PERI®

Formwork Technology for Architectural Concrete

Visible concrete surfaces
realised with PERI MAXIMO.

PERI Branch Office in Düsseldorf,
Viersen, Germany

PERI Formwork Technology for Architectural Concrete

Technology
References

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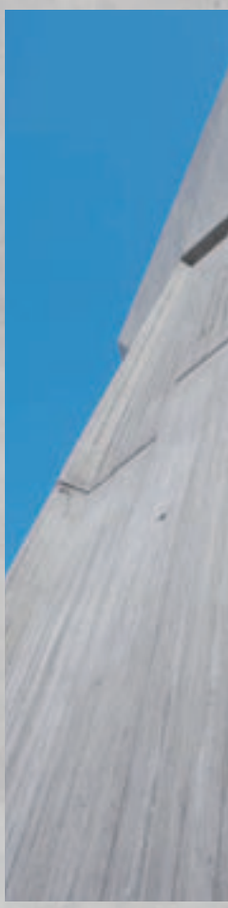
Architectural concrete
The modern-day language of architects

Whether it is at breathtaking heights or through extreme forms and structures – the visions of architects for the realisation of museums, concert halls, stadiums or bridges place the highest possible demands on the construction industry around the world. In many cases, architectural concrete is the modern solution, whether it is for civil engineering, economic or aesthetic reasons.

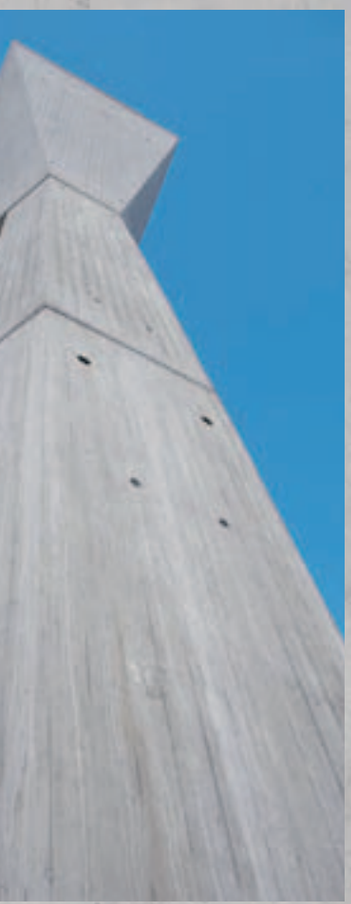
PERI provides its customers in the construction industry with practical help and support: selection, planning and supply of formlining and formwork systems which are optimally matched to the project requirements. The right formwork solution for every architectural concrete surface, from standard formwork to special designs. The best results arise from the very close cooperation between architects, contractors and PERI engineers.

University of Applied Sciences Campus, Salzburg-Urstein, Austria



Kulmbachtal Bridge, Nabburg, Germany

Club & Spa Balthus, Vitacura, Santiago, Chile



Münstertor, Neue Mitte Ulm, Germany

National Museum for Contemporary Art MAXXI,
Rome, Italy

Basic principles for the realisation
of architectural concrete structures and components

Architectural concrete has developed into one of the most important means of design in modern architecture. No other building material can be used and processed in such a versatile manner. Through the design capabilities of the fresh concrete, almost any shape and quality can be economically realised with the help of appropriate formwork systems and formlining. Architectural concrete is used for nearly all construction tasks and, according to the DBV (German Concrete Assosiation) Code of Conduct "Architectural Concrete", is divided into four classes.

The creation of architectural concrete as a design element is influenced by:

- the formlining and formwork system;
- the concrete mix including type of cement and aggregates;
- added pigments;
- selection of a suitable release agent:
- subsequent surface treatment such as washing, sanding, polishing and sandblasting;
- hydrophobizing impregnation, colour varnishing and coatings.

The development of the building material concrete with new concrete types such as high-strength, lightly-compacted and self-compacting concretes as well as fibre-reinforced concretes (steel and textile fibres) opens further areas of application also for architectural concrete.

DIN 18217 "Concrete Surfaces and Formlining" is considered as the basic standard for architectural concrete. It provides guidance regarding which kinds of concrete surfaces can be produced.

Aesthetic references are not stipulated in this standard because there are no binding regulations for the production of architectural concrete. This is understandable as the creative intent of a planner cannot be standardised. His task is to describe as comprehensively and clearly as possible his individual ideas about the appearance of a concrete structural component.

With the DBV Code of Conduct "Architectural Concrete" which defines specific architectural concrete classes and the associated requirement criteria, good technical support is available to planners, those tendering contracts and contractors themselves.

It is strongly recommended to put out to tender, assign and supply the services on the basis of this Code of Conduct.

Architectural concrete according to the DBV guidelines “Architectural Concrete”

SB 1
Concrete surfaces with low design requirements (basements, underground garages, commercially used spaces).

SB 2
Concrete surfaces with standard design requirements (staircase areas, retaining walls, civil engineering structures, hydraulic engineering).

SB 3
Concrete surfaces with high design requirements (facades in building construction).

SB 4
Concrete surfaces with particularly high design requirements (prestigious structural components in building construction, cultural buildings).

In the architectural concrete classes, requirement criteria are identified:

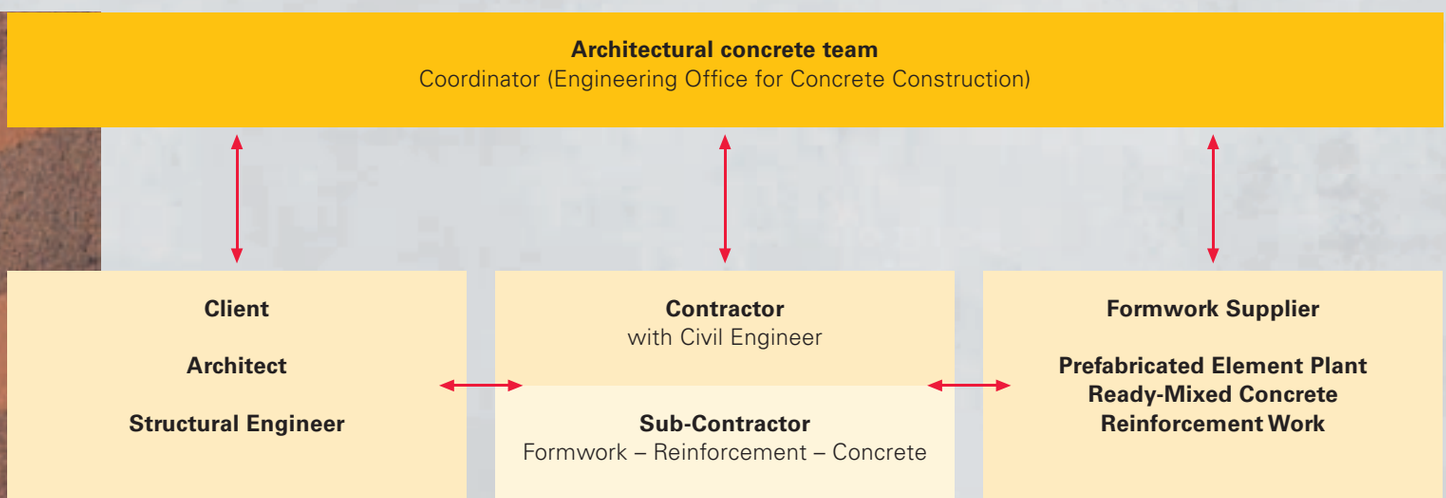
- texture, panel joint
- porosity
- colour uniformity
- evenness
- construction and formlining joints
- test surfaces
- formlining class

DBV Guidelines “Architectural Concrete”
Publisher: BDZ and DBV

The architectural concrete team

For the planning and execution of structures and structural components with special concrete surface requirements, the coordinated co-operation of all parties involved is essential. The expectations and requirements of the planners and clients must correspond to that which can be realised in the actual execution.

The best solution for a good result is the creation of an architectural concrete team. As the contract has not been normally allocated in the planning phase and no final decision has been taken regarding who will carry out the work, consultation agreements with competent specialist companies (e.g. formwork manufacturer) or experienced engineering offices. The selected engineering office can then assume the role of architectural concrete coordinator in the following architectural concrete team.



The structure of the architectural concrete team makes it very clear just how complex the challenge is to produce architectural concrete. As a formwork provider, PERI presents the influences and possibilities in this brochure regarding how architectural concrete surfaces can be designed and realised with formwork and formlining.

Assignment of tasks and call for tenders

Requirements can be realised without any increase in time and expense

Requirements can be guaranteed by the contractor.

Requirements can be realised with additional time and expense

(e.g. new formlining, screwed from the rear, joints are sealed)

Requirements can be guaranteed by the contractor. Additional expenses are to be taken into account in the calculation.

Requirements that can only be partially realised

Requirements cannot be guaranteed. Additional expense cannot be calculated in advance.

Requirements on the visible surface that cannot be accurately fulfilled with current techniques

- Uniform colour of all visible surfaces on the structure
- Uniform pore structure (pore size and distribution) in an individual surface as well as in all visible surfaces on the structure
- Blistering of visible surfaces of in-situ structural components.

The following deviations can only partially be avoided

- Slight differences in colour between consecutive layers of concrete pours
- Pore accumulation in the upper part of vertical structural elements
- Markings due to reinforcement or from large-size aggregates
- Slight bleeding at joints between formlining boards or panels, tie holes or similar
- Low frequency and extent of bleed water effect
- Cloud formation and marbling
- Individual lime and rust plumes on vertical structural elements
- Traces of rust on the bottom side of horizontal structural elements.

Requirements cannot be realised

Contract not put out to tender, requirements are basically rejected by the contractor

The following requirements cannot, for example, be realised

- Pore-free architectural concrete surfaces
- Formlining joint as thin, uniform line
- Non-bordered sharp edges with no breakage and bleeding
- Offset-free joints of the formlining and formwork panels
- Perfect uniform colour of architectural concrete surfaces

The basic requirements for fulfilling the wishes of owners and architects regarding architectural concrete surfaces are:

- a clear list of tasks,
- an implementation offer which fulfils the list of tasks.

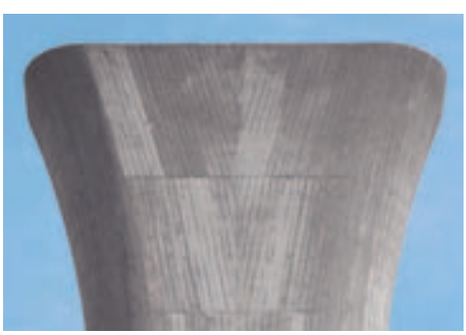
This appears to be logical but is extremely difficult in practice.

In the VOB (German Construction Contract Procedures) Part A § 9 Performance Specification, General Information, it is required that:

(1) The work is to be described clearly and in sufficient detail so that all tenderers can understand the description in the same way and are able to calculate their prices with great certainty and without extensive preparatory work.

(2) No unusual risk may be imposed on the contractor regarding circumstances and events over which he has no influence, and whose effects on the prices and deadlines cannot be estimated in advance.

In DIN 18217 Concrete Surfaces and Formlining, Section 2.3 "Concrete surfaces with requirements regarding the appearance" stipulates:
"These are visibly remaining concrete surfaces, for which a clear and practically executable description must be available. A comparison with buildings already completed can be an effective help. Sample pieces can be agreed and used as a basis for the execution."



In the DIN 18331 references section, it is stipulated that:

0.2.4
For visibly remaining concrete surfaces, among other things:

- classification of the visible surfaces
- surface texture, description of the formwork and formlining systems if necessary, surface design of non-formed areas
- colour
- surface structure
- formation of joints, edges, ties and tie holes as well as formwork joints, number of test surfaces, selection of the reference surface.

These basic principles should not only be featured in the call for bids and awarding of contracts according to the VOB, but also complied with in practice. The contractor can only offer the required service if he actually knows what the client expects and if this is the situation, the client is then in a position to make demands.

There is no binding definition in the technical (e.g. in the DIN standards) or legal sense by which the extent of work required for building a structure or structural component in architectural concrete is more closely defined. This is a reason why differences could arise between contracting parties whether the contractor has complied with his contractual obligations during the construction of a structure or structural element in architectural concrete.

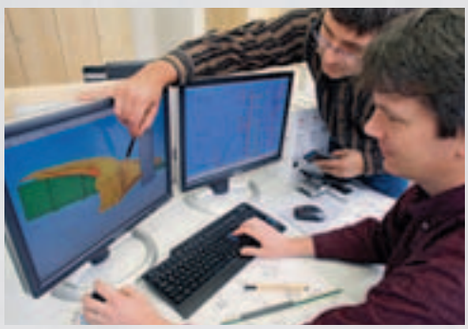
PERI – the competent partner in the architectural concrete team

Consultation

For the selection of the most suitable formwork system and formlining, architects are expertly advised by our specialist engineers. Accompanying detailed solutions are thereby provided which also have an affect on the architectural concrete concepts of the architect.

Construction companies are provided with specialist support for the drafting of formwork offers including during the submission phase.

If the construction company is awarded the contract, we provide an offer which fulfils the desired architectural concrete requirements made on the formwork. In the process, we are able to offer cost-effective solutions through the use of system equipment from the rental park which can meet the quality requirements.

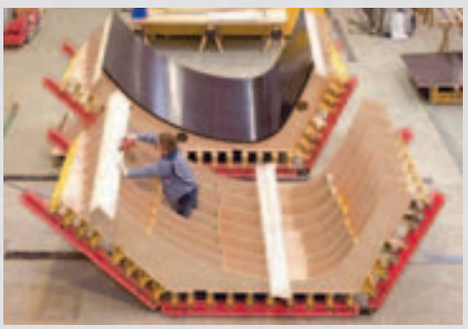


Formwork planning

In case of order, we provide the complete planning of the formwork for the pre-assembly as well as the execution on the construction site. If necessary, the planning is supplemented by required assembly drawings and static calculations.

Especially with geometrically complicated forms, the demands of the architect can often only be realised with self-compacting or lightly-compacting concrete. The higher fresh concrete pressures that occur here are taken into consideration by the building contractor during the formwork planning according to the specifications provided.

In this respect, the revised version of the DIN 18218 provides realistic load assumptions which ensure an economical formwork solution.



Pre-assembly

In the PERI formwork assembly, the formwork elements are prefabricated according to project specifications and in transportable units. If requested, on-time transport to the construction site can also be organised.

Construction site support

In order to efficiently arrange the formwork utilisation from the beginning, construction site personnel are briefed and trained by experienced PERI supervisors.

Rental and delivery service

The proven PERI rental and delivery service is also available for architectural concrete formwork.

Project completion

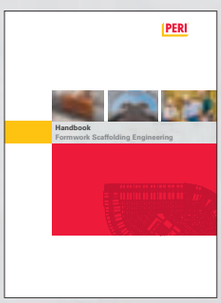
Even the return of materials is handled in a customer-oriented manner. Thus, dismantling and cleaning of the formwork equipment at the PERI logistics centres can be arranged at cost-effective conditions.

Good architectural concrete is a team performance of all those involved, from the architect to the concreting workers on the construction site.

PERI as a competent formwork provider has decades of experience with the realization of a very wide range of architectural concrete structures and structural components. This experience is added to expertise of the architectural concrete team by PERI specialists also as service and service features.

Formwork systems

In modern formwork construction, system formwork or shuttering is primarily used which consists mainly of system components. A comprehensive presentation of the PERI formwork and scaffolding systems and their applications is available in the PERI Handbook.



At numerous locations around the world, PERI presents its system equipment from the extensive product range to its customers. A specially-developed seminar programme as well as practical training for customers are aimed at ensuring the maximum possible cost-effective use of the systems.

