PERI

Architecture and concrete

The canteen at the PERI headquarters in Weissenhorn was designed by the daughter of the company founder, architect Nathalie Schwörer, in collaboration with architects Mühlich, Fink & Partner.

You can find even more project examples from well-known architects online:

©Hiepler-Brunier Photo Studio esw.

Dear architecture enthusiasts,

With our brochure "PERI Architecture and concrete", I, as an architect and as a partner of PERI, would like to share my fascination for the building material concrete with you. In my view, the special feature of concrete is its versatility – both in terms of design possibilities and in terms of production and processing.

As early as the design phase, our experts in formwork, scaffolding and civil engineering provide assistance in the form of tailored solutions that make complex construction with concrete possible in the first place. Be it in the development of creative shapes, the execution of joint patterns or the implementation of structures and colours. In doing so, PERI not only places its trust in tried-and-tested systems and the expertise it has built up over many years, but also in new technologies such as BIM, sensors or 3D construction printing.

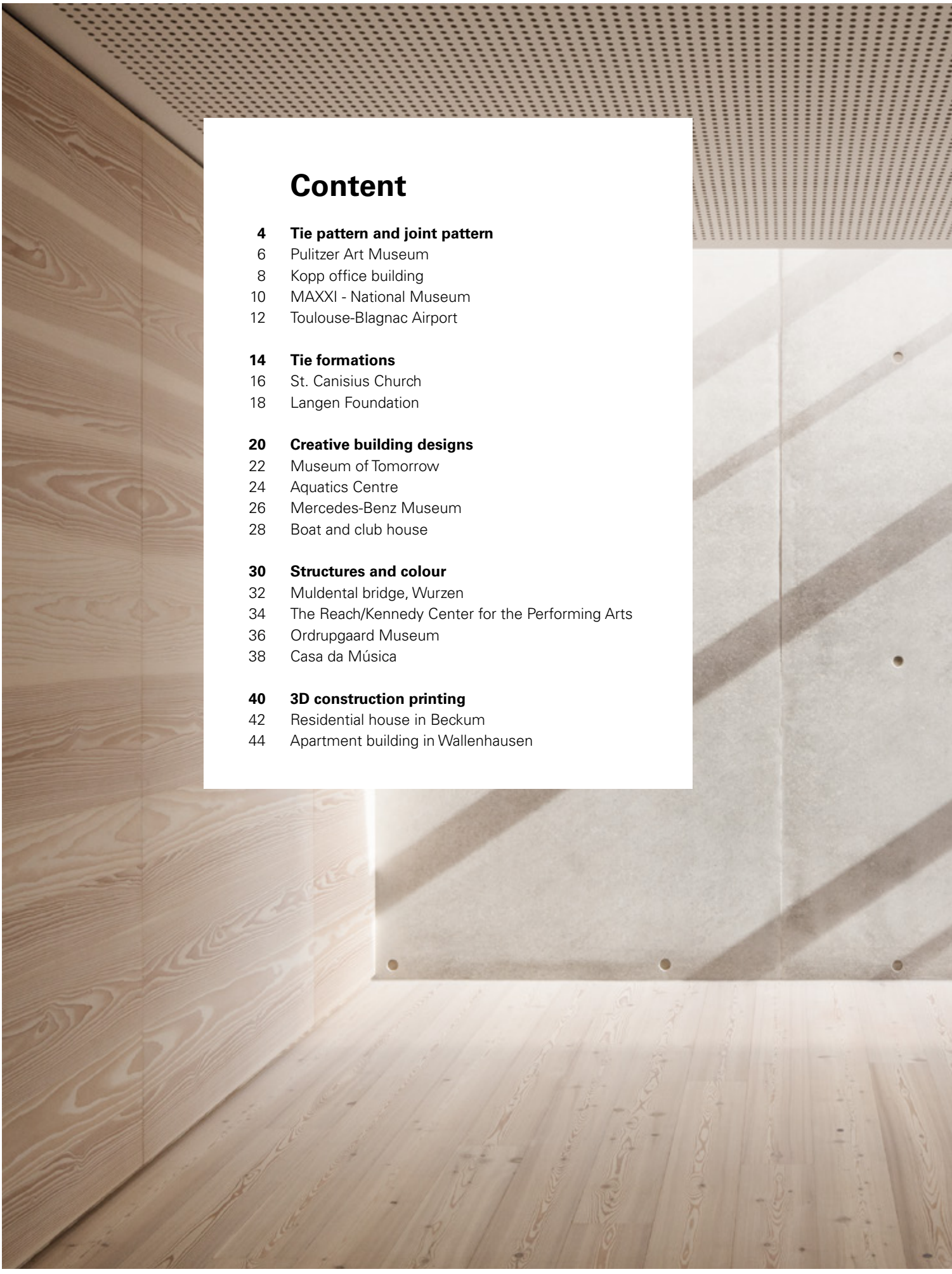
The following pages will provide you with information about formwork and concrete as well as a selection of projects that, to a certain degree, could only be realised thanks to PERI's expertise. For example, the Mercedes Benz Museum in Stuttgart, for which PERI developed a new formwork method, or the London Aquatics Centre designed by Zaha Hadid, for which PERI realised special-purpose, freeform formwork.

I hope you enjoy reading it!

Yours,
Nathalie Schwörer

About PERI

PERI is one of the leading manufacturers of formwork systems, scaffold systems and civil engineering solutions and is a pioneering 3D construction printing provider. The southern German family-owned company was founded in 1969 by Artur and Christl Schwörer and is now represented by over 60 subsidiaries on all continents.

