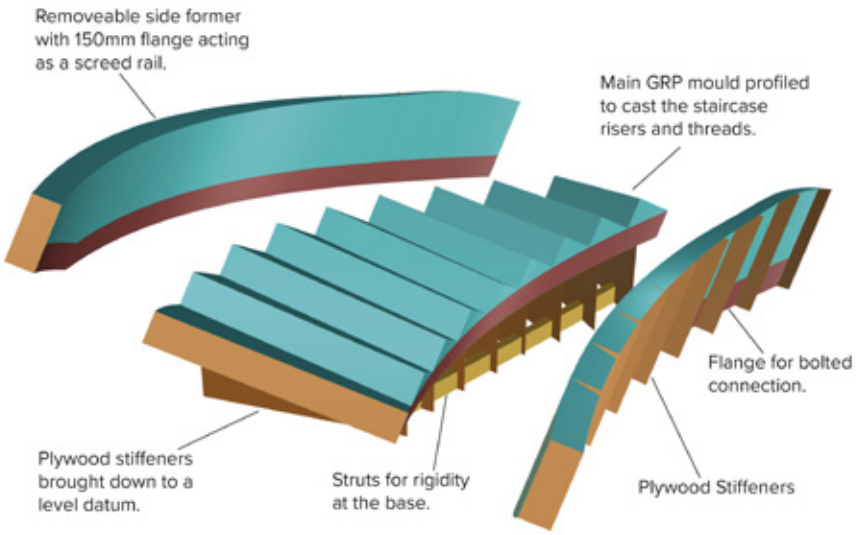
The Architect's design consisted of 30 helical staircases with four variations of riser heights. Cordek provided four Glass Fibre Reinforced Moulds so that the stairs could be precast upside down. This allowed for a quick, safe and simple installation of the stairs prior to landings being cast in-situ, tying the spiralling risers into the core. The accuracy of the formers was essential to ensure the exacting dimensions of the staircase design were achieved. The fully integrated design included demountable sides to the moulds to allow easy striking of the concrete units and multiple reuses.

The Process

From the architect's 3D design, Cordek's Project Design Team created an inverted 3D model of the staircases, orientated to optimise the pre-casting process. This digital model was programmed into a 5-axis CNC router to manufacture an accurate pattern for the staircase. The pattern, made from an expanded polystyrene core coated in an epoxy tooling paste, was painted in preparation for the manufacture of the GRP mould. The fibreglass mould could then be laminated onto the pattern and reinforced with plywood stiffeners, to provide sufficient strength and rigidity to withstand the casting of the three tonne concrete units. The detachable side formers included alignment tabs and bolted connections.

After the moulds had been manufactured, the four patterns were shipped to Byrne Brothers to be used as templates for the fabrication of the reinforcement cages.





Summary

Detailed planning and design at the beginning of the process, combined with modern digital methods of manufacture, resulted in a cost-effective solution which achieved the quality and multiple reuses required from this demanding project.

CASE STUDY 2

PATTERNS & MOULDS

Dream, St Helens, Merseyside

St Helens, Merseyside

Engineer: Arup
Contractor: Cheetham Hill Construction
Designer: Jaume Plensa
Market Sector: Patterns & Moulds
Product: Filcor with Polyurethane and Epoxy Resin Finish Moulds

Dream is a 20-metre-high landmark sculpture created by world renowned Spanish artist Jaume Plensa. It sits on the Sutton Manor site on the edge of St Helens and has established itself as a landmark to the area, bestowed with numerous awards, attracting thousands of visitors every year. Cordek's involvement in the project was to create multiple unique moulds for the chosen material to be cast.

Project Scope

The public art project was proposed and driven forward by ex-miners and was featured as part of Channel 4's Big Art Project. The scale and design of the artwork, together with the nature of the site and former spoil heap, presented considerable technical challenges. The chosen material was a bespoke mixture of white cement, Spanish dolomite, and titanium dioxide pigment which also added to the build challenge.

The Solution

Cordek was invited to supply the numerous individual moulds needed for the concrete to be cast into. When extracted, these sections would eventually come together to form the final sculpture.

Full 3D modelling was required to calculate the complex geometries involved and facilitate both the pre-cast concrete moulding process and the assembly of the artwork.

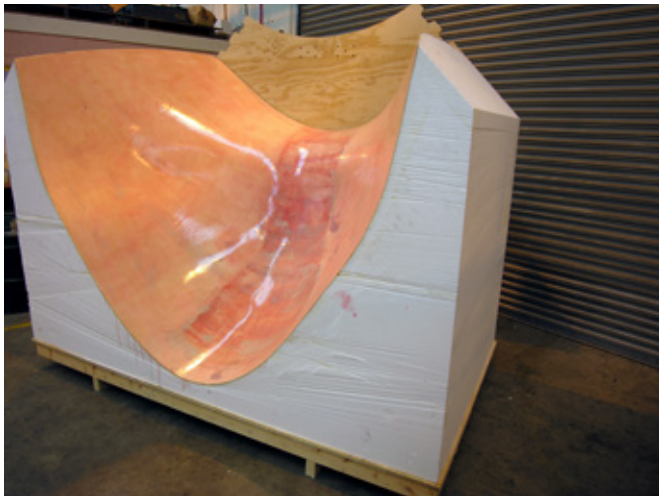
To translate the design from model to mould, the artist's sculpture was digitally scanned and then refined to re-create the original surfaces and provide an internal void. Panel sizes, visible joints and fixing types, and locations, plus handling, loading and transportation requirements were paramount.

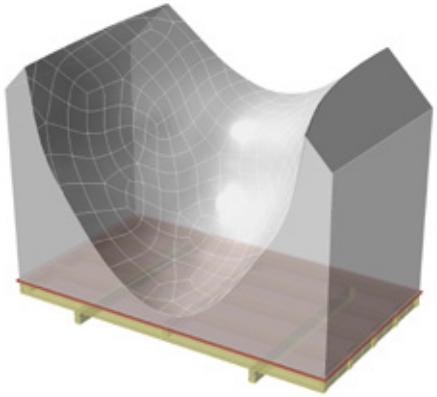
The Process

Due to its size and weight, the eventual configuration was made up of 54 individual panels, each one determined both by artistic requirements and the two-fold connection system used to hold the panels together, and in effect create an integrated monolithic structure.

Cordek's Project Design Team digitally created the 3D mould profile required to support the concrete pressure, which was in excess of 50kN/m^2. Profile blocks of high density expanded polystyrene were laminated to a plywood bed ready for routing. Using a 13m long 5-axis router the surface of the profiles were machined back to a level 10mm below the final sculpted surface. A layer of dense polyurethane foam, approximately 20mm thick, was then applied to the surfaces. Once the coating had cured the moulds were ready for the final machining. This involved machining with a 10mm-diameter routing tool and a 1-2mm step over between passes. The final process for the sculpted surface of the mould was to seal the foam with an epoxy resin to facilitate the striking of the moulds.

The unique moulds were shipped to Evans Concrete, where they were used to create the individual concrete/dolomite panels composing the sculpture.





Summary

The sculpture has now established itself as a landmark to the area, bestowed with numerous awards and attracts thousands of visitors every year.

BESPOKE SOLUTIONS

FOR ON-SITE CONSTRUCTION
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If you would like to discuss a project,
please phone **01403 799600** and ask to speak
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