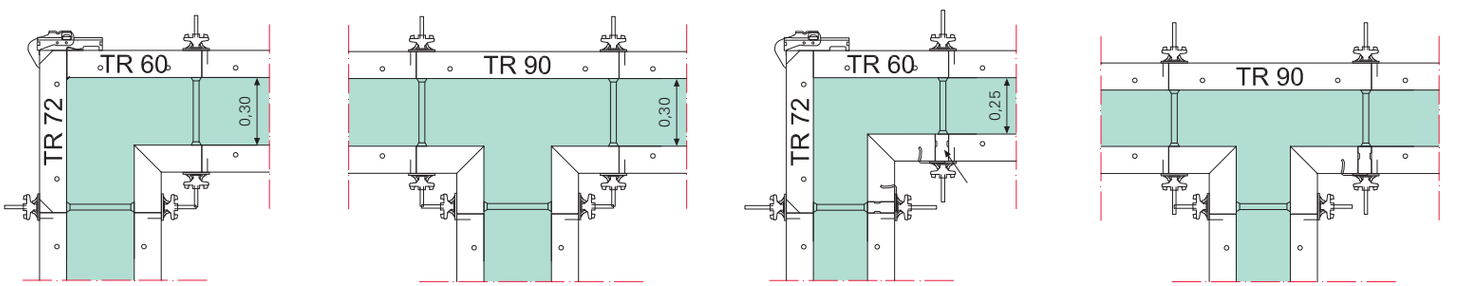
Panel formwork for walls

The formwork systems are divided into panel formwork and girder formwork according to their main design features.

These categories are in turn sub-divided into wall, slab and column. For each of these segments, PERI provides different formwork systems which promise the greatest possible benefits depending on requirements.

- Walls, e.g. MAXIMO and TRIO
- Slabs, e.g. SKYDECK and GRIDFLEX
- Columns, e.g. RAPID

Extended TRIO panels for 8.00 m high walls.



Standardised solutions for forming wall corners and T-junctions with wall thicknesses of 30 and 24 cm with TRIO sytem components.

The principle of the panel formwork is represented through the PERI TRIO system. Other panel formwork systems are similar in their concrete surface result. The panel and formwork anchor arrangement varies greatly between the systems. The panel sizes are arranged in a defined formlining pattern (250 mm or 300 mm).

The formlining (usually non-absorbent plastic-coated sheets) is protected around the edges and is installed in the frame. As a result, the panel joints leave a typical impression on the concrete surface

PERI MAXIMO for walls

With the development of the MAXIMO and the special MX tie technology with ties installed from one side, PERI once again confirms its role as technological market leader. MAXIMO fulfils very high requirements regarding cost-effectiveness and achievable quality of workmanship.
The PERI MAXIMO has been designed for a permissible fresh concrete pressure of 80 kN/m² uniform load according to DIN 18202, Table 3, Line 6.
Through the defined arrangement of the individual panels, any remaining visible concrete surfaces can be designed as required. The uniform arrangement of the tie points, which are positioned throughout in the centre of the panels, underline the achievable results even more.

With MAXIMO, visible concrete surfaces can be cost-effectively formed. In addition, various panel combination possibilities are available, the so-called MX grid arrangement. These allow the planner or construction company to realise the wall areas with different joint and tie layouts and thus achieve an attractive optimal effect.

The conical MX tie system does not require any spacers and cones. Tie operations are carried out by one worker and from one side only.

Improved concrete finish through a neat joint and tie arrangement.

Example of concrete surface design using the MAXIMO MX “stacked” grid arrangement.

Girder formwork for walls

For the types of application with girder formwork, the PERI programme offers a range of different systems.

Walls and columns
e.g. VARIO GT 24

Slabs
e.g. MULTIFLEX

The main principle of girder formwork is shown using the PERI VARIO GT 24 as an example. Other girder formwork systems are similar in their respective concrete finish. The grid arrangement of the standard sections and the formwork ties can vary. Formwork sections are pre-fabricated formwork elements consisting of formlining, main beams and waling.

We differentiate

Standard elements
Prefabricated sections with pre-determined element sizes stored in rental parks, partly equipped with formlining for secondary requirements and as supporting panel for an architectural concrete formliner.

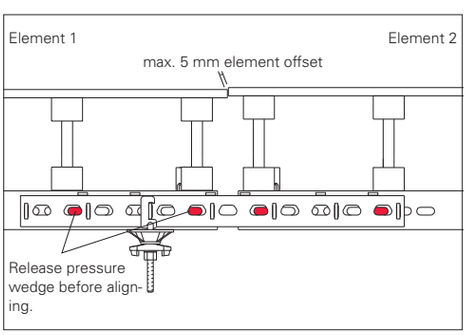
Object-related formwork elements
As before; however, these formwork sections are project-planned and produced according to the special requirements. Thereby, the formlining (type, size, fixing), girder and waling (spacings) as well as the tie arrangement are freely selectable whilst taking into account the system´s principles. The possible transportation dimensions are to be taken into consideration during pre-assembly at the plant.

Especially with high fresh concrete pressures which arise when using self-compacing or lightly compacted concretes, cost-effective solutions can be realised with the VARIO GT 24 girder formwork. On request, PERI provides load cells with whose help the formwork load can be controlled and limited during concreting.

For using formwork for architectural concrete surfaces, it should be noted that panel formwork is mainly used as the rental formwork supplied by the rental parks. As a result, the individual formwork elements have different utilisation rates and can also feature repaired areas. The quality of the formwork is regulated in the quality guidelines laid down by the GSV Güteschutzverband Betonschalung e.V. – (the German Quality Protection Association for Concrete Formwork). With this rental formwork, the lower architectural concrete classification of SB 1 and SB 2 according to the DBV Code of Conduct "Architectural Concrete" can be achieved. For the higher SB 3 and SB 4 architectural concrete classes, the use of panel formwork through a special joint and tie arrangement along with the requirements on the formlining is no longer possible to a limited extent, or with the use of PERI MAXIMO (see page 17). Girder formwork from the standard range of formwork through to project-specific special designs are used. The increase in time and effort associated with the manufacture of the formwork also has an effect on the costs of the formwork. Coordinating the architect´s ideas and plans, regarding the concrete surface together with it´s design possibilities through the formwork to be used at an early stage, can thereby minimize the costs quite considerably.

Formlining compensation on the panel joint. At the same time, the VKS coupling can also be used as a "standard" panel connection.

The functionality of the VARIO Coupling Concrete Finish VKS ensures clean and accurate panel joints through the possible compensation of up to 5 mm offsets.



Curved walls

Panel formwork
RUNDFLEX Plus

Girder formwork
RUNDFLEX

Curved walls can be constructed polygonally in the form of a polygon with panel formwork through inserted trapezoidal cover strips.

Circular wall areas are formed with special girder formwork systems with which the required radius is achieved by means of adjustable spindles connecting the single waler sections. Bending radii are continuously possible from 1.00 m to approx. 20.00 m.

The curvature of the formlining is achieved through special profiled timber – cut to match the curvature radius – which is inserted between the formlining and girder position.

Architectural concrete facade of spiral ramp with a neat joint arrangement.

Formwork system: PERI RUNDFLEX

Column formwork

The correct choice of formwork system is a prerequisite also for the construction of reinforced concrete columns in order to be able to fulfil the required quality standard. Depending on the requirements of the column cross-section, the finish of the edges as well as the concrete surface, panel and girder formwork are used.

The VARIO GT 24 girder formwork carrier can be adapted to suit almost any required cross-section. With special formlining, first-class concrete surfaces are achieved which also includes the realisation of sharp edges.

The special design of the panel joints on the SRS circular column formwork prevents any concrete bleeding taking place. This means that best quality surfaces for columns with diameters from 25 to 70 cm can be achieved in 5 cm increments.

RAPID panel formwork allows the construction of immaculate concrete surfaces with cross-sections from 60 x 20 cm to 60 x 60 cm.

Slab formwork

Grid element slab formwork
GRIDFLEX

Panelized slab formwork
SKYDECK

Customised slab tables

Girder slab formwork
MULTIFLEX

According to the design principle, slab formwork is divided into:

- girder slab formwork, e.g. MULTIFLEX
- panelized slab formwork, e.g. SKYDECK
- girder grid slab formwork, e.g. GRIDFLEX
- large-sized formwork, e.g. table modules, customised tables

The quality of the concrete surface is dependent on the quality of the formlining selected, the method of fixing, the layout and frequency of the joints. In the case of a MODULAR panel application, the quality of the concrete surface is dependent on the condition of the steel frame, the condition of the formlining and the frequency of the panel joints.

3D customised formwork

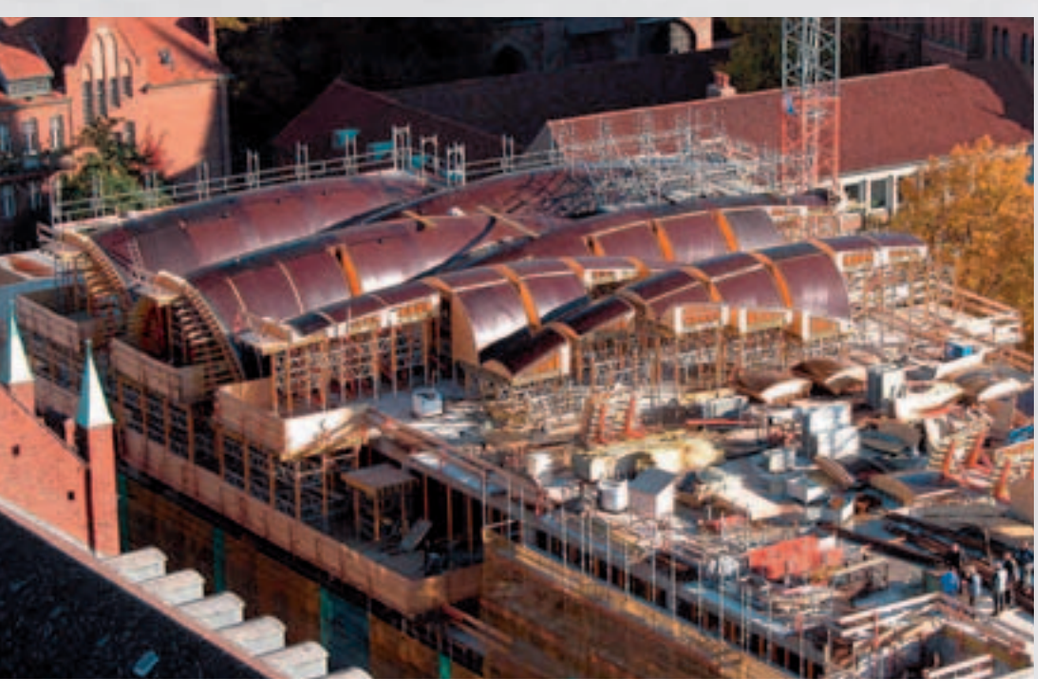
"Ice Cream Cone" Roof, Lübeck, Germany

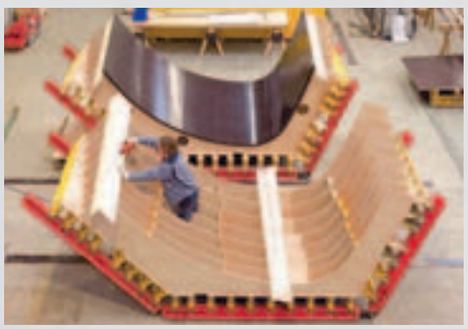
Through the use of extraordinary geometrical forms, owners and architects increasingly set visual accents for a wide range of reinforced concrete structures. These so-called 3D free-form surfaces can hardly be realised with conventional formworking methods.

Furthermore, there is the fact that most of the remaining visible surfaces are to be realised in highest quality and with sharp edges. For this, PERI delivers completely pre-assembled 3D formwork elements to the construction site. There, the elements can simply be joined together and then positioned with the help of measuring points, auxiliary axes and erection aid. Consequently, on-site utilisation takes place similar to that of a systemized formwork.

On the basis of a 3D building model, PERI develops a formwork concept consisting of statically supporting basic elements and form-giving 3D formwork units whilst taking into consideration the maximum transportation dimensions. The rentable basic elements are comprised mainly of the variable PERI VARIO GT 24 girder wall formwork system.

Subsequently, a geometry data base is set up which serves for producing CNC precision-made individual timber formers as well as the assembly of the units at the PERI assembly halls.





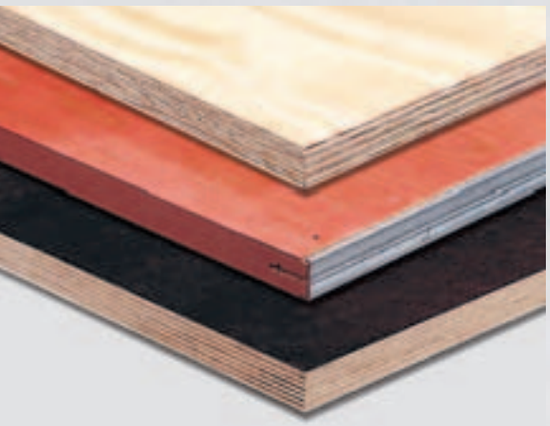
Assembly

Loading

Assembly on the construction site

Administration Building near Munich, Germany

Formlining



Through the selection of the formlining, a large number of design possibilities for the concrete surface structure are possible. In the process, the formlining determines the surface character of the concrete – independent of any subsequent processing or treatment. The person writing the tender documents must have detailed knowledge of the formlining together with the material properties, the coatings and the processing, as well as the interaction with the release agent and the fresh concrete, and take this into account during the planning. The specifications of the concrete surface must be well-defined so that the contractor can take into account all aspects relevant to the materials and applications without any risk when selecting the formlining to be used. He must be able to assess the feasibility and to point out any expected tolerances and/or fluctuations in the results.

Four properties in the formlining have an influence on the concrete surface:

Absorbency of the formlining	**Concrete surface light/dark**
Surface texture (structure)	**Concrete surface texture**
Formlining joints	**Grid arrangement of the oncrete surface**
Fixing of the formlining	**Imprints on the concrete surface**

Note: the compatibility of the selected concrete mix with the formlining surface and the release agent is to be checked or tested.

Absorption properties and formlining surfaces

Absorbency	Formlining and Surface	Number of uses for architectural concrete
good	Drainvlies (only limited suitability for architectural concrete, risk of wrinkling)	1 – 15, according to manufacturer´s instructions
	Timber panels, uncoated (chipboards according to DIN 68793, OSB panels)	approx. 3 – 5
moderate	Boards, boarded panels, uncoated, untreated	approx. 3 – 5 (possibly 7)
	3-ply panels, uncoated	approx. 5 – 8
	Plywood boards, uncoated	approx. 5 – 8
poor	Plywood boards with absorbent film coating	approx. 3 – 6
	Paper-wrapped column form, impregnated (column formwork)	1
	Boards, boarded panels, coated	approx. 8 – 12
	3-ply panels and plywood with melamine resin coating	approx. 10 – 15
very poor	Boards (plywood, blockboards of thin or thick laminations, OSB timber panels) film-coated (increase in film thickness results in a decrease in absorbency)	Depends on surface requirements – up to 35, possibly more
	Paper-wrapped column form with fitted plastic foil	1
	All-plastic panels (composite construction)	Depends on surface requirements – up to approx. 50
	Plastic matrixes, foil, tubes	As per manufacturer´s specifications
none	Metal formlining	Design-dependent

The formlining surface can be absorbent or non-absorbent, i.e. different quantities of water are extracted from the fresh concrete in the concrete fringe area. If the concrete is compacted by means of vibrators, fine particles, water and air pores migrate to the formwork surface. As a result, the water/cement ratio is thus increased in this concrete edge area. The extraction of mixing water through the formlining lowers the water/cement ratio of the concrete in the fringe area.
The more water which is extracted from the concrete on the surface results in a darker colour. At the same time, the degree of porosity is reduced on the surface. The more smoother and non-absorbent the surface of the formlining is, the greater the tendency for irregularities to occur. Examples of this include: colour fluctuations, clouding, marbling or bleed water effects on the concrete surface. The table provides an overview of the absorption properties of the most frequently used formlining materials. The applied influencing factors are not completely predictable or influenceable, and are, in part, subject to application-related limitations. The information contained in the table serves as orientation and is to be assessed on an individual basis.

Surface texture (surface structure)

The surface texture of the formlining is formed on the concrete surface as a negative imprint. In the process, the accuracy of the impression depends on the concrete. Illustrations of self-compacting concrete with a high proportion of fine aggregate are considerably more exact and detailed than vibrated concreted with a low proportion of fine aggregate. Coating of the formlining surface, particularly for structured concrete surfaces, can homogenize the structure.