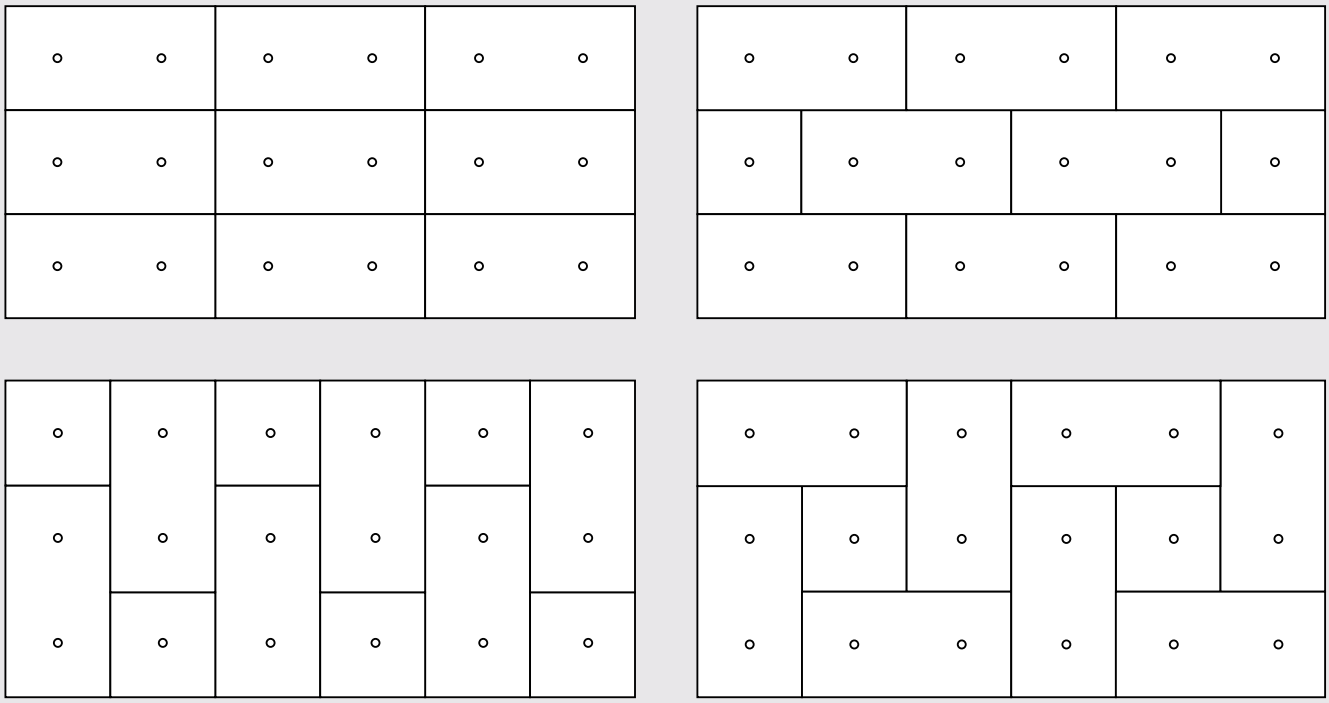


Content

@Hiepler-Brunier Photo Studio esw.

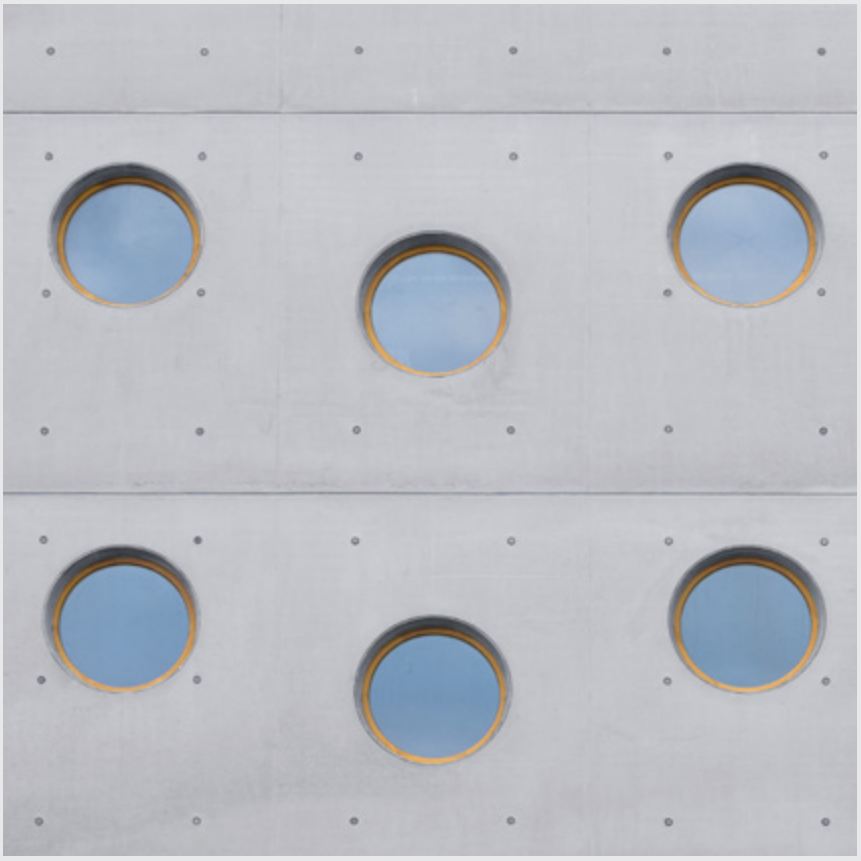
Tie pattern and joint pattern

The tie and joint pattern is often used for the design of exposed concrete projects. The formwork used plays an important role here. In that case of panel formwork, the tie pattern and frame impression in the concrete are predefined. With the centrally arranged tie points, the result is a regular joint pattern – both horizontally and vertically. By enabling you to combine different panel sizes, PERI also affords you flexibility when designing the concrete surfaces. As a rule, panel formwork achieves architectural concrete results ranging from SB 1 to SB 2. With PERI MAXIMO, it is even possible to produce architectural concrete class SB 3 following consultation with the client.



The variable arrangement of individual MAXIMO elements makes it possible to create visually appealing concrete surfaces without leaving indentations at unoccupied tie points.

MAXIMO Panel Formwork elements are available in six heights from 30 cm up to 3.30 m as well as in five widths from 30 cm to 2.40 m in 30 cm increments. There is also a 45-cm-wide element that reduces the use of filler plates even further. In addition, the MAXIMO system has up to 40% fewer tie points than other formwork systems, ensuring an even more uniform concrete finish.



Girder formwork offers universal design options without a frame impression in the concrete finish. While prefabricated standard sections have fixed element sizes according to specifications, object-specific formwork sections are more versatile. The formlining (type, size, fixing), girder and ledger position (spacing) as well as the tie pattern can be freely selected in compliance with the system principles. Depending on the system used, architectural concrete results ranging from SB 3 to SB 4 can be achieved.

With PERI Library+, architects have the option of integrating the appropriate formwork solution into a Revit model as early as the planning phase so that they can visualise the final concrete finish in advance.

© Aaron Dougherty

Pulitzer Art Museum

SAINT LOUIS, USA - Tadao Ando

The Pulitzer Art Museum presents contemporary and historical art on two levels. The almost windowless art centre designed by Japanese star architect Tadao Ando consists of two cubic structures with impressive exposed architectural concrete surfaces and razor-sharp edges.

The smooth, untextured concrete finish with precisely arranged tie points was realised with PERI VARIO Girder Wall Formwork. It was possible to adapt the girder wall formwork to a wide variety of wall shapes.


KOPP

By combining the MAXIMO Panel Formwork with the PERI UP scaffolding, it was possible to cast the 7.20-m-high external walls in a single pouring operation. Because magnet cones were used during the forming process, the tie holes could then be sealed using concrete cones.

Kopp office building

EMERKINGEN, GERMANY

The modern, two-storey office building of the family-owned company Kopp from the Upper Swabian town of Emerkingen near Ulm impresses with its exposed concrete facade with a clearly structured joint and tie pattern. It was also important for the project that the exterior walls and window openings harmonise with the pattern.

MAXXI - National Museum

ROME, ITALY — Zaha Hadid

The national art museum MAXXI by architect Zaha Hadid is the first museum for contemporary art in the Italian capital. The museum is characterised by several, widely curved architectural concrete walls with heights of up to 14 m, which appear to flow into, over and under each other. Inside, the building is dominated by generous galleries, slopes and curves.

The curved areas were realised in Rome using polygonally arranged VARIO formwork elements. These were also tailored to the self-compacting concrete SBV that was used, making it possible to achieve a very high surface quality.

@ Adrien Roussel

The special chequerboard joint and tie pattern was created with pre-assembled VARIO GT 24 Formwork. The formwork panel joints, tie cones and additional dummy ties were positioned precisely so that fine triangular panicles and a uniform tie pattern could be created.

Toulouse-Blagnac Airport

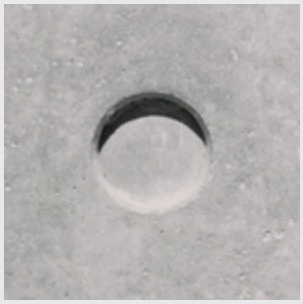
TOULOUSE, FRANCE — Cardete Huet Architectes

The architectural design by Cardete Huet Architectes is captivating on account of its semi-circularly placed reinforced concrete columns on a triangular ground plan. The 40,000 m² terminal building D houses 24 check-in counters and 13 departure gates.

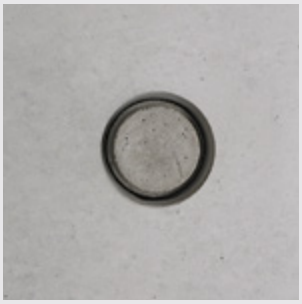
Tie formations

The tie holes are a very effective design element of exposed concrete walls. These can either remain open or be closed. Fibre concrete or poured concrete cones or plugs are suitable for closure. Depending on whether the closure is flush with the wall element or offset to the rear, the result is a flush closure or a shadow joint.

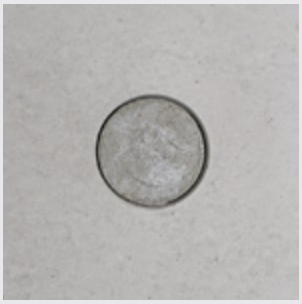
Cone impression, unplugged



Plugged with recessed concrete cone

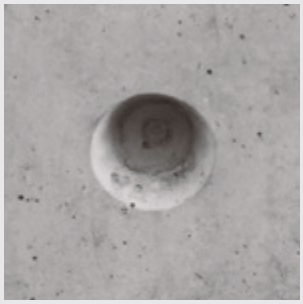


Plugged with silhouette cone



Plugged with flush-fitted concrete cone

Blind tie on formwork panel



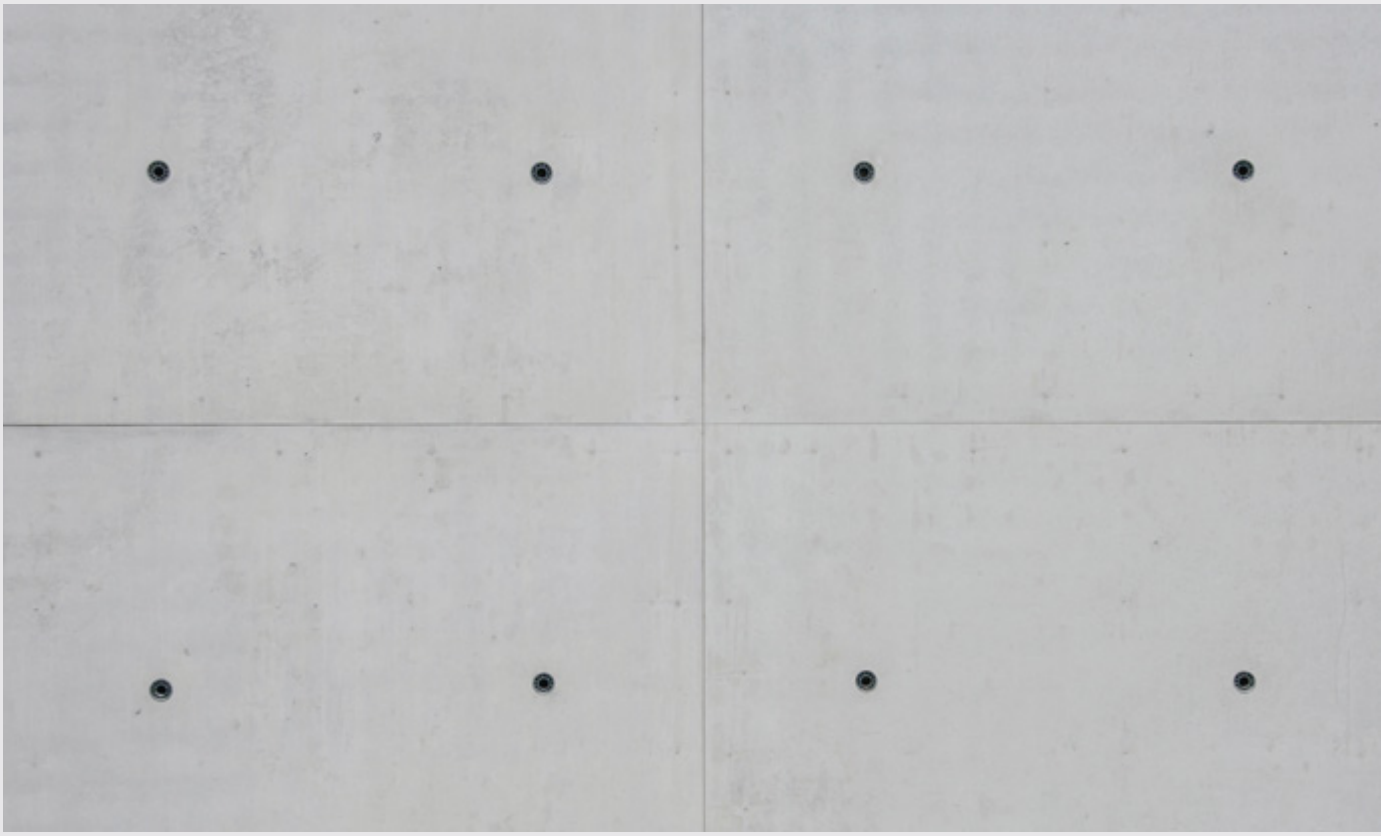
Concrete impression with blind cone

Fin-Ply formwork panel

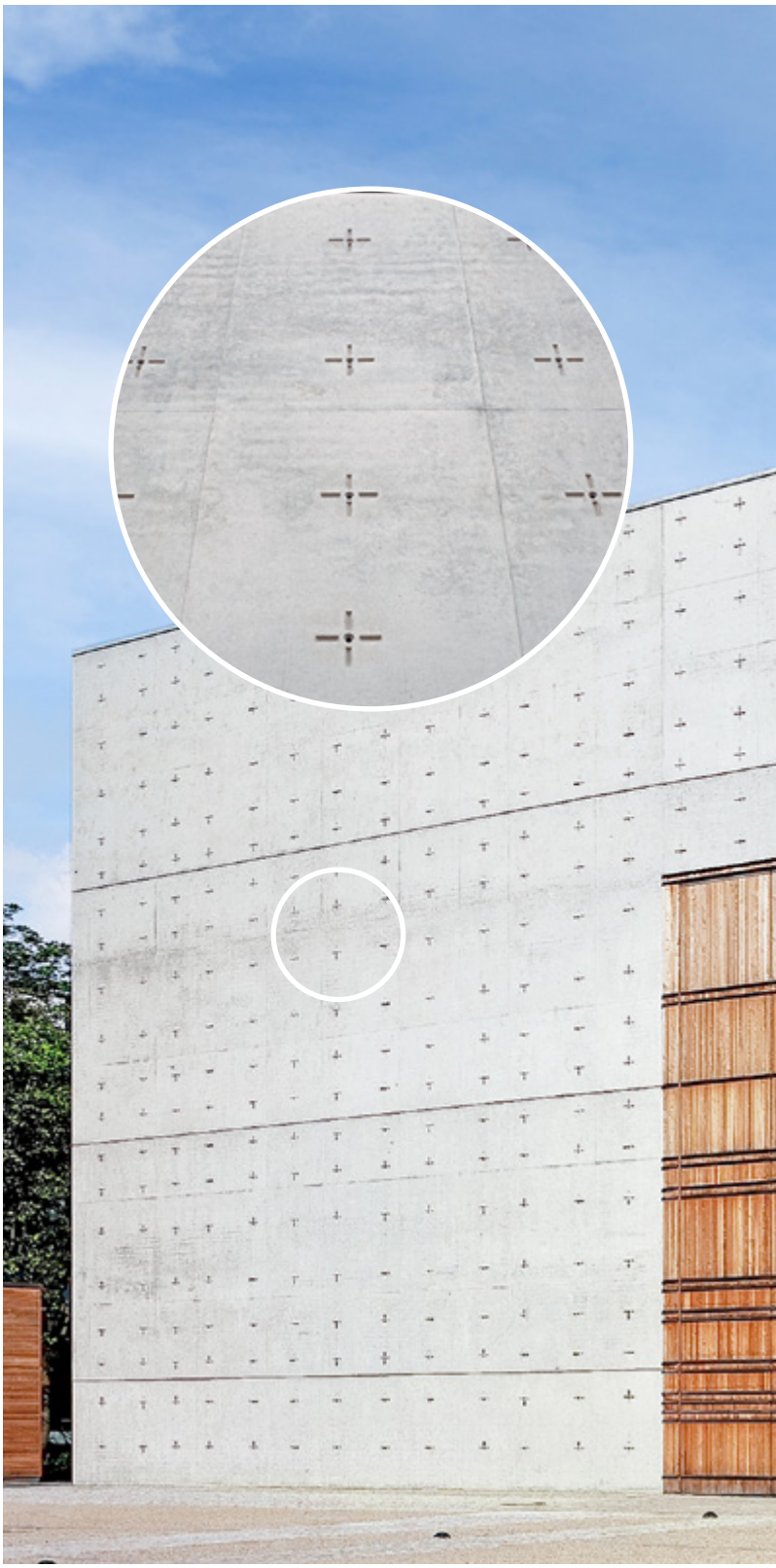
Formwork panel with blind cone

Climbing cones normally leave a visual impression in the concrete surface that is different to the one left by tie cones. PERI has therefore developed special-purpose climbing ties whose openings are plugged with the same concrete cones used for closing tie openings.

The pattern of the formwork ties depends on the system used and can only be influenced to a limited extent, for example by so-called blind ties. They supplement the tie points required for the formwork. This creates an even and orderly tie pattern.



PERI VARIO GT 24 Girder Formwork elements with film-coated plywood as formlining and nailed-on matrix parts achieved the best architectural concrete results. Tolerances in the formwork joint area were minimised using an architectural concrete coupling.



St. Canisius Church

BERLIN, GERMANY — Büttner – Neumann – Braun BDA Berlin

The architectural office Büttner – Neumann – Braun BDA Berlin has designed a new meeting place for the St. Canisius parish in Berlin. The reinforced concrete construction is characterised by regularly arranged formwork joints with tie points and construction joints.

Langen Foundation

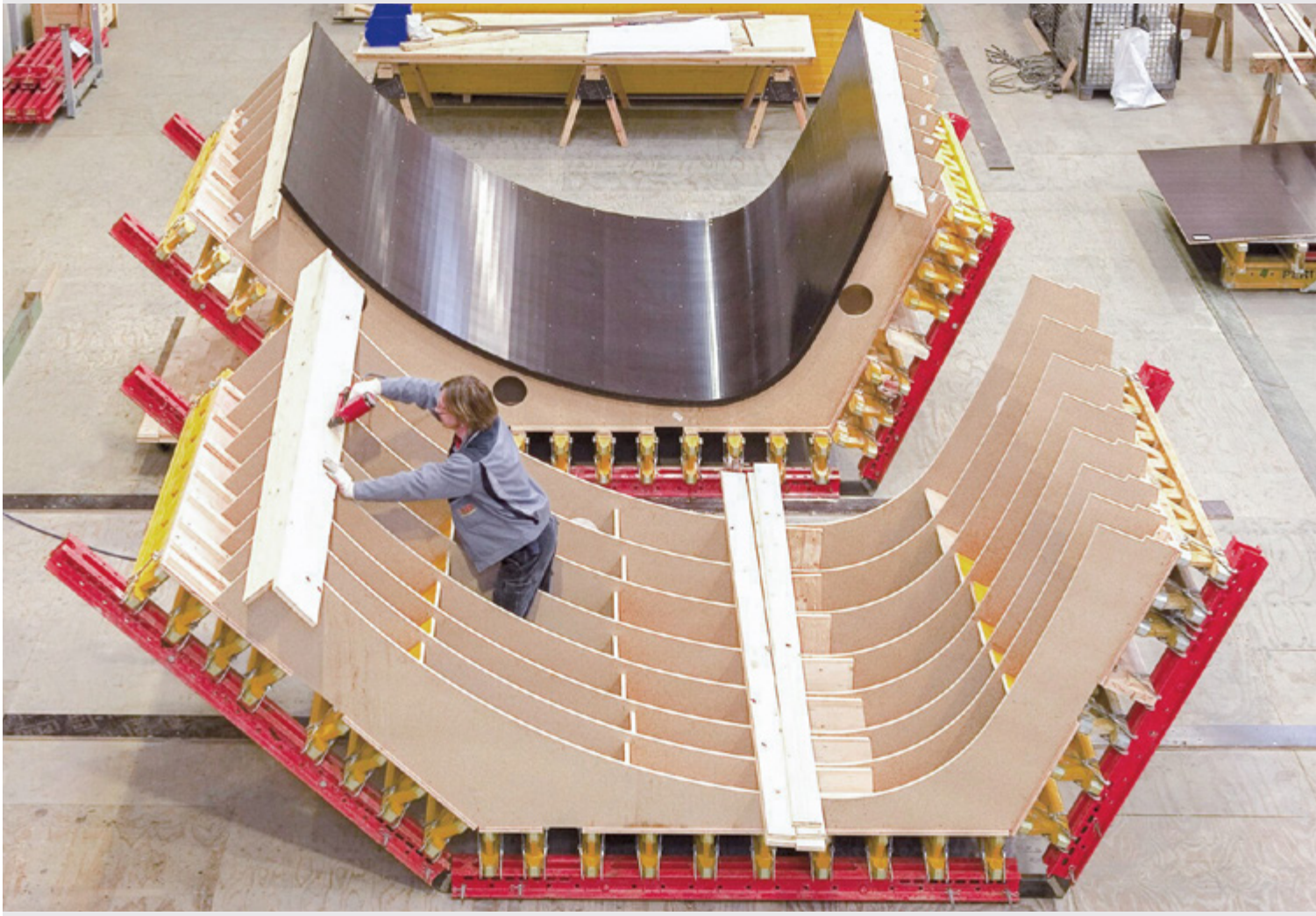
NEUSS-HOMBROICH, GERMANY — Tadao Ando

For the art collection of the Langen Foundation, the Japanese star architect Tadao Ando designed an exhibition building made of concrete, glass and steel. Characteristic of his buildings is the visible structure of the formwork panels used, which together with the accurate tie points create a striking image.

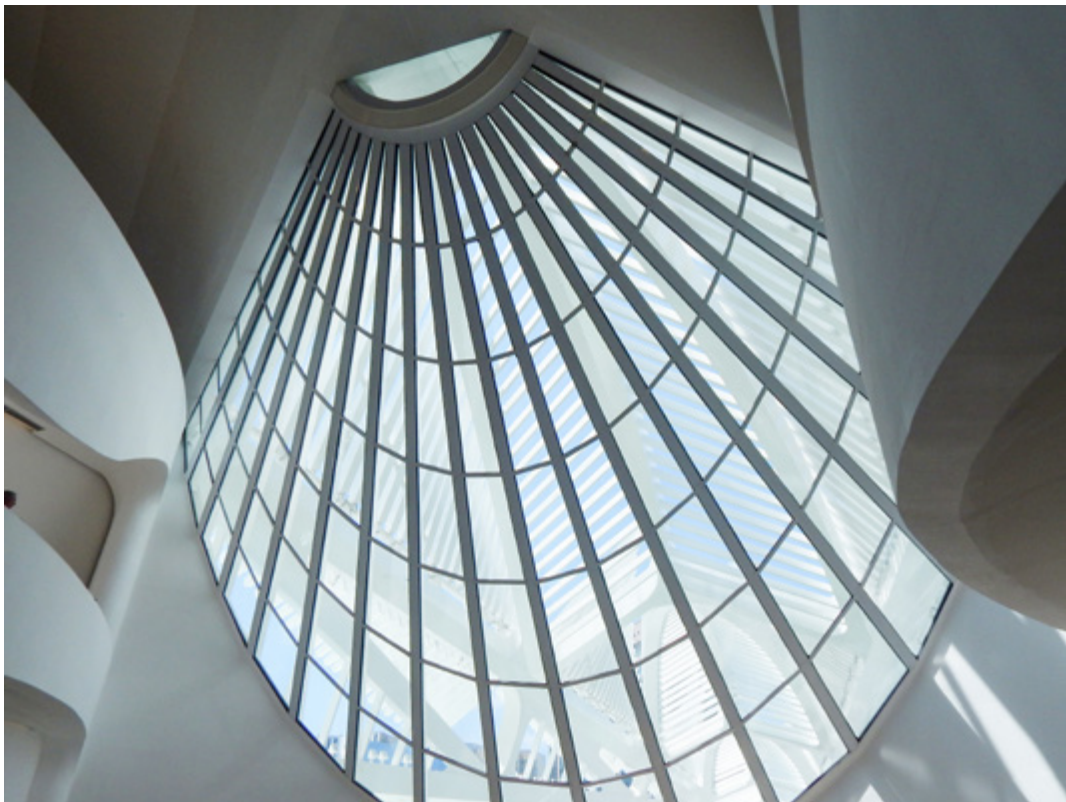
Installation of the six striking tie points per plate was carried out with the help of VARIO GT 24 Formwork Units, which were covered with blind plugs.

Creative building forms

Unusual geometries, sharp edges or curved surfaces are the distinguishing features of many buildings. For their realisation, specially made freeform formwork is usually required. PERI engineers plan these architecture-specific formwork bodies on the basis of a 3D model. To ensure that the subsequently visible joint and tie pattern is arranged precisely, they always take the formwork assembly on the construction site into account as well. The 3D solids can then be pre-assembled with millimetre precision in the factory so that they can be assembled easily on the construction site at a later date. PERI's extensive international project experience has resulted in a high degree of standardisation and refinement of the formwork project process. This paves the way, for example, for larger elements, improved panel connections as well as higher concrete pressure levels and concreting heights than would normally be possible. At the same time, concrete surfaces of the highest architectural concrete quality can be achieved without visible imprints in the concrete.



Curved walls can also be constructed using systems from PERI, namely by means of polygonal approximations to the desired geometry with the aid of panel formwork or with custom-made girder formwork. Circular wall areas with bending radii from 1.00 m to about 20.00 m can be realised steplessly. Recesses in the concrete for light openings, windows or doors can be realised with custom-made recess boxes. In addition, PERI offers ready-made recess formwork in predefined lengths and widths for right-angled openings.



© Edvaldo LL Souza on unsplash

Museum of Tomorrow

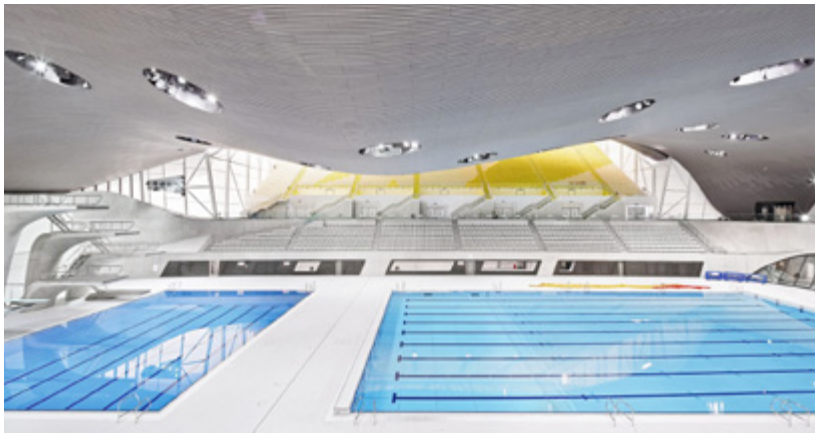
RIO DE JANEIRO, BRAZIL — Santiago Calatrava

When designing the Museum of Tomorrow with a movable facade and roof, architect and engineer Santiago Calatrava was inspired by pineapple plants. Two floors connected by sloping ramps offer 5,000 m² of exhibition space.

PERI planned and manufactured over 3,500 project formwork units for the extraordinary museum in cast-in-place concrete construction. The assembled 3D overall formwork was supported by PERI UP shoring and working scaffold as well as a VARIOKIT frame reconstruction.

@ Hufton + Crow

N.M.Bear/Shutterstock.com



© Hufton + Crow

Aquatics Centre

LONDON, UNITED KINGDOM — Zaha Hadid

The interior of the water sports arena, which was designed by Zaha Hadid on the occasion of the 2012 Olympic Games, impresses with complex geometries and the curved shape of the roof construction, which is visible from afar. During construction, not only did maximum exposed concrete requirements have to be met, but due to the subsequent glazing, work also had to be carried out with the utmost precision.

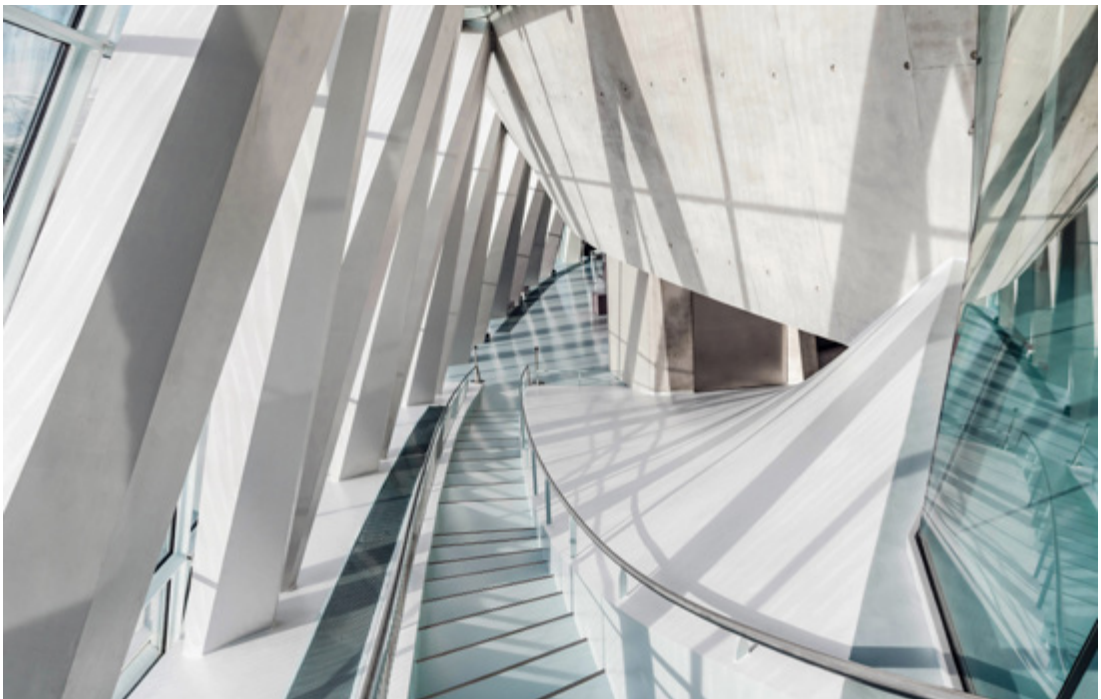
Formwork with millimetre precision was required in order to create the flowing geometries. PERI manufactured more than 200 individual formwork units and delivered them to London on a just-in-time basis. Using a 3D model that showed the full element arrangement, all of the details could also be coordinated in advance – ensuring that the concrete finish was consistent all the way round.

Special-purpose formwork construction in a class of its own: In collaboration with the company Züblin, PERI developed a new formwork method that made it possible to concrete the double-curved surfaces. Up to 50 formwork carpenters implemented the 3D plans of the application engineers. PERI verified the feasibility of the approach using samples, which also acted as a decision-making aid for the architects with regard to the surface results.

Mercedes-Benz Museum

STUTTGART, GERMANY — UNStudio architecture firm

The building by the architecture firm UNStudio van Berkel & Bos has the structure of a double helix. Almost all walls and ceilings, ramps and supports are curved or turned in on themselves and merge into one another using gentle, flowing contours. The ceilings span 33 metres without supports – and none of the 1,800 triangular window panes is identical to another.



Mercedes-Benz AG Architect: UNStudio van Berkel & Bos, Amsterdam; Museum designer: Prof. HG Merz, Stuttgart

TRIO Panel Formwork with doubled-up recess boxes was used on PERI folding platforms. Concreting was carried out using only six formwork elements in ten sections, whereby the formwork sets were used in a mirrored and rotated fashion.

Boat and club house

FUSSACH, AUSTRIA — Baumschlager-Eberle

The boat and club house in Fußach, Austria, towers like a monolith above the shores of Lake Constance. The 14-m-high, sophisticated architectural concrete building with a glass envelope draws on the visual elements of the harbour. The tree-like openings in the 8.50-m-high walls and the crystalline glass facade in front allows light to enter the interior in a varied manner. The firm Baumschlager-Eberle carried out the architectural work for the project.

Structures and colour

Visible concrete surfaces can also be formed with the aid of the formlining. This determines the surface character of the concrete in interaction with the release agent and the fresh concrete. The surface texture of the formlining creates a negative imprint on the concrete surface. The absorbency of the formlining affects the colour of the concrete surface in terms of brightness and intensity of colour. In addition, the natural colour of the concrete can be influenced by the use of aggregates and white and grey pigments. The interplay between the formlining and the film structure is a fundamental factor in realising coloured concrete walls.

Overview of formwork panels and concreting result*

FinPly for smooth surfaces

Formlining: Birch wood with phenolic resin film
Concrete surface: light, highly porous, very smooth, untextured
Surface: smooth, non-absorbent

FinPly Pro for very smooth surfaces

Formlining: Birch wood with UV-resistant plastic coating
Concrete surface: light, low-porosity, smooth, matt, untextured, no sign of the wood grain
Surface: smooth, non-absorbent

Rough sawn boards for visible structure

Formlining Boards, rough sawn, tongue-and-grooved
Concrete surface: light, more porous, textured
Fixing: clamped
Surface: rough sawn, coated = non-absorbent

Planed boards for slight texture

Formlining Boards, planed, tongue-and-grooved
Concrete surface: dark, low-porosity, slightly textured
Fixing: clamped
Surface: planed, uncoated = absorbent

* Availability differs from country to country

PERI offers the ideal combination of formwork, formlining and coating for the successful production of coloured concrete surfaces. Formlining with weak absorption properties is particularly suitable for forming coloured concrete walls (e.g. PERI 3-layer plate). Sensors can also be used to optimise the concrete surface to an even greater extent. Thus, with PERI Insite, the ideal striking time can be determined through continuous temperature measurement, meaning that honeycombing and pore formation can be avoided.

White architectural concrete

Casa da Música, Porto

Black architectural concrete

V&A Museum of Design, Dundee

3-layer plate for light timber structure

Formlining 3-S Panel with melamine resin coating
Concrete surface: light, more porous, wood grain only marginally discernible
Surface: brushed, coated = non-absorbent

3-layer plate for visible timber structure

Formlining: 3-S Panel without coating
Concrete surface: dark, low-porosity, wood grain
Surface: brushed, uncoated = absorbent

Muldental Bridge, Wurzen

LEIPZIG, GERMANY — Arand Architekten

The architectural design of the Muldental Bridge in the Mulde Valley was produced by the architectural office Arnd Architekten in Berlin and boasts an impressive total length of 528 m. The bridge project consists of two bridge structures, a river bridge and a foreshore bridge. The approximately 215-m-long river bridge is a steel composite bridge with a span of one hundred metres, supported on two massive river piers.

For the twelve pairs of piers, PERI supplied pre-assembled formwork sets that utilised VARIO GT 24 Girder Wall Formwork. The formwork elements, covered with rough-sawn board formwork, provided the characteristic surface texture. The bridge is also better protected against corrosion on account of the absorption properties of the boards used.

Photo: Cowles Graphic Design

It was possible to construct the vertically and horizontally curved walls by combining PERI standard systems such as GT 24 Girder Formwork and RUNDFLEX Circular Formwork as well as project-specific special-purpose solutions. Geometry boxes, which were clad with battens and stapled with planks of poplar wood after placement, provided the special surface texture.

@Michael Friedlander, Cowles Graphic Design Inc.

The REACH/Kennedy Center for the Performing Arts

WASHINGTON D.C., USA — Steven Holl Architects

The building extension at the Kennedy Center for the Performing Arts, commonly known as "The REACH", was designed by Steven Holl Architects. It comprises three interconnected pavilions made of white in-situ concrete, which are characterised by their distinctive, clear-cut lines and ergonomic, sweeping curves. The project won the American Concrete Institute's "ACI Overall Excellence Award" in 2020.

Ordrupgaard Museum

CHARLOTTENLUND, DENMARK — Zaha Hadid

In 2005, a modern extension by architect Zaha Hadid was constructed at the Ordrupgaard Museum near Copenhagen. Hadid opts against using right angles in her design. The black-dyed concrete walls and ceilings appear to flow into one another. The shifts in elevation between the various floors of the building and the curves in the outer skin are intended to ensure that the building blends harmoniously into the landscape.

VARIO GT 24 Girder-Wall Formwork was used to create this unusual structure. For the transition areas between walls and slabs with their differing radii, it was supplemented with supports and articulated walers.

The versatile VARIO GT 24 Wall Formwork was used to create the polygonal shape of the building. This was combined with MULTIPROP Towers so as to support the high loads of the overhanging wall areas. White concrete was used exclusively for all concrete components to prevent mixing with other concrete.

Casa da Música

PORTO, PORTUGAL — Rem Koolhaas and Ellen van Loon

The architectural concrete building designed by architects Rem Koolhaas and Ellen van Loon resembles a crystal whose form develops from within. The centrepiece of the building is the concert hall. The white concrete shell encases a stack of cube-shaped rooms and wraps around them like a skin.

Photo: nitpicker/Shutterstock.com

Photo: Flo Barth/Shutterstock.com

3D construction printing

3D printers offer a wealth of new architectural design possibilities that can be implemented quickly and cost-effectively. From unique shapes to special surfaces and colours, almost anything can be achieved. With the COBOD BOD2 construction printer, PERI turned the technology into a full-scale construction process in 2020, creating the first 3D-printed houses that are rented out and occupied on a routine basis.

Surfaces with a 3D-printed effect are the hallmark of COBOD BOD2 buildings. In addition to vibrant structures, surfaces with a smooth look are also possible without any problems. A terrace structure is a good choice for easier plastering. There are next to no limits for the printer – showers, fireplaces, kitchen substructures and much more can be printed with ease. Further design possibilities are offered by playing with overhangs as well as different heights and widths of the print layers.

Interested?
Scan the QR code for more information

Building the circular walls of the house was much quicker and cheaper with the COBOD BOD2 than with conventional construction methods. In addition, other elements can be produced by the printer, such as the fireplace or some of the bathroom fittings.

Residential house in Beckum

BECKUM, GERMANY — MENSE-KORTE ingenieure+architekten

The two-storey detached house in Beckum, North Rhine-Westphalia with around 80 sqm of living space is the first printed residential house in Germany. It was planned by the architectural office MENSE-KORTE ingenieure+architekten from Beckum.

Apartment building Wallenhausen

WALLENHAUSEN, GERMANY — Mühlich, Fink & Partner

The building consisting of five apartments with approx. 380 square metres of living space was designed by the architecture firm Mühlich, Fink & Partner BDA from Ulm. It features the vibrant surface structure that is typical of 3D construction printing. Otherwise than that, it reflects the typical style of a traditional apartment building; the innovative construction method became the norm in this case.

The printing time for the residential building with a full basement and approx. 380 m² of living space was only six weeks. The pipes and connections for water, electricity and the like that needed to be installed at a later time were already taken into account by the COBOD BOD2 during the printing process.