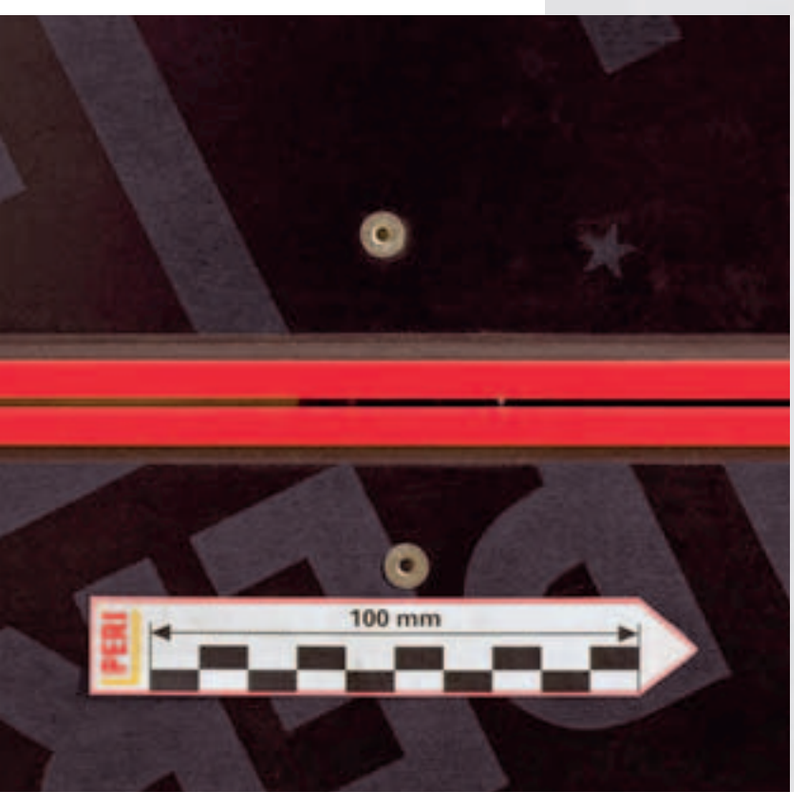
Formlining joints

The formlining joints, including formwork element joints, construction and structural joints are structural and material-related requirements and should also therefore be visible in the concrete surface finish.

It should be noted that the material and processing-related tolerances of the formlining and formwork system in the joints are visible and balanced. As a general rule, the formlining is butt-jointed with each other.

This joint is not absolutely tight and very fine particles can leak from the concrete at these places. This becomes visible on the concrete surface through dark-coloured markings. By means of additional measures, such as sealing the joints with closed-cell sealing strips or through elastic filler compound, this can be counteracted. The sealing materials must be non-absorbent and the compatibility with the fresh concrete used and release agent are to be tested beforehand.

PERI TRIO panel joint



Concrete surface imprints

Fixing of the formlining

Normally, the formlining is fixed from the concrete side to the sub-construction. The following fixing means are used:

- nails and screw nails
- staples
- screws
- also rivets and adhesive connections for panel formwork.

These fixing points are visible on the formlining surface and thus on the concrete surface itself. Especially for meeting architectural concrete requirements, these fixing points are to be arranged in a neat and tidy grid pattern (formwork system-dependent).

Nail and screw heads should protrude from the board surface (approx. 1.0 - 1.5 mm). Due to the nail or screw head projection, this causes a clear imprint in the concrete surface which remains throughout the service life also if swelling occurs on the plywood board. Countersunk screws and nails result in protruding "concrete warts" on the concrete surface. Through the different wood strengths (early and late wood, branches, moisture content), a uniform projection of the nails and screw heads cannot be guaranteed. Staples are invariably fixed slightly sunken to surface-flushed in the direction of the fibre. The imprint in the formlining is enlarged during the first concreting cycle.

If the concrete surface should remain free of any imprints, the formlining must be fixed on at the rear. This requires the use of formlining of at least 21 mm thick and an additional support formlining (also as open formwork).

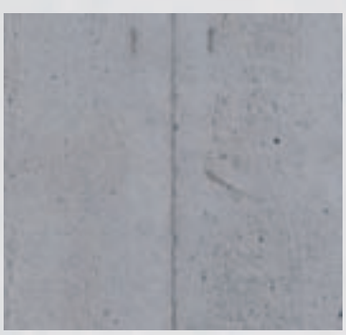
Countersinking the screw and nail heads when fixing from the front and the subsequent filling and sanding of the fastening points on the formlining can nevertheless lead to markings on the concrete surface (different absorption and swelling behaviour with formlining and filler material).

Formlining sheets and concrete results
Boards, jointed, rough-sawn

Formlining	Boards, jointed
Surface	Rough-sawn, untreated = absorbent
Fixing	Screwed
Concrete surface	Dark, low in pores, structured

Formlining	Boards, jointed
Surface	Rough-sawn, coated = non-absorbent
Fixing	Stapled
Concrete surface	Light, high porosity, structured

Example of fixing: screwed

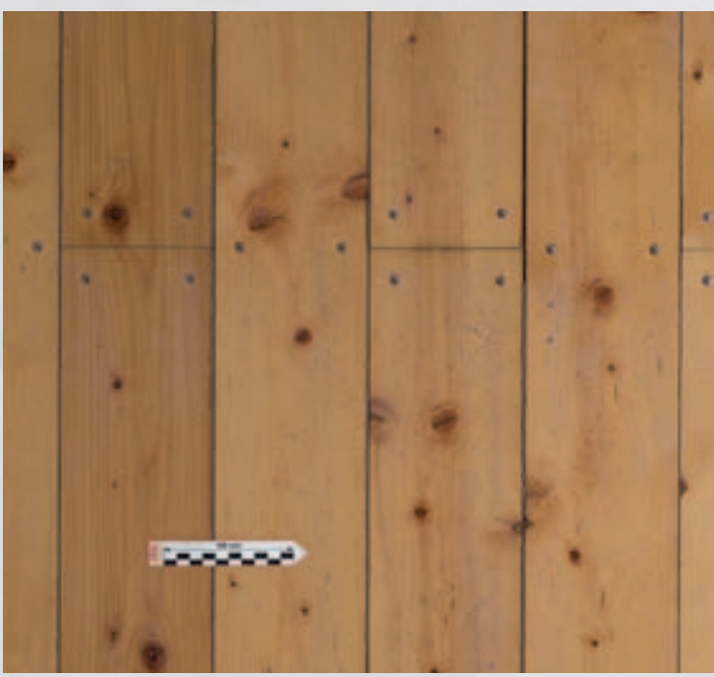


Example of fixing: staples

Formlining sheets and concrete results
Boards, jointed, prepared

Formlining	Boards jointed
Surface	Prepared, untreated = absorbent
Fixing	Stapled
Concrete surface	Dark, low in pores, poorly structured

Formlining	Boards joints
Surface	Prepared, coated = non-absorbent
Fixing	Nailed
Concrete surface	Lighter, high porosity, very poorly structured

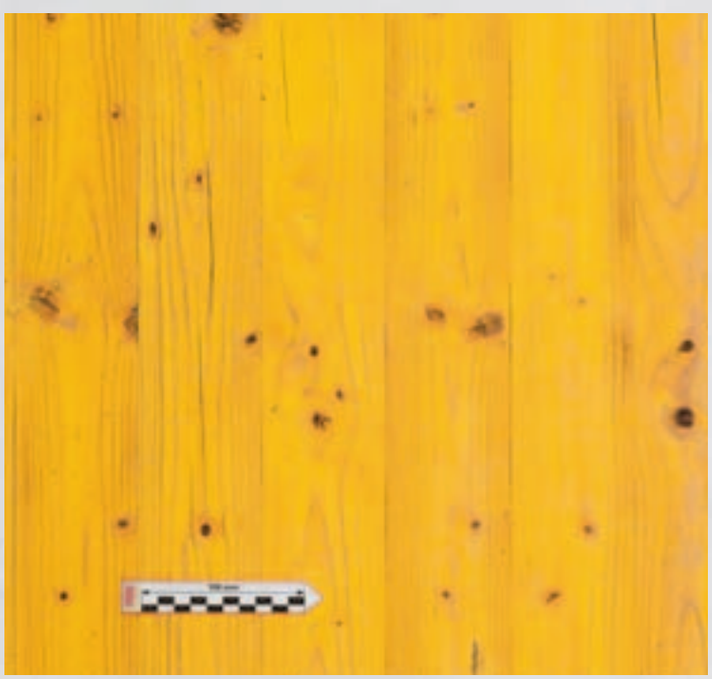


Example of fixing: staples

Example of fixng: nails

Formlining sheets and concrete results

3-ply panels, brushed surface



Detail example:
Imprint on concrete surface

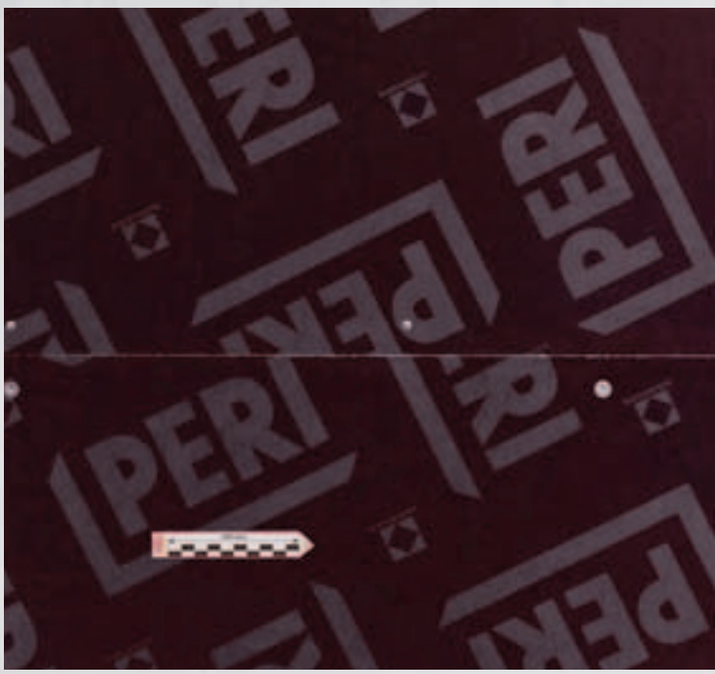
Formlining	3-ply panels
Surface	Brushed, untreated = absorbent
Concrete surface	Dark, low in pores, wood grain structured

Detail example:
Imprint on concrete surface

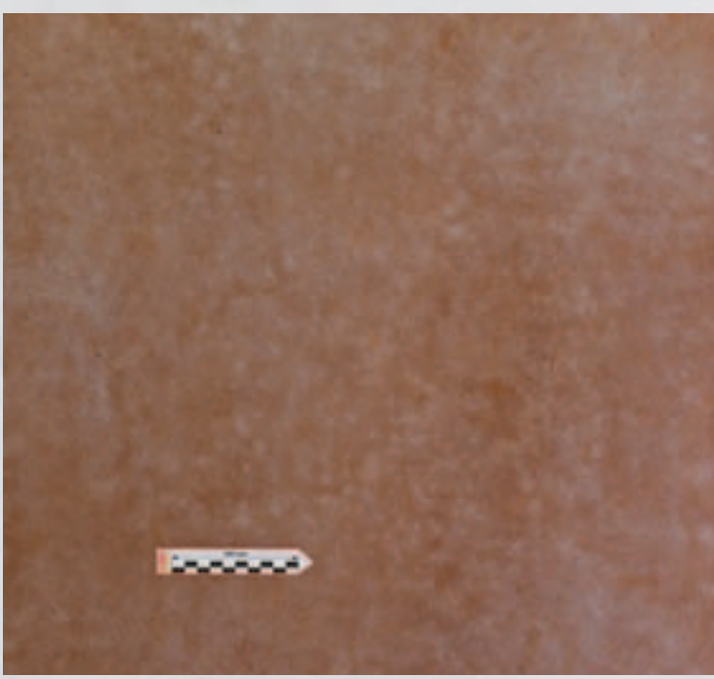
Formlining	3-ply panels
Surface	Brushed, coated = non-absorbent
Concrete surface	Light, high porosity, wood grain only faintly visible

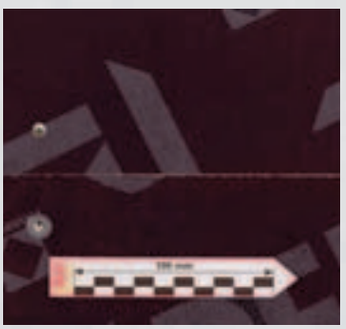
Formlining sheets and concrete results
Fin-Ply and Beto-S, film-coated

Formlining	Fin-Ply, birch wood with 240 g/m² phenolic resin
Surface	Smooth, non-absorbent
Concrete surface	Light, high porosity, very smooth, structured



Formlining	Beto-S, Vlies-covered birch plywood
Surface	Finely structured, absorbent
Concrete surface	Light, low porosity, matt and lightly structured





Example of fixing:
nailed at the top, screwed at the bottom

Example of fixing: screwed

Tie point formation

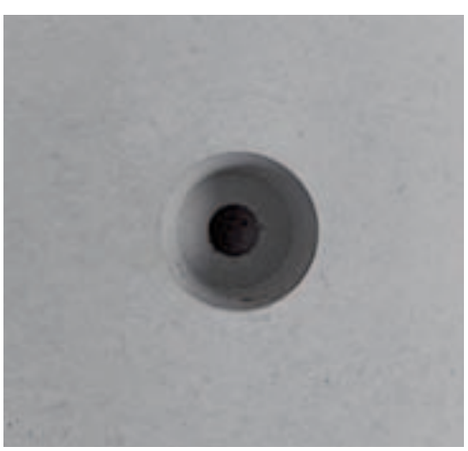
The arrangement of the formwork ties is dependent on the formwork system and can only be slightly influenced. The tie points required for the formwork can be supplemented by so-called blind anchors to ensure the formation of a neat and uniform tie pattern.

Through the cones used with the formwork ties, tie point arrangements can be configured differently. Due to the tie expansion which occurs during concreting, the architectural concrete cones should be equipped with a lip seal or an additional cellular rubber. Thus, sharp-edged tie holes can be achieved without any discharge of fine particles.

The following features examples of tie point formation in architectural concrete.

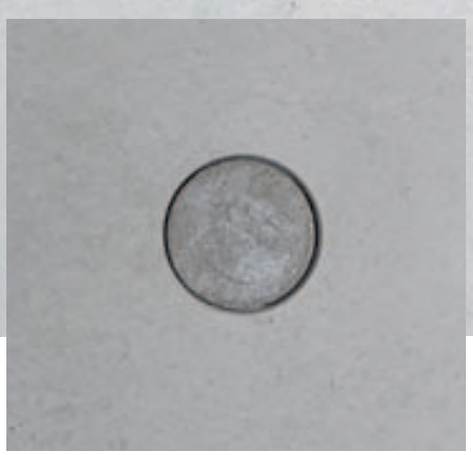
Fin-Ply plywood formlining with PERI DK sealing cone

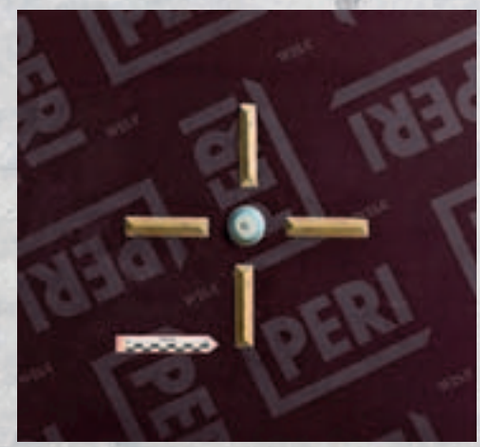
Cone impression, unplugged



Plugged with silhouette cone

Plugged with flush-fitted concrete cone





Fin-Ply plywood formlining

Tie point plugged with blind anchor

Additional decoration

A neat joint and tie arrangement

General Building Construction

Watertower, Leudelange, Luxembourg

For many years now, architects have re-discovered the potential of architectural concrete in building construction and to use it as an important design element. Parallel to the development of the building material and the process technologies, the requirements have also risen quite significantly. High-strength as well as liquefied through to self-compacting concretes facilitate the realisation of more slender concrete constructions along with more diverse forms. Curved and inclined walls and slabs are a frequently featured design elements. The formwork construction industry has adjusted itself to the situation. The desire for

Grand Kingsbury, Chicago, USA

achieving smooth, joint-free concrete surfaces as far as possible can be satisfied with the range of available large-sized formlining. However, the high proportion of admixtures and additives in the concrete result in new problems which still have to be thoroughly investigated.

In this sensitive area, the planning architects together with the building contractor should agree on what is feasible in order to achieve good architectural concrete surfaces. Excessive demands and rectification work cause inadequate and unsatisfactory results.

As components in the more protected inner areas are not exposed to weathering, the aging process of these concrete surfaces takes place substantially more slowly. On the other hand, concrete surfaces on the inside are considered from very short distances. With this, details will become considerably more accentuated. The result of this is that architectural concrete class SB 3 and SB 4 or higher are frequently demanded by architects.

The following pages show examples of successfully realised projects.

Neue Mitte Ulm, Germany
Architectural concrete as central design element

Münstertor

Architecture
Stephan Braunfels Architekten, Berlin
Contractor
Georg Reisch GmbH & Co. KG, Bad Saulgau
Field Service
PERI Weissenhorn, Germany

Sparkasse

Architecture
Stephan Braunfels Architekten, Berlin
Contractor
Matthäus Schmid GmbH & Co. KG, Baltringen
Field Service
PERI Weissenhorn, Germany

Kunsthalle Weishaupt

Architecture
Wöhr Heugenhauser Architekten, Munich
Contractor
Kurt Motz e.K., Illertissen
Field Service
PERI Weissenhorn, Germany

With these three building complexes, the main road through the city centre – the Neue Straße – was reduced to that of the historical old town proportions, and the architectural difference between Münsterplatz and the market place could be overcome. Designed by Stephen Braunfels und Wolfram Wöhr, the new structures are used a retail building, office block and museum repectively, an harmonious arrangement enhancing the quality of the downtown area. Positioned side-by-side, the structures were initiated by three different owners and also realised by three different construction companies each with a different concrete supplier.

In spite of these conditions, a uniform architectural concrete finish with a light grey-blue surface was to be realised - without bleeding, discolorations and differences in colour between the individual concreting sections whilst ensuring joint-free concreting which included crack bridging capabilities.

As formlining, a smooth non-absorbent and large-sized birch plywood formlining was selected. The formwork was realised with VARIO GT 24 together with customised special elements. Screw imprints on the concrete surface were totally unacceptable which meant the Fin-Ply Maxi formlining was installed from the rear using a 3-S board as support. The formlining and panel joints were additionally sealed by means of a bonded 3 mm sealing tape. The 3 tie positions were pre-determined with tie spacings of 1.55 m. The permissible low tolerances regarding straightness and flatness could be maintained.

Architectural concrete requirements

- Uniform smooth architectural concrete finish without any screw imprints.
- Surface without bleeding, discolorations and differences in colour.
- Joint-free concreting.

Solution

- VARIO GT 24 girder wall formwork with Fin-Ply Maxi formlining screwed on from the rear.
- Internal vibrator and concreting with pump.
- Bonded 3 mm sealing tape as crack bridging.

University of Applied Sciences Campus, Salzburg-Urstein, Austria

Formwork concept fulfils architectural concrete requirements

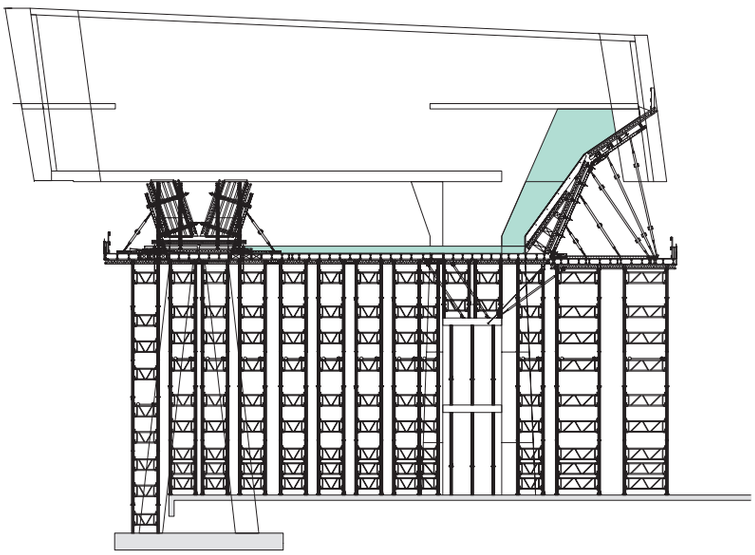
Ing.
Günter Reisinger
Site Manager
Josef Pfeifenberger
Site Foreman

"Through careful planning and development regarding the geometry and joint arrangement, we could fully meet the specifications of the architect."

South of Salzburg, only few hundred metres away from the famous Urstein Castle, the very modern university of applied sciences building in Austria was constructed. The futuristically designed complex with its clear lines and forms provides the best conditions for the around 1,500 students to complete their eight-semester long studies. Without doubt, the architectural highlight is the library which rests on 14.00 m high supports. The massive reinforced concrete columns feature tapering cross-sections along with, in part, inclinations in both axes – and heavily reinforced due to static reasons. They form a substantial design element with their architectural concrete surfaces. Therefore, the formwork was to be assembled without ties and sharp edges. As formlining, a slightly absorbent smooth plywood sheet was selected. The joint pattern of the formlining was agreed on with the architect.

Through the high degree of reinforcement in the supports and the inclined position, the use of SCC (self-compacting concrete) was required and had to be taken into consideration during the formwork design. Consequently, column formwork on the basis of PERI VARIO girder formwork was used. Through the use of SCC, the formwork was designed to handle the hydrostatic concrete pressure which resulted in very close girder and waler spacings. As formlining, the PERI Beto-S with a slightly absorbent MDO film coating was chosen. Thus it was possible to achieve a smooth but matt concrete finish with low porosity. The inclined column formwork made the correct selection of the release agent, together with the interaction of the formlining and concrete mix, through on-site testing indispensable.

Architecture
Gerhard Wittfeld, Aachen
Contractor
Alpine Mayreder Bau GmbH – Salzburg Office
Field Service
PERI VIB Mondsee and PERI Weissenhorn, Germany



Until self-supporting capability had been achieved, loads were safely carried by two slab levels as well as one shear wall section, including cantilevered reinforced concrete columns, with the help of the lightweight aluminum MULTIPROP system.

Positioning of the customised formwork from the PERI formwork construction for the inclined column section.

Architectural concrete requirements

- Forming without ties and sharp-edged columns.
- Smooth, matt concrete surfaces with low porosity.
- Self-compacting concrete due to the high degree of reinforcement and inclined column geometry.
- Joint arrangement pre-determined by the architect.

Solution

- Project-related, pre-assembled column formwork on the basis of PERI VARIO GT 24.
- PERI Beto-S with an absorbent coating.
- The formwork was designed for hydrostatic concrete pressure.
- SRU walers and push-pull props.

Specifications fulfilled: sharp-edged column sections constructed without ties in outstanding architectural concrete quality.

Galileo Satellite Control Centre, Oberpfaffenhofen, Germany

The hall of this unusual architectural concrete structure is dominated by three inclined reinforced concrete towers, the so-called tower supports. These towers symbolise over-sized telescopes which observe satellites in outer space and have been designed to carry the loads of the hall slab positioned at a height of over 9 m. Integrated parabolic-shaped vertical openings serve as entrances in the lower tower sections and as a light source in the upper area.

The facade of the building complex features window openings as well as specified regular tie points and horizontal pilaster strips. The partial glazing allows a view of the dominant tower supports in the generously dimensioned reception hall.

The window recesses
for altogether 59 openings with lengths of 3.75 m and angled reveals, a total of eight box-out sets were planned, supplied and precision-manufactured by PERI.

Galileo Satellite Control Centre, Oberpfaffenhofen, Germany

Complicated forms accurately and efficent formed in architectural concrete quality

The PERI formwork solution made a significant contribution in ensuring that the complicated geometry of the three inclined towers could be constructed with extraordinary precision even when site personnel was under pressure to meet deadlines.

Stefan Schütz
General Foreman

"From the very first use onwards, we received a perfect solution for the inclined towers. Delivery took place on time and the formwork elements fitted with millimetre accuracy. We are right on schedule as well as being able to achieve a maximum precision forming and surface finishing."

Architecture
Schultes Frank Architekten, Berlin
Contractor
Dechant Bau GmbH, Weismain
Field Service
PERI Munich and Weissenhorn, Germany

The tower supports
with a cross-sectional form comprising of different radii which extend with different inclinations. For their construction, customized VARIO GT 24 formwork elements were used. The building geometry from the architect was prepared by PERI engineers so that the cut and assembly of the individual formwork units could take place with millimetre accuracy. Subsequently, PERI supplied the ready-to-use, pre-assembled 3D formwork to the construction site.
The concreting cycle height of 1.62 m allowed anchoring for the elements to take place outside of the concreting section. Plywood formlining with the large-area PERI Fin-Ply Maxi reduced the number of joints to a minimum.

The walls
feature a pre-determined joint and tie arrangement and were constructed with VARIO GT 24 formwork elements. The plywood formlining joints were accurately bevelled at the PERI assembly facilities and resulted in perfectly aligned, parallel-positioned triangular-shaped pilaster strips in the concrete finish. In order to ensure that no additional flaws appeared in the concrete surface, the anchor points of the wall formwork were used for the suspension points of the KG 180 climbing brackets.

Architectural concrete requirements

- A minimum number and pre-determined positioning of the tie points for the tower supports.
- Small number of pylwood joints.
- Pre-defined joint and tie arrangement with horizontal pilaster strips in the wall areas.
- Distinctive wall recesses with angles reveals.
- Smallest radii of up to 35 cm.

Solution

- A pre-determined concreting cycle height of 1.62 m in order to position the anchoring outside of the concreting section.
- Use of large-sized PERI Fin-Ply Maxi formlining.
- Use of the VARIO GT 24 girder wall formwork system, pre-assembled at the PERI assembly hall complete with bevelled formlining joints and delivered directly to the construction site.
- Specially planned and manufactured box-outs for the angled reveals of the windows.

Guy Dolmaire Secondary School, Mirecourt, France

Top-quality architectural concrete surfaces with VARIO girder formwork for circular and straight walls

Two of the altogether four stairwells. VARIO with concreting platforms on climbing scaffold ready for concreting.

Architectural concrete requirements

- Straight walls: mirror the coffered surfaces with changing board direction.
- Circular wall areas: changing radii of curvature and high degree of accuracy.
- Light-coloured, high porosity, very smooth surfaces.

Solution

- VARIO GT 24 with double box-outs for the coffered surfaces.
- VARIO GT 24 with adapted profiled boards on the curves.
- Smooth, non-absorbent, film-coated PERI Fin-Ply formlining.

The coffer-type external wall as an architectural design element, partly filled with concrete in alternating horizontal and vertical board structure.

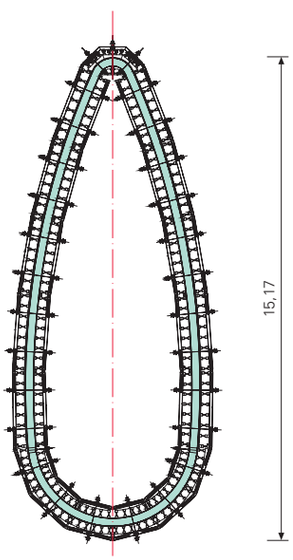
The stairwell core has an architectural concrete finish which stiffens the complete structure, and is characterized by the extraordinary wood and laminated beam construction.

Pierre Voillaume
Site Manager

"The good contact with the PERI sales engineer, optimal planning together with the planning department and architects, the pre-assembled formwork units plus the advanced PERI formwork technology, enabled us to finish on schedule as well as producing top-quality results."

For the building of a new secondary school in Mirecourt, the concrete surfaces on the coffer-type, structured external walls and the four oval-shaped stairwells were designed to have high-grade finishes. This required exact scheduling for when the formwork was to be used. Customised formwork elements were needed to take into account pre-determined plywood joints and tie positions which were also versitile enough to be used on climbing formwork. In the stairwells, the formwork units switched from tower to tower which allowed them to be positioned on each of the CB climbing scaffold units which had climbed to the next pouring step. The fixing points for the CB climbing units had to be on the same axis as the formwork ties.

PERI supplied a practical and cost-effective formwork solution based on the VARIO GT 24 girder wall formwork system: VARIO special elements for the straight walls and VARIO GT 24 circular formwork for the round wall sections, with customised profiled timbers providing a reliable reference of the required radii.



Ground plan of a stairwell with special VARIO elements and double plywood layer.

Architektur
Architecte Associé: Olivier Paré
Bauunternehmen
Petot S.A.S. Epinal
Projektbetreuung
PERI France Est

BMW Central Building, Leipzig, Germany

Load-bearing building structures in architectural concrete design

Bernhard Pech
Managing Director

"Together with our longstanding partner, PERI, we could create outstanding architectural concrete quality for this very challenging structure."

In the north of Leipzig, the BMW Group has created one of the most modern car factories in the world. Around 5,500 employees produce up to 650 vehicles of the BMW 3 Series per day.

The central building connects the car body production, paint shop and assembly facility. As the main entrance to the plant, it accommodates office and communication areas, restaurant, various workshops and laboratories. The high quality requirements on the concrete surfaces, as well as the demanding geometry of the building, required a formwork system which could be adapted to meet the individual requirements.

According to the planning coverage of the wall views, special VARIO GT 24 formwork elements were prefabricated and brought to the construction site. As a result, 32,500 m² of wall surfaces with heights up to 18 m were formed and concreted with self-compacting concrete in the space of seven months.

Architectural concrete requirements

- High demands on the geometries and concrete surfaces.
- Different requirements on the formlining.
- The use of self-compacting concrete with up to 18 m concreting heights.

Solution

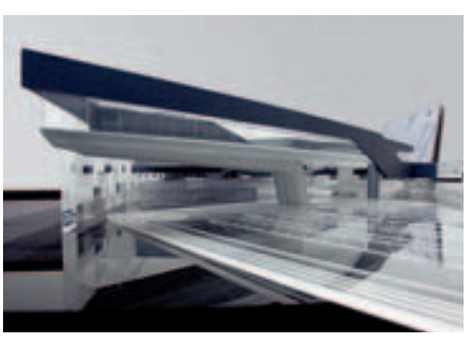
- Special VARIO GT 24 girder formwork.
- Various types of formlining.
- VARIO GT 24 system specially designed for the use of SCC.

Dimensionally-accurate execution with the best quality concrete surfaces – the result of the VARIO GT 24 system which was specially designed for the use of self-compacting concrete.

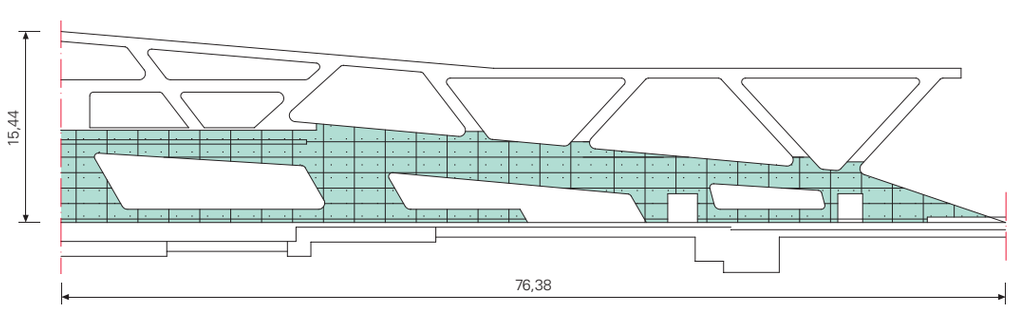
Architecture
Zaha Hadid, London
Contractor
Central Building Consortium (Shell):
Wolff & Müller, Dresden Office and OBAG mbH, Bautzen
Field Service
PERI Leipzig, Germany

The loads of the upstand beams along with the up to 60 cm thick and 10.00 m high slabs were safely transferred via shoring towers of the MULTIPROP system.

The PERI product portfolio provides optimal system equipment for each requirement.



The building concept developed by the architect Zaha Hadid, makes automobile production for both visitors and workers very transparent. Thus, body shells and painted vehicles are transported a number of times through the central building in full view.

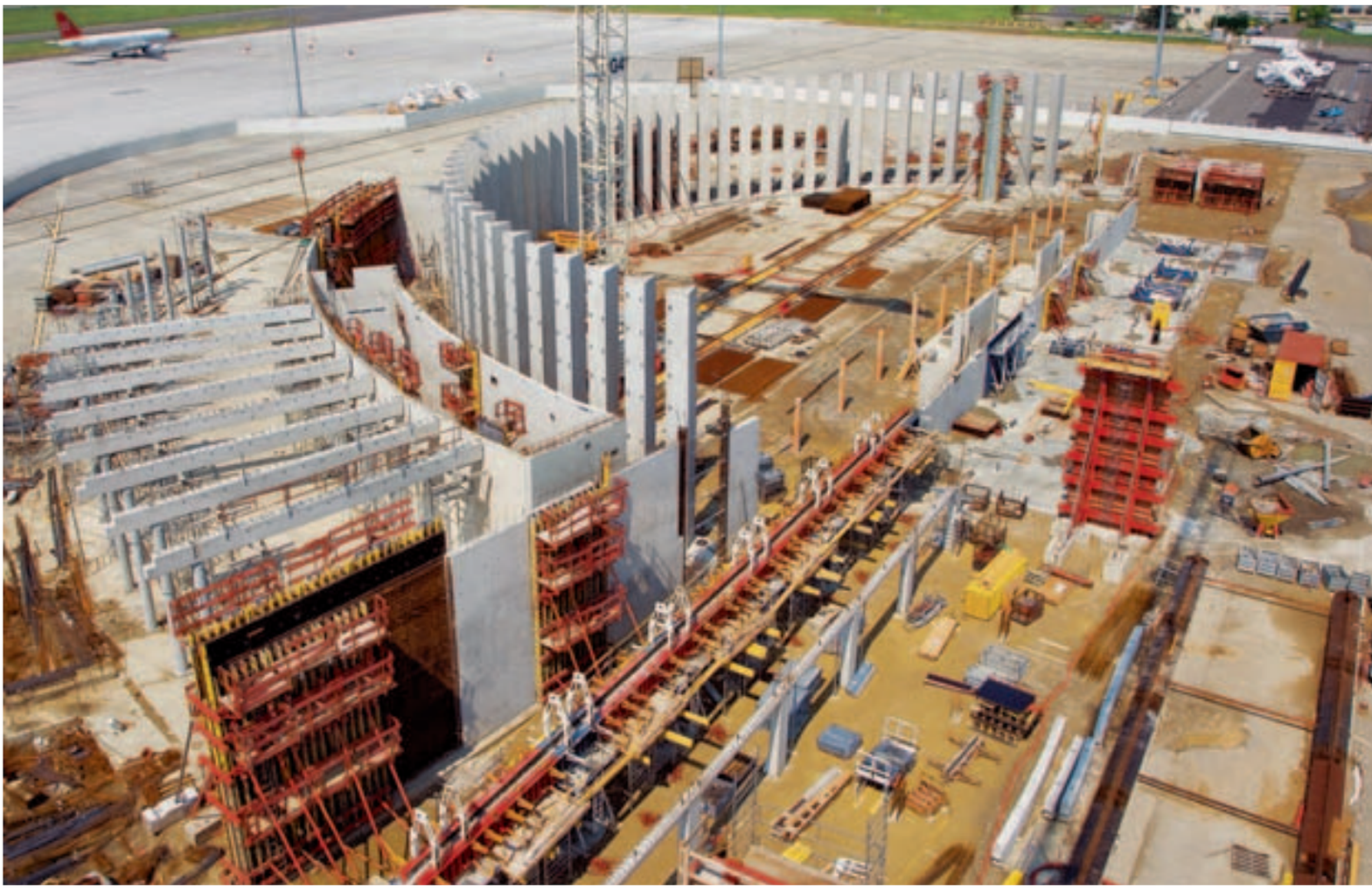


In front of the special assembly of 9,000 m² VARIO girder wall formwork, PERI provided a visual presentation of the concept complete with formlining joints and tie points.

Toulouse-Blagnac Airport, France

With six million passengers annually, Toulouse-Blagnac in southern France is the country´s fourth biggest airport. The headquarters of the European Airbus Group is also based here. In Toulouse, the final assembly of the new A380 wide-bodied aircraft is carried out which took off on its maiden flight from Toulouse-Blagnac in April 2005. Due to the increase in the number of passengers, the airport operator invested around 200 million euros in an extensive expansion and modernization programme.

Toulouse-Blagnac Airport, France
Triangular-shaped pilaster strips and defined tie pattern



Architectural concrete requirements

- Special joint and tie arrangement in a checkerboard pattern.
- Execution of the formlining joints as fine triangular-shaped pilaster strips.
- Construction of the columns completely without tie points.
- Concreted wall sections without ties (9.72 m high; 70 cm thick).

Solution

- Prefabrication of the VARIO GT 24 formwork units with accurately-positioned ties and dummy cones.
- Formlining joints bevelled in PERI assembly hall.
- The high concrete pressure could also be carried by the VARIO at heights of 11.75 m.
- PERI RCS and HD for safe load transfer (to the ground).

Eric Mantovani
General Foreman

"Although this was the first time we have worked with PERI systems, we were able to meet the high demands of the architect. Also with the support provided by PERI and the results achieved, we are more than satisfied!"

In order to be able to construct the up to 9.72 m high and 70 cm thick wall sections without ties, the wall formwork elements were effectively strengthened by means of rentable system equipment. Universal RCS climbing rails as vertical walers and strong HDT main beams as lateral waling provided here a safe transfer of load in the laterally positioned anchoring points – located outside of the up to 5.44 m long concrete wall.

High walls and columns in top architectural concrete quality – the PERI VARIO GT 24 wall formwork system provided the ideal basis for cost-effectively realisation of the demanding geometrical and surface requirements.

Architecture
Cardete Huet Architectes
Contractors
G.B.M.P., Tournefeuille Socotrao, Roques-Sur-Garonne G.C.C., Toulouse
Field Service
PERI Ste Livrade und Meaux, France

With formwork know-how and system equipment from PERI, the high architectural concrete requirements could be cost-effectively fulfilled.

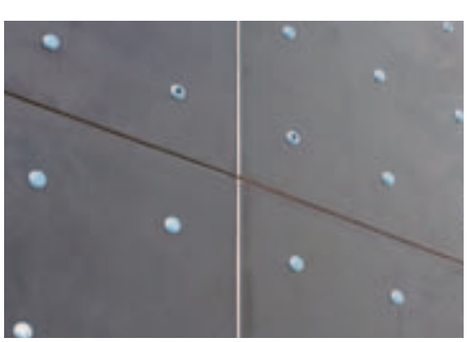
One of the most important elements of the construction work was the new Hall D passenger terminal. The 40,000 m² complex contains 24 check-in desks and 13 departure gates. These so-called docks are arranged in a semi-circular pattern at the end of the terminal.

The architectural design called for a special joint and tie arrangement for the visible reinforced concrete walls. For this, preassembled ready-to-use VARIO GT 24 formwork units were used whereby the plywood formlining joints were already accurately bevelled at the PERI assembly facilities along with the exact positioning of the anchor cones and additional blank cones. Through the PERI formwork solution together with optimal concrete quality and processing, the contractors were in a position to easily achieve the best results: structurally-designed architectural concrete walls featuring fine triangular-shaped pilaster strips and a uniform tie pattern.

The semi-circular positioned reinforced concrete columns featured a triangular-shaped ground plan with 1.30 m leg lengths. The PERI concept, on the basis of VARIO GT 24 wall formwork, allowed the columns to be constructed in one pour for the complete height of 11.75 m without any visible tie positions.

Both of the formwork sets used each consisted of only two individual elements so that not only could striking and shuttering be efficiently carried out but also moving with the crane. This meant site crews were in a position to construct one column per day with each featuring an excellent architectural concrete finish.

PERI VARIO GT 24 formwork units with bevelled plywood formlining joints ...



... and accurately-positioned tie cones ...

... for architecturally designed architectural concrete walls.

Consecretion Hall, Neubiberg, Germany

Formwork supplier, architect and building contractor one team for achieving the best result

Horst Plaul
Site Foreman

"With the PERI VARIO formwork as a customised solution, we achieve very good architectural concrete quality. Even during striking, the nibs visibly remain as a positive impression."

By adding a higher proportion of fine aggregate in the grading curve of the concrete mix, partial bleeding of the concrete could be considerably reduced. And with the aim of achieving a uniform concrete colour, surplus release agent was cleaned off the formlining with a cloth before each concreting operation.

Architecture
Emanuela Freiin von Branca, Munich
Contractor
Wilhelm Markgraf GmbH, Munich
Field Service
PERI Munich, Germany

On the site of the former military airport Neubiberg, new cemetery grounds complete with administration building, funeral parlour and columbarium were developed. The monumental architecture has been shaped by a stringent geometry and design elements. Deliberately irregularly-planted fruit trees and perennial borders lighten up the atmosphere of the entire facility.

Even before commencing work on the reinforced concrete structure with its special requirements regarding the geometry and surface finish, the PERI specialists could convince the architect and contractor with precisely the right solution. VARIO GT 24 girder wall formwork with defined formlining sheet sizes and tie positions was the system of choice. For particular accentuation of the panel impressions, the formlining and element butt joints were accurately milled at an angle which resulted in the formation of clean nibs on the concrete surface. In order to avoid further imperfections in the concrete finish, the plywood formlining sheets were screwed on from the rear.

Diagonally-milled formlining joints result in nibs in the concrete finish.

The puristic architectonic design was constructed with great accuracy and in high quality: the consecretion hall after completion.

Architectural concrete requirements

- Defined joint and tie arrangement.
- Joints designed as nibs in the concrete surface.
- Light surface, high porosity and smooth.

Solution

- VARIO GT 24 customised elements.
- Formlining on open formwork in the joint area chamfered for the formation of nibs.
- Smooth formlining, non-absorbent and screwed on at the rear.

Blue Heaven Hotel, Frankfurt am Main, Germany

High architectural concrete quality cost-efficiently realised

The Blue Heaven hotel development provides the Frankfurt skyline with yet another eye-catcher and represents a stunning centre of attraction for international visitors to this modern and vibrant city. Not only is it the building height of 87 m with 19 floors but, in particular, the distinctive silhouette of the hotel itself. A two-level basement, a 15 m high base construction with an extremely complicated support structure, 15 standard storeys and three specially-designed upper floors form the main elements of this project.

The architectural concrete surfaces were to be realised using a non-absorbent formlining resulting in smooth fairfaced concrete low in pores. The formlining format and arrangement of the formwork ties were predefined by the architect. The PERI solution comprised of TRIO Structure panel formwork with double-layer Fin-Ply 21 mm formlining.

The panel cut (joint arrangement) followed the specifications of the architect. Wall surfaces without architectural concrete requirements were formed using standard TRIO panels from the PERI rental park. The 15 m high walls of the ground floor are formed in two concreting sections (6.60 m + 8.40 m) with a horizontal accentuated joint. For the supports in this area, with 1.50 m x 0.75 m cross-sections and a height of 14.30 m, the VARIO column formwork was ideally suited due to its high rigidity and variability. The design of the column formwork allowed concreting in one pour without any construction joints which significantly contributed to producing the required concrete finish for the supports.

Conclusion: if the architect takes into consideration the features of the formwork systems in his design concept for the architectural concrete surfaces, cost-effective solutions with a high fairfaced concrete quality can be achieved in a short construction period.

While architects set great store on glass and steel for the outside, they design many inside areas with high quality architectural concrete.

Architecture
John Seifert Architects, Frankfurt/Main
Contractor (Shell)
Bilfinger Berger AG,
Frankfurt/Main Office
Field Service
PERI Ebersgöns, Germany

Architectural concrete requirements

- Smooth, low-pore architectural concrete.
- Pre-determined tie arrangement specified by the architect.
- 14.30 m high columns without construction joints.

Solution

- TRIO Structure panel formwork with double-layer Fin-Ply 21 mm formlining.
- Panel cuts and configuration of the formwork elements according to specifications.
- VARIO column formwork.

The PERI formwork concept allowed the construction team to complete the 15 standard floors in only four days in each case.

With PERI know-how and formwork technology, the concrete shell of the "Blue Heaven" hotel in Frankfurt am Main was completed in only ten months.

Josef Eich
Foreman
Dipl. Ing.
Anwar Naamnih
Project Manager

"The extremely competent and detailed PERI formwork planning made a decisive contribution to the effective completion and success of this construction project. Enormous time savings could be achieved by the site crews, in particular through the TRIO striking panels, the slab tables and PERI UP Rosett shoring."

Animal Shelter, Berlin-Falkenberg, Germany

Architectural concrete re-defined with the best results

A town for animals – a bird´s eye view of this very impressive project.

The world´s largest animal shelter was constructed based on the design of the Berlin architect, Dietrich Bangert. 37,000 m² of wall area, 19,000 m² of slab area and well over 200 individually designed circular columns were to be realised in a core construction time schedule of only five months. Highest quality requirements were demanded for the extraordinary building geometries.

Through the close co-operation of the construction company, the site team and the PERI branch offices in Berlin and Stuttgart, formwork solutions were developed that could fulfill all of the architect's demands in the best way possible.

The PERI customised steel formwork for circular columns with cylindrical shafts and blunt cone heads were plumbed in and concreted at 231 positions.

Architecture
Dietrich Bangert Architekten, Berlin
Contractor
Friedrich Stetzler Bau-Unternehmung, Pforzheim
Field Service
PERI Berlin and Stuttgart

Excellent architectural concrete result thanks to the VKS coupling for architectural concrete.

Examples for this are the successful tie spacings that were all correlated to the reference level or the exact implementation of the pre-determined joint arrangement. Element connections in the wall areas, which so far had been not possible, could now be achieved by the use of the new VARIO VKS coupling for architectural concrete. For the first time, it was possible to almost fully compensate thickness tolerances in the plywood.

The slab areas also provided numerous demands. Trapezoidal-shaped UNIPORTAL tables had to safely carry tonnes of heavy prefabricated concrete units for concreting into the slabs. Apart from this, there were demanding shapes of vertical and circular designed parapets to be realised with the VT table modules.

Difficult, artistically-shaped circular columns with shafts flattened out at different heights and blunt coned heads, mirror the creativity that was required in order to be able to complete this project. The basis for optimal implemention of these shapes and surfaces was created by the SRS circular column system that was specially adapted to the geometry.

Dietmar Schilli
Site Manager

"The high architectural concrete requirements placed by the architects could not have been met without the new VARIO coupling for architectural concrete."

Architectural concrete requirements

- Light-coloured, high porosity, smooth surface.
- Minimum of joint offsets.
- No fixing imprints,
- Uniformly defined tie pattern.

Solution

- Smooth, non-absorbent, even PERI Fin-Ply formlining.
- VKS coupling for architectural concrete.
- Formlining screwed on from the rear.
- VARIO GT 24 with open formwork, in curved areas with profiled boards.

Crematorium, Berlin-Treptow, Germany

This "Temple of Geometry" is described as a masterpiece of building art regarding the architecture and execution. It was created according to the ideas of the architect, Axel Schultes, who was also responsible for the design of the Federal Chancellery in Berlin.

Crematorium, Berlin-Treptow, Germany

A balance between space and light

VARIO units 2.50 x 3.00 and 2.50 x 4.80 m were extended to a formwork height of 7.80 m by means of extension splices and later concreted in one pour.

The design of the visible concrete surfaces continues throughout the whole building.

Gigantic architectural concrete surfaces with positive visible joints give the impression of giant blocks of stone. This is underlined by a variable rising height grid of 82 to 105 cm. The walls were in part up to 10.15 m and formed using 3.84 m wide VARIO panels, and concreted in one pour. Foyers that rise to the height of the building with up to 55 cm thick walls and the roof slab are visually characterised with defined dummy joints and regularly-arranged tie points that were constructed with DK concrete cones from the PERI anchor programme.

The project was planned and executed to perfection right down to the last detail. Even in the transition areas from wall to slab, the surfaces required were achieved by panel joints being offset by ¼ and arranged consistantly throughout.

Udo Voßkamp
Site Manager

"The universal uses of the VARIO and MULTIFLEX girder formwork systems make our work easy under the extreme demands presented by the architect. All of us are very proud of the architectural concrete results we achieved."

Architectural concrete requirements

- Smooth concrete surface, no visible fixing means, sharp edges.
- Continuation of the board joints of the wall formwork also in the slab formwork.
- Pre-determined tie point arrangement.

Solution

- VARIO GT 24 customised formwork with smooth, coated formlining screwed on from the rear.
- MULTIFLEX slab formwork in part supported by ST 100 stacking towers.
- DK cone system.

Strict geometrically-structured construction components and concrete surfaces achieve a high degree of space effect in spite of the maximum austerity of the materials used.

Architecture
Axel Schultes Architekten, Berlin
Contractors
BILFINGER+BERGER Bauaktiengesellschaft, Berlin and Schalungsbau Roxheim
Field Service
PERI Berlin and Stuttgart

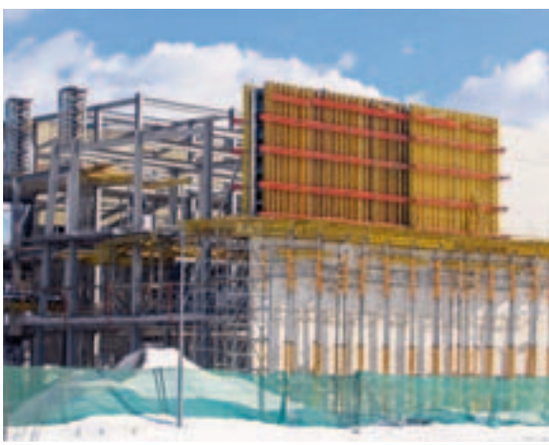
The only visible sign that indicates this high-tech crematorium contains functional technology are the chimneys integrated into the north facade.

White Wind Office Building, Riga, Latvia

Impressive presentation of architectural concrete superbly realised

The result speaks for itself. Due to the excellent teamwork between architect, contractor and formwork supplier, first-class results were achieved.

For realisation of the different light apertures and the diagonally-positioned breakline on the facade walls, precision-made prefabricated box-outs were made and doubled up on VARIO elements.



VARIO GT 24 elements on MULTIPROP system and RAPID column formwork: used with great effect to produce sharp-edged column cross-sections in immaculate quality.

Flooded by light through generously-dimensioned glazing, the high-quality timber claddings in the interior area create an atmosphere that is impressively presented through the massive facade walls, whose power is softened by horizontal and vertical openings. In this way, the building complex aims to present a new understanding between humans and the workplace.

PERI Latvia provided building contractor Re& RH with a convincing concept on the basis of the VARIO GT 24 girder wall formwork system which was fitted with Fin Ply plywood formlining; this enabled the construction crew to accurately realise the specified smooth and almost non-porous concrete for the visible surfaces and in the highest quality.

Architectural concrete requirements

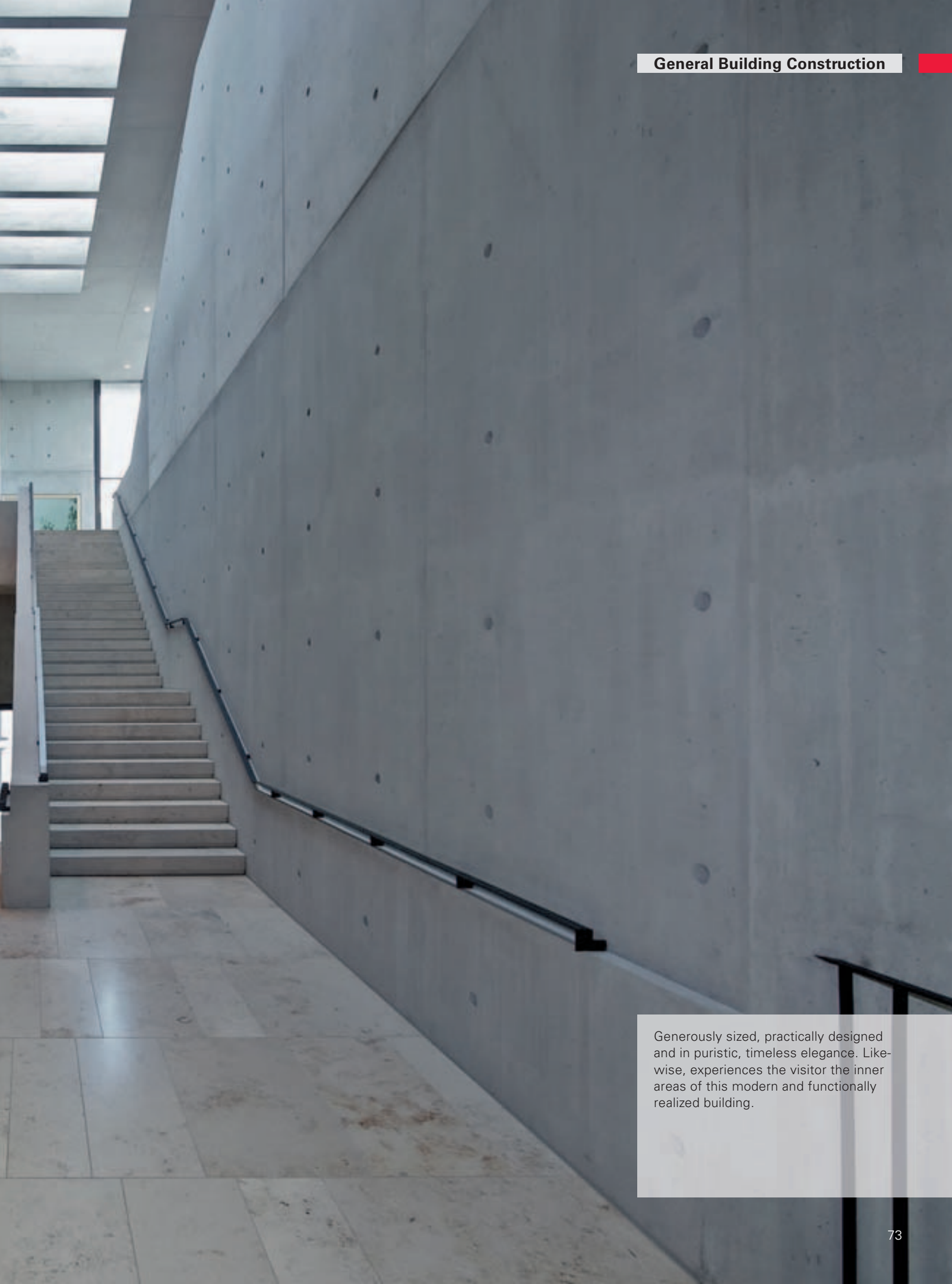
- Smooth, white and almost pore-free concrete.
- No imprints in the concrete surface.
- Accurately positioned box-outs – horizontal and vertical, as well as a diagonal breakline in the main walls.
- Pre-determined joint and tie arrangement.
- No bleeding from formlining joints.

Solution

- Use of PERI Fin-Ply 21 mm formlining.
- Formlining screwed on from the rear.
- Double box-outs on VARIO GT 24 girder wall formwork elements.
- Defined formlining dimensions and specified tie positions.
- Sealed formlining joints.

Architecture
Sergejs Nikiforovs (LAS), Riga
Contractor
Re&Re, Riga, Latvia
Field Service
PERI Latvia

State and District Court, Frankfurt an der Oder, Germany



Generously sized, practically designed and in puristic, timeless elegance. Likewise, experiences the visitor the inner areas of this modern and functionally realized building.

State and District Court, Frankfurt an der Oder, Germany

Aesthetic and heat-insulating – massive facade in lightweight concrete

With VARIO GT 24 girder wall formwork for the walls and SKYDECK for the slabs without special surface requirements, the construction team fulfilled the architectural specifications with very high quality.

A massive reinforced concrete roof over the entrance to the inner court harmoniously closes the connection of the individual building sections.

The box-outs for the different window sizes were accurately positioned on the VARIO GT 24 formwork elements according to the construction plans.

The monumental-like building design by the Berlin-based architects, Bumiller & Junkers, has a two-fold effect: seen from all directions, it represents a solitaire and is certainly recognizable as one at a distance. This is achieved through linear structural component proportions which are dominated by an apparently random arrangement of different window dimensions of the facade walls.

In order to achieve an ideal indoor atmosphere, single-leaf massive external walls with high thermal insulation and the ability to adjust the level of humidity was one goal of the project developers. As a result, lightweight concrete was selected for the construction of the continuous facade in architectural concrete. This meant, the costs for a facade covering which would normally be required were saved. Apart from system equipment optimally suited for the respective task, the know-how of the PERI specialists from the Berlin branch office also greatly contributed to the fact that the project was completed exactly to the wishes of the architects and owner in the highest quality.

Architecture
Bumiller & Junkers, Berlin
Contractor
Heitkamp, Eisenhüttenstadt
Field Service
PERI Berlin, Germany

Rainer Thon
Site Foreman

"With the high requirements demanded by the architects regarding the quality of the architectural lightweight concrete, we would have not managed without PERI."

Architectural concrete requirements

- Pre-determined joint and tie arrangement for the inside and outside areas.
- Striking facade design through a window arrangement which, in combination with the selected tie pattern, decisively stage-manages the overall appearance.
- Massive, single-leaf facade walls with high thermal insulation for saving on the cost of an additional facade covering.
- Tie point formation with cylindrical openings.

Solution

- VARIO GT 24 girder wall formwork with formlining sheet sizes according to specifications along with tie point positioning and formation.
- Accurate assembly of the box-outs on the VARIO GT 24 formwork elements.
- Use of lightweight concrete.
- Use of DK cones, closure of tie rod sleeves, remaining openings unclosed.

Cultural Buildings

Especially in the area of cultural buildings, architects and project planners use architectural concrete as a means of design. Apart from the artistic requirements of the visible concrete surfaces, specially conceived structural forms or individual components frequently dominate the appearance. During formwork planning, particularly attention should be given to ensuring a neat joint and tie pattern as well as the orderly arrangement of the formwork panels. Then, the panel joints which are to formed, the tie arrangement along with the actual formation of the tie points themselves are important design elements of this area of application.

In order to achieve a uniform finish of the concrete surface, particular attention must be paid to the type of concrete selected and the entire processing technology of the concrete including any subsequent treatment. If increased requirements are placed on the appearance of the concrete surfaces, it is recommended that the formwork is fitted with new formlining. If requested, the tie pattern can be supplemented through the use of dummy ties to form a neat symmetrical design. For invitations to tender involving architectural concrete in the area of cultural buildings, it is recommended to take into consideration architectural concrete classes SB3 and SB4 featured the DBV Code of Conduct.

The following pages show examples of successfully realised projects.

Auditorium, Tenerife, Spain

Art Museum, Milwaukee, USA

Ordrupgaard Museum, Charlottenlund, Denmark

St. Canisius Church, Berlin, Germany

Langen Foundation, Neuss-Hombroich, Germany

A work of art for works of art made of perfectly designed concrete and glass

Architectural concrete requirements

- Each of the formlining sheets was to feature six tie points in a uniform arrangement.
- Individual formliner dimensions w/h = 1800 mm x 900 mm.
- Same joint pattern for complete area, tightly-sealed formwork panel and formlining joints, sharp edges.

Solution

- VARIO GT 24 girder formwork covered with open formwork, formlining screwed from the rear. Formwork designed for 100 kN/m² concrete pressure.
- Reduction in the number of joint offsets through the use of the coupling for architectural concrete.

Ready-to-use VARIO GT 24 formwork unit complete with dummy plugs and sprayed with release agent.

Through the use of the VARIO coupling for architectural concrete, offset-free panel joints could be achieved.

Architecture
Tadao Ando Architect & Associates, Osaka, Japan
Contractor
Florack GmbH, Bonn
Field Service
PERI Willich, Germany

Planned by the Japanese star architect, Tadao Ando, the Langen Foundation art collection found a new home. Built on an island, the Hombroich museum building is a typical Ando design whereby the use of architecturally-designed concrete surfaces has turned the structure into a work of art itself.

This museum is the latest in a line of well-known projects which stand out through their puristic style of simplicity. This includes the Pulitzer Art Museum in St. Louis, the Modern Art Museum in Fort Worth as well as the Berlin Memorial "Topography of Terror" – all these projects were realised with PERI formwork technology.

Even during construction of the building shell, high demands were placed on the concrete surfaces. An exact plywood arrangement had to be used caused by the pre-determined number, position and spacing of individual ties, and all corners had to be formed with sharp edges. VARIO GT 24 girder wall formwork with a special plywood format of 1.80 x 0.90 m was used whereby the plywood was screwed on from the rear. Six tie positions were used for each form-liner. As the high number of tie points were not a statical but an optical requirement, dummy plugs were utilised. The formwork was designed for SCC self-compacting concrete.

Thomas Schieren
Supervisor

"As had been expected, we could achieve excellent concrete results with the PERI formwork solution. We have worked together with PERI for 20 years now and have always been well served."

The main emphasis of the museum´s collection is formed by exhibits of classical modern art up to the present day. The glass veranda annex accommodates work by Japanese artists of the past millenium.

National Museum for Contemporary Art MAXXI, Rome, Italy

With the construction of the new National Museum for Art and Architecture of the 21st Century in Rome, Zaha Hadid has once again designed a building that is in a class of its own. In order to be able to fulfil the high architectural concrete requirements, the consortium of construction companies decided in favour of PERI formwork and scaffolding systems.

National Museum for Contemporary Art MAXXI, Rome, Italy
14 m high curved walls in architectural concrete

Geom
Gianni Scenna
Site Manager

"PERI´s planned use of the formwork and on-site support ensured the best possible construction progress. With VARIO, we had the perfect wall formwork system at our disposal which enabled us to create both form and dimension for this extraordinary structure. Matched for use with self-compacting concrete with fresh concrete pressures up to 150 kN/m², we could therefore achieve very high quality surfaces."

Architecture
Zaha Hadid, London
Contractor
ARGE MAXXI 2006
Field Service
PERI Italy and PERI Weissenhorn, Germany

The concrete loads resulting from construction of the reverse-inclined front wall were safely transferred to the ground via a frame construction unit and MULTIPROP towers.

14 m high PERI VARIO elements were arranged polygonally in the curved areas. With large-sized Fin-Ply Maxi plywood as formlining on the VARIO elements, excellent concrete surface quality could be achieved.

The MAXXI in Rome is the first and only national museum for contemporary art in Italy.

This extraordinary designed structure is characterised by twisting reinforced concrete walls with heights of up to 14 m. For the straight wall sections, which were constructed using architectural concrete, the flexible VARIO GT 24 girder wall formwork system proved to be an advantage. For the external formwork, large elements with heights of 14 metres were used. High load-bearing GT 24 girders, along with offset panel height extensions, ensured that no deflections occured during erection and concrete pressures of 150 kN/m² could safely be accommodated.

For realising the curved areas with twisted surfaces, PERI delivered pre-assembled 3D formwork elements based on rentable VARIO standard elements directly to the construction site. In addition, a three-dimensional CAD building model was created. The form-giving formwork units were produced in the PERI assembly hall. Due to the high degree of accuracy, these special elements could then be easily joined together and put in position on site.

Architectural concrete requirements

- Smooth architectural concrete with specified joint and tie arrangement.
- Wall heights up to 14.00 m without horizontal concrete joints.

Solution

- VARIO GT 24 as girder and wall formwork system and VKS in order to minimise offsets in joint areas.
- Concrete pressure up to 150 kN/m² for SCC can be accommodated.

Pulitzer Art Museum, Saint Louis, USA

Clear geometrical forms and the highest standards of quality

Flexible PERI VARIO girder wall formwork: the formwork joints and fixings along with the arrangement of the tie points were accurately aligned and resulted in a uniform concrete surface.

The Pulitzer Foundation for the Arts is an impressive architectural concrete building designed by the Japanese architect Tadao Ando and realised using PERI formwork technology.

For the best-possible concrete finish, the PERI VARIO elements were fitted with new Fin-Ply formliners after every third concreting phase.

The two-storey, almost windowless art centre is comprised of two cubic structures complete with impressive architectural concrete surfaces. During its construction, no compromises were made or even considered because the concrete results were not to have been in any way inferior to the architect´s design. Even on the corners, as well as all wall box-outs, no deviations were allowed in order to achieve straight and razor-sharp edges.

All those involved in the construction were very aware from the beginning onwards that this was indeed not just a building but more a work of art.

The VARIO GT 24 wall formwork system was easy and simple to use on site and could be readily adapted to the wide range of wall forms. At the same time, the high load-bearing GT 24 lattice girders and the load-distributing steel walers of the formwork elements could be arranged so that, during concreting, deflections could be kept to an absolute minimum in spite of intensive concrete vibrations. The protracted and time-consuming planning and construction phases were reflected in the superb results when the project was completed.

Steve Morby
Senior Project Manager

"The VARIO system was easy to assemble for the wide range of wall forms. Due to the cost-savings and the amazing concrete results that were achieved, we will be using VARIO again for other projects."

Architecture
Tadao Ando, Architekt & Associates
Contractor
BSI Constructors, St. Louis
Field Service
PERI Indianapolis, USA

For constructing the architectural concrete components with PERI VARIO GT 24, only millimetre dimensional deviations were allowed.

Architectural concrete requirements

- Uniform structure-free concrete finish.
- Only millimetre dimensional deviations allowed.
- Stringent quality standards for the architectural concrete itself.

Solution

- PERI VARIO GT 24 with PERI Fin-Ply formlining.
- Small plastic plates at the joint edges of the formlining to prevent bleeding.
- Regular change of formlining after every third concreting cycle.
- Use of the VKS coupling for architectural concrete.

Würth Art Museum, Erstein, France

14 m high walls in architectural concrete quality

Serge Bellusso
Site Foreman

"We have worked with PERI formwork for over 15 years now and have always achieved good architectural concrete results. The systems are easy to understand and function well. In addition, PERI always provides immediate qualified answers and solutions to specific questions. The PERI VARIO system was the only choice for us with these high walls. The results fully meet the architect´s expectations."

Two longitudinally extended cubes border an exhibition hall at the Würth Art Museum in the Elsass. Glazed areas set in the wall sections provide visitors a view of the sculpture garden. In addition, construction of up to 14-metre high reinforced concrete walls in architectural concrete quality was required. For this, the locally-based contractors decided in favour of the variable VARIO GT 24 girder wall formwork. Together with PERI engineers, a formwork solution was developed which it made possible for the site team to meet all requirements regarding the formlining joints and screw positions along with the execution and requested positioning of the tie points. The use of SCC self-compacting concrete and the large concreting heights made it necessary to configure the formwork system to handle a concrete pressure of 120 kN/m². GT 24 lattice girders, installed with a maximum spacing of 20 cm, provided safe and reliable load transfer into the steel walers. The specially-designed rows of slotted holes on the PERI steel walers together with VKZ couplers ensured continuously flush and sealed element joints.

After consultation with the architect, a uniform anchor grid of 120 x 85 cm was determined. Assembly of individual components to form complete movable formwork units took place on site. Logical assembly sequences and detailed construction drawings drawn up by the PERI engineers guaranteed that all work procedures could be accurately and quickly implemented by the site crews.

Owned by the globally-operating Würth Group, works from Emil Nolde and Max Ernst along with many contemporary paintings, drawings and sculptures are exhibited on an area of 3,000 m².

VARIO GT 24 made it possible to meet the requirements placed on the formlining joint arrangement as well as the specified execution and positioning of the tie points.

Due to the use of self-compacting concrete and the large concreting heights, the VARIO wall formwork system was designed to handle a concrete pressure of 120 kN/m².

The up to 14.00 x 2.50 m VARIO formwork elements were used around 30 times. For aligning the formwork and safe transfer of wind loads, PERI provided the contractors a perfectly co-ordinated solution from the PERI push-pull prop programme – for all required formwork heights. RSS III, RS 1000 and RS 1400 push-pull props were all used in this project. Shear wall sections could also be temporarily supported with the PERI system equipment.

Architecture
Clément Vergely, Lyon
Contractor
Dicker SAS, Barr/Andlau
Field Service
PERI Bernolsheim, France

Architectural concrete requirements

- Smooth concrete surfaces.
- Pre-determined formlining and joint arrangement.
- High concrete pressure due to wall heights of up to 13.50 m, without hotizontal construction joints, self-compacting concrete.

Solution

- Formed with non-absorbent, coated formlining, PERI Fin-Ply.
- Formlining in a chessboard-like arrangement, screwed on from the front.
- VARIO GT 24 girder wall formwork. Accommodate a concrete pressure of 120 kN/m².

Mercedes-Benz Museum, Stuttgart, Germany

Special formwork construction with 3D volume units

Graphic DaimlerChrysler

The design concept developed by the Dutch architect, Ben van Berkel, avoids the use of corners and edges to a large extent. The concept is based on a double helix (helix = twist, spiral). The unusual structure was considered to be an extremely difficult challenge for the contractors and, in particular, for formwork technology itself. Fast material availability, competent operational planning and punctual delivery of the large quantities of materials required during the project and, above all, the difficult realization of the extraordinary element geometry compelled the consortium – for ensuring the most economical solution possible – to find a competent and efficient formwork and scaffolding partner. As a result, PERI was already included in the tendering phase as a partner.

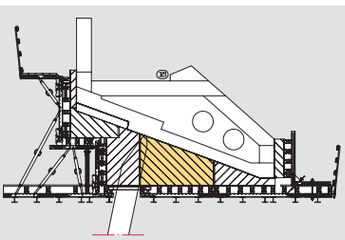
Requirements

Apart from dealing with the difficult geometrical design, high quality surface finishes, sharp edges, tight formwork joints, no indentations, an orderly screw arrangement and defined, well-arranged tie positions demanded extremely close consultation with the architects for both the Twist and Mythos areas.

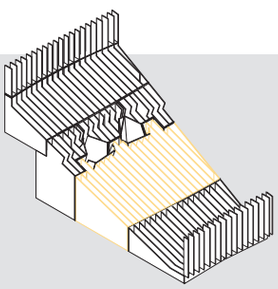
Special formwork construction

Due to the special characteristics of the construction unit forms, the all-sided twisted areas were realized with elements produced at the PERI assembly facility. The basis for the difficult production of the 3D formwork units were PERI VARIO GT 24 standard elements. The large quntities of materials and the short construction period called for an extremely high level of commitment from the PERI engineers involved: in peak times, up to 50 specialist formwork carpenters for customized formwork construction were busy at four different locations to efficiently convert the planning done by up to 30 design engineers.

Schematic 3D presentation of the Mythos segment (yellow), Twist (green) and satellite cores (light green).



Section design and formwork element assembly.

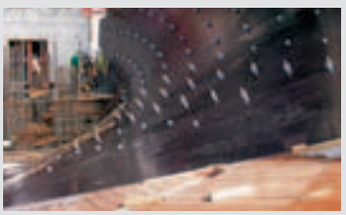


Planning of the 3D formwork units.

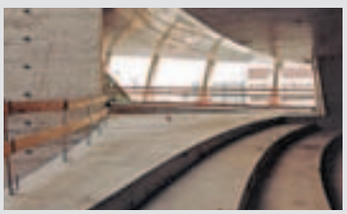
Construction of the 3D formwork units in the PERI assembly hall on the basis of VARIO basic elements.

On the basis of sample units, the feasibility of planning procedures was checked and the realisation of possible concrete surfaces was also determined.

Use of complete formwork elements on the construction site.

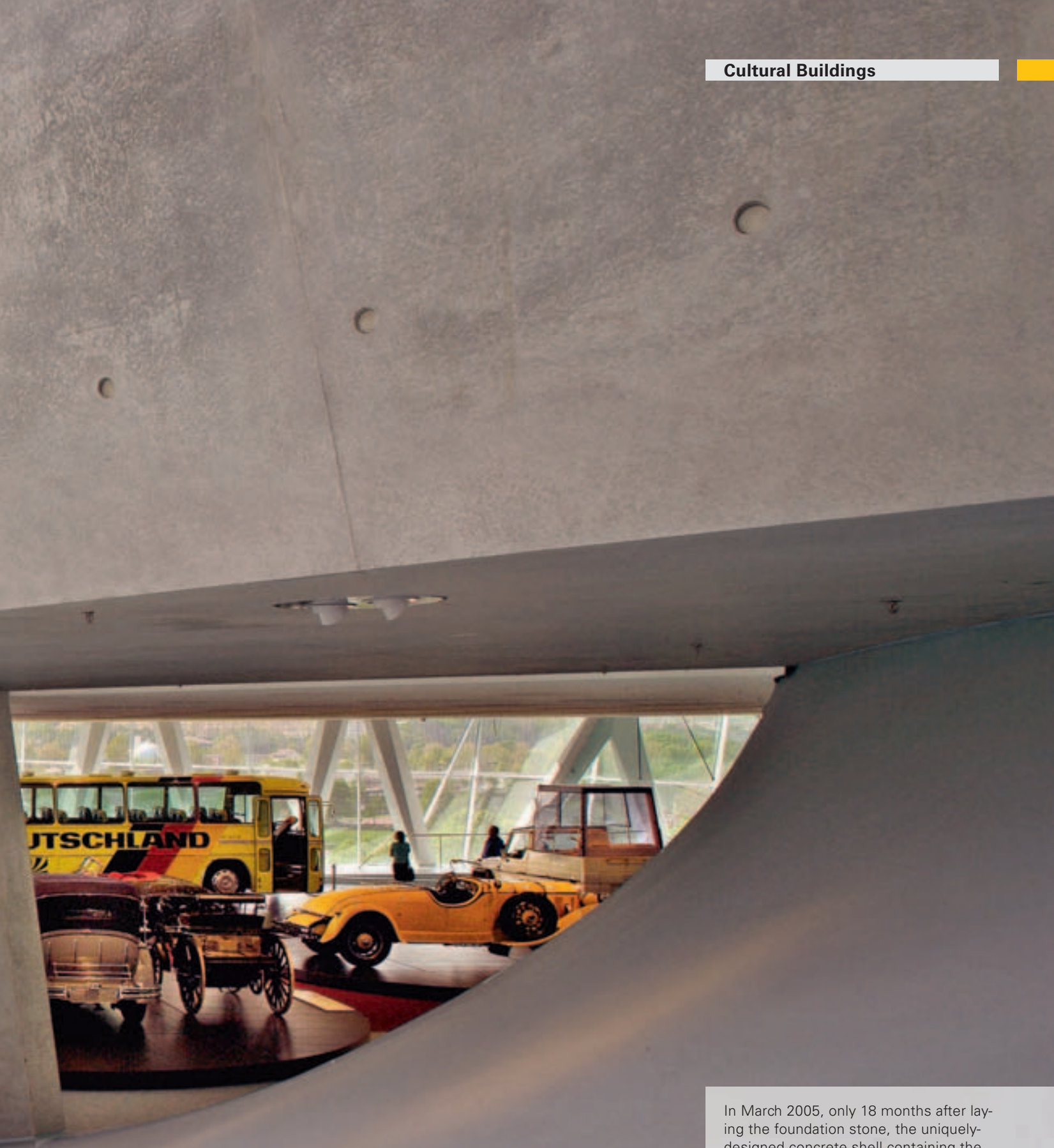


Implementation of the 3D model on the construction site with clearly defined tie positions and formlining joints.



The result: sharp edges, highest quality surface finishes and a uniform tie arrangement.

Mercedes-Benz Museum, Stuttgart, Germany



In March 2005, only 18 months after laying the foundation stone, the uniquely-designed concrete shell containing the museum, technical equipment, connecting building, arena and multi-storey car park was finished.

On 20th May 2006, DaimlerChrysler AG officially opened the new Mercedes Benz Museum for visitors from all around the world.

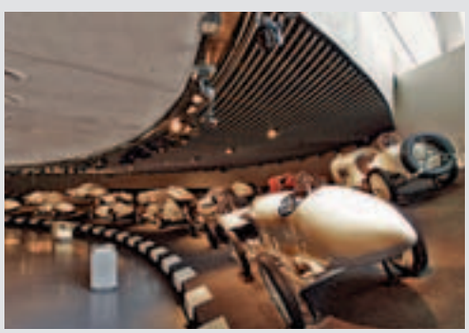
Architectural concrete requirements

- Difficult geometrical form of the "Twist" and "Mythos" structural elements as 3D formwork units.
- Extremely high surface qualities, sharp edges, tight formwork joints.
- Neat screw pattern, defined and orderly tie positions.

Solution

- Formwork on the basis of PERI VARIO basic elements, delivered pre-assembled to the construction site.
- VKS and VRS aligning clamp for neat and accurate formlining joints.
- 3D model for determining the tie positions and formwork panel joints.

Up to 5,000 visitors daily can experience 120 years of automobile history in the new Mercedes Benz museum.



Mercedes-Benz Museum, Stuttgart, Germany

Extreme use of system equipment for a short construction period

The team of supervisors

"Construction of this difficult building whilst under enormous time pressure is a unique achievement. The complicated PERI formwork units could be handled like system formwork and we could achieve excellent concrete surface results. Naturally, we are very proud to have mastered this tremendous challenge together with PERI."

Apart from extensive production of special formwork units, enormous quantities of standard equipment from the PERI rental park were also transported on time to the construction site.

Overview of systems and components:

- 1,900 linear metres of HD 200 heavy duty props
- 33,800 linear metres of MULTIPROP post shores
- 3,700 linear metres of ST 100 stacking towers
- Numerous SB brace frames
- 1,700 m² PERI VT table modules
- 1,800 m² TRIO panel formwork
- 2,200 m² RUNDFLEX circular wall formwork
- 1,150 m² VARIO customised wall formwork
- 6,100 m² of VARIO girder wall formwork with double 3D formwork units for the stair and satellite main cores, the inclined cinema wall with changing radii over two floors (Level 0 and level 1) as well as in other areas.
- 10,000 m² of 3D box-outs with VARIO formwork as a base for particularly complicated segments containing multiple curved concrete surfaces.

This impressive project required unique engineering and assembly services on the construction site itself, a high level of management expertise for the efficient coordination of the work carried out. In addition, it placed high demands on scheduling the enormous quantities of materials.

Specialists from Züblin and PERI worked very closely together in order to meet the extremely high requirements of the architect. The vast experience of the PERI formwork engineers and the efficiency of PERI´s assembly department made a large contribution to the success of this project.

Contractors
Ed. Züblin AG, Stuttgart and
Wolff & Müller GmbH & Co. KG, Stuttgart
Field Service
PERI Weissenhorn and Stuttgart, Germany

St. Canisius Church, Berlin, Germany

Smooth panel joints and configured tie point arrangement

Architectural concrete requirements

- Smooth, non-absorbent formlining.
- Formlining fixings are not visible.
- Panel joints as well as tie pattern and formation according to the specifications of the architect.

Solution

- Use of the VARIO coupling for architectural concrete in order to minimize the tolerances in the area of formlining joints.
- Customised VARIO GT 24 girder formwork elements with coated plywood as formlining, screwed on at the front and smoothed over with filler material.
- Tie point formation according to specifications, blind tie points in part.

Architecture
Büttner – Neumann – Braun BDA, Berlin
Contractor
Hoch- und Ingenieurgesellschaft Brandenburg GmbH
Field Service
PERI Berlin, Germany

The St. Canisius parishioners in Berlin needed a new meeting place after their church had been destroyed by fire. The modern reinforced concrete design is characterised by exact, defined requirements placed on the visible concrete surfaces.
Apart from regularly-arranged plywood joints, another consideration was how to harmonise tie positions and construction joints. Furthermore, the strict evenness tolerances according to DIN 18202 also had to be taken into consideration.

With VARIO GT 24, the contractor found the optimal system to meet all the requirements. Materials totalling 540 m² were used and quantitative and qualitative targets were achieved with first-class results.

The VARIO VKS coupling for architectural concrete provided neat and accurate panel joints by compensating recesses of up to 5 mm.

Andreas Müller
Project Manager
Detlef Hübner
Site Foreman

"With the prefabricated VARIO girder wall elements and the VARIO coupling for architectural concrete from PERI, we could fulfill the quality requirements in the best way possible!"

Matrices nailed to the plywood produced perfect imprints in the concrete and were completed with irregularly arranged metal inlays.

As far as concreting height, concrete surface quality and tie pattern were concerned, the flexible VARIO GT 24 system fulfilled all the requirements.

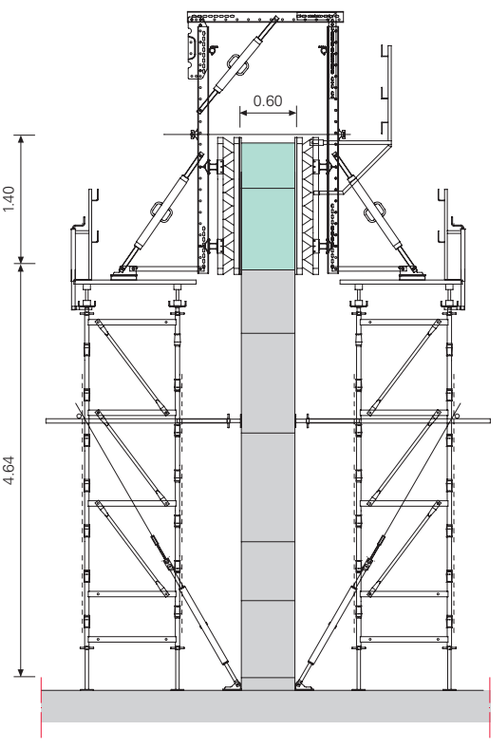
Catholic Church Centre, Köln-Blumenberg, Germany

Special type of architectural concrete for the construction of a new church

The building structure consists of a curved wall on one side with 82 m inner and 90 m outer radii respectively. The other wall comprises two conically tapering wall sections which meet centrically in a semi-circular altar niche.

The church, chapel, crypt and confessional of this extraordinarily-designed structure were to be formed from low-shrinkage concrete. The concrete, which consisted of different aggregates for the colouring, had to be poured in 13 horizontal layers without the use of ties.

The PERI proposal – a cost-efficient solution consisting entirely of rental components – was based on universal steel walers U 120 and a customized steel construction for the tensioning and intermediate frames. 6 m long units were positioned in pairs after the supporting scaffold, consisting of ST 100 stacking towers, was adjusted. Construction crews were then able to keep to the planned weekly cycles. Safe working conditions on the continuously connected ST 100 platforms increased the productivity and impressed the construction site team as well as the health and safety officials.



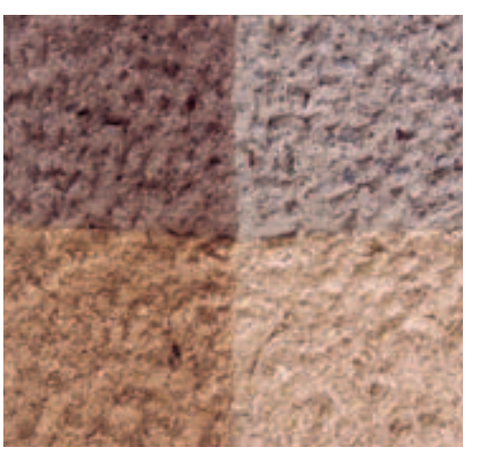
Section of formwork for curved wall without ties through the concrete.

Architecture
Bienefeld Architectural Office, Cologne
Contractors
Arge Neubau Kirchenzentrum Blumenberg
Ph. Holzmann AG, Cologne
Wollwert GmbH & Co. KG, Cologne
Field Service
PERI Willich, Germany

Ulrich Neumann
Site Manager

"From all the offers we received, PERI provided the best formwork proposal. Due to the use of standard components, it was the most cost-effective proposal, as well."

The finishing of the set concrete with pointers provided the required surface design.



The colour effect of the individual pouring layers was achieved by using different aggregates. Artificial colouring was not allowed.

Architectural concrete requirements

- Low shrinkage architectural concrete as joint-free monolithic building.
- Individually poured layers of different coloured concrete.
- The horizontal layers should be distinguished from each other using non-exact straight lines.

Solution

- Special steel construction for the tensioning and intermediate frames.
- Special formwork with frames made of 120 steel walers on adjusted ST 100 stacking towers – following the slip-form principle.

Library, Königgrätz, Czech Republic

Award-winning structure in best architectural concrete quality

Designed as an X-shape in the ground plan, accentuated through regularly spaced circular windows in the external facade as well as a defined tie and joint pattern in the wall areas, the architectural concept of this library building has created a new highlight in the continuing urban development of the city of Königgrätz.

Walls and slabs were to be realised using a sandwich construction. The visible surface areas of the cavity wall construction – inside 25 cm, insulation 12 cm and outside 13 cm – featured architectural concrete of the highest quality, were non-porous and required no deviations in the shading. Furthermore, fulfilment of the criteria should be supported through the use of self-compacting concrete.

The feasibility of the desired requirements was checked before the actual start of construction work by the "architectural concrete team"– consisting of architect, building contractor, concrete supplier and formwork provider – by means of a test wall and subsequently approved. As a result, VARIO GT 24 girder wall formwork panels measuring 3.30 x 2.50 m were used, whose flexible waler arrangement allowed optimal adaptation to the required tie arrangement whereby the formlining was screwed on from the rear in order to avoid unsightly imprints in the concrete finish.

Due to the outstanding concrete results, the architect's office – in consultation with the owner and contrary to the original concept – decided in favour of orange-coloured facade paintwork on all outside surfaces.

Miloš Filipi
Site Manager

"Already during the planning phase, we worked intensively with the PERI formwork in order to be able to realize the pre-determined joint arrangement of 2.50 x 3.30 m. For using the self-compacting concrete, PERI provided us with a customised and high load-bearing formwork solution based on VARIO girder wall formwork. The owner is very satisfied with the results we achieved."

Architectural concrete requirements

- Defined joint arrangement on wall and slab surfaces.
- Pre-determined tie pattern for the wall areas.
- Smooth architectural concrete without pores and no deviations in the shading.
- Use of self-compacting concrete.

Solution

- Formlining is screwed on at the rear.
- Use of the high load-bearing PERI VARIO GT 24 girder wall formwork, with positioning of the walers coordinated to suit the tie pattern.

Architecture
Projektil Architekti, Roman Brychty, Prague
Contractor
VCES a.s. Firma VHS, Hradec Kálové
Field Service
PERI Jesenice, Czech Republic

Library, Königgrätz, Czech Republic

The interior design of this architectural concept is also characterised by a clear line arrangement, orderly structure of the component elements as well as through an appealing colour scheme which provides simple orientation for the visitors.

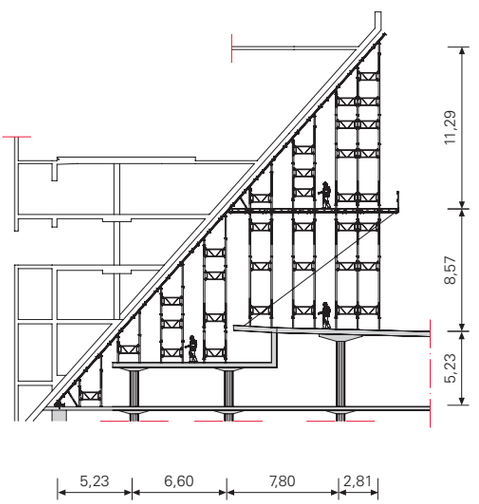
Casa da Música Concert Hall, Porto, Portugal

High, diversely angled wall areas with architectural concrete surfaces

The PERI MULTIPROP towers could easily be adapted to the slope of the walls. Special couplings provided rigid and precise connections for the VARIO formwork and MULTIPROP shoring. Horizontal loads from the components were safely carried by temporary cable-stays.

Architecture
Office for Metropolitan Architecture, Rotterdam
Contractors
Somague/Mesquita/Casa da Mùsica, ACE
Field Service
PERI Portugal, Porto

Built to coincide with "Porto 2001 – European Culture Capital", the concert hall is pictured here after the structural work had been completed.



Source: A. Minson, The Concrete Centre.

The architecture of this concert hall was the creation of Rem Koolhaas and Ellen van Loon. The architectural concrete structure resembles a crystal, whose form develops from the inside out whereby the concert hall forms the heart of the building. The concrete cover encloses a stack of spatial cubes and stretches around this like a skin, including the free spaces within. White concrete was exclusively used for all visible concrete components in order to prevent any mixing with other concretes.
The concrete mixture, with characteristics such as colour, texture, reflectivity, porosity and cracking behaviour, was created especially for the structure and the final choice was based on a series of test pieces.

The main supporting structure of the Casa Música consists of 40 cm thick external walls as well as two 1.00 m thick longitudinal walls of the main concert hall which were formed using the VARIO GT 24 girder wall formwork system while conforming to the specified joint and tie arrangement. Through the very flexible adaptability of this system, the special geometrical requirements were able to be fulfilled and even the fixing of the required climbing scaffold could be matched to suit the requested tie arrangement. Transfer of the high loads from the overhanging wall areas through to reaching self-supporting capability was carried out with the help of the MULTIPROP system.

Ing.
Matus Fernandes
Site Manager

"The technical solution from PERI was easy and safe to implement. This enabled us to achieve the high quality standards and keep on schedule without any problems!"

Architectural concrete requirements

- Architectural concrete surfaces with regular joint and tie arrangement.
- High concrete pressure due to large inclined surfaces.

Solution

- Adaptability of the VARIO GT 24 to the special geometrical forms.
- Adjustment of the climbing scaffold to the defined tie positions.
- Transfer of the concreting loads with the MULTIPROP system.

Ordrupgaard Museum, Charlottenlund, Denmark

Flowing forms in black concrete

For the realisation of the unusual component forms, a high number of serial parts in the PERI product range were used.

Architecture
Zaha Hadid Architects, London
Contractor
E. Pihl & Son A.S, Kgs. Lyngby
Field Service
PERI Denmark

Architect Zaha Hadid, famous for her sophisticated construction projects based on unconventional design techniques, was awarded the contract for the extension of the Ordrupgaard Museum in the face of tough international competition.

The original design of the exhibition areas and the choice of materials, which were to meet requirements regarding inconspicuousness and transparency, primary elements of design that strike the visitor from the moment of entering the museum.

The walls and slabs of the concrete construction, realised in black-coloured concrete, seem to flow harmoniously into each other. Hadid waived the use right angles, and with the increase in levels to the various floors as well as curvatures in the outer skin, she provides elegance as well as harmonious integration of the building into the surrounding landscape.

On basis of VARIO GT 24 girder wall formwork, PERI supplied a formwork system which completely satisfied the requirements. Supplemented by standard components, such as the GRV articulated waler and the MULTIPROP system, the transition areas – which were characterised by changing radii – could be accurately and, at the same time, efficiently formed, from inclined walls to the slabs. Through the careful coordination of the formlining measures as well as the almost unlimited possibilities with VARIO to be able to freely position the tie points, the uniform pre-determined joint and tie arrangement for the architectural concrete surfaces could be reliably realised.

Hadid´s 500 m² extension building fits perfectly into the surrounding landscape as a narrow structure.

The interiors are, to a large extent, windowless and introvertiert Although there is limited natural daylight, state-of-the-art lightig systems increases the visitors´ concentration on the exhibits themselves.

Design freedom with VARIO GT 24: formlining sheet dimensions and tie positions are executable in almost any combination.

Florante Submarino Restaurant, Valencia, Spain

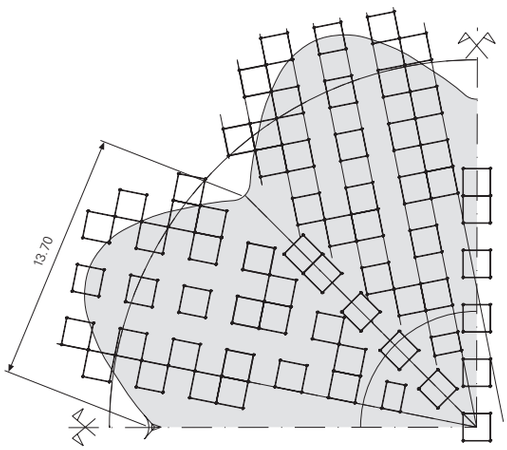
Cost-effectively realised falsework for a bold roof construction

In spite of the extraordinary shape of the roof, the clear arrangement was still evident. The PERI UP Rosett falsework ensured a reliable transfer of the loads, almost free of diagonal braces.

The valleys of the converging roof paraboloids demanded careful execution.

The three-man erection team needed 794 working hours to erect the PERI UP Rosett falsework. Extension splices coupled the high load-bearing GT 24 girders forming an aligned and bending-resistant joint.

Architect
Felix Candéla, Spain
Contractor
UTE Parque Oceanográfico
Field Service
PERI Madrid, Spain



101 vertical legs were necessary to construct the formwork of each rotunda with the selected basic grid of 1.50 m.

The PERI Rosett falsework reached a height of 13.70 m.

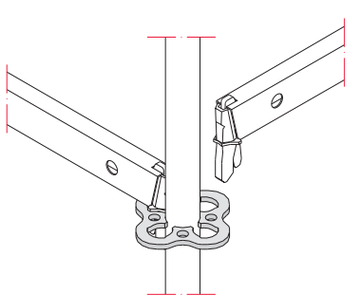
Valencia, known as the city of the arts and sciences, set a milestone for the cultural development of the whole region with this project. On an area of 350,000 m² there are bold and futuristically-striking Theme Parks that symbolise the beginning of the new millennium.

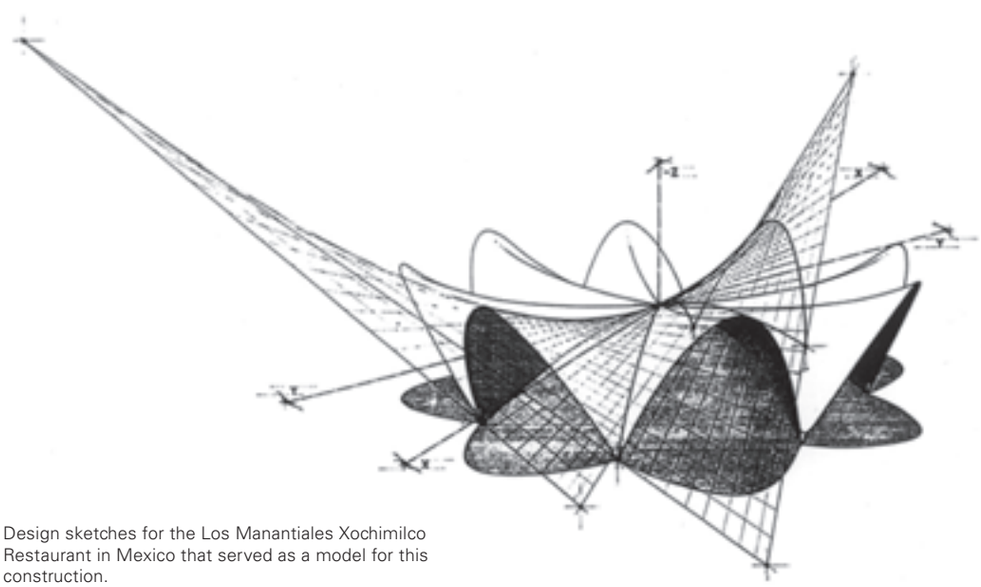
In the "Parque Oceanografico" there is an underwater restaurant,designed by the Spanish architect Felix Candela, that gives the appearance it is swimming.

A spectacular roof covers approximately 500 seating places. The shape of this reinforced concrete shell is characterised by eight symmetrical, hyperbolic-shaped paraboloids. A roof area of 2,100 m² was to be formed with varying slab thicknesses from 8 to 80 cm.

PERI supplied a convincing formwork and falsework concept: with 77 t of PERI UP Rosett materials, the structure of the building could be accurately executed as a three-dimensional bridging space. Following this, 3,600 m of GT 24 girders were placed in crosshead spindles that in turn supported the formlining which comprised of individual boards.

Centrepiece of PERI UP Rosett is the node with its high rigidity. The shape of the rosette openings fix the ledger ends in a straight line. Angles of up to 45° are also possible for tension or compression braces. One hammer blow is sufficient to create a rigid connection.





Design sketches for the Los Manantiales Xochimilco Restaurant in Mexico that served as a model for this construction.

Boat and Club House, Fußach, Austria

As a monolith rising 14 metres over the water level, packed in a delicate glass shell and designed with clearly defined concrete components throughout, the architecture of this structure takes up visual elements of the port and consolidates these in a very unusual way.

Boat and Club House, Fußach, Austria

Glass wrapped, tree-like load bearing structure in concrete

Bmst. Ing. Werner Schedler
Managing Director
Dietmar Kohler
Site Foreman

"We are very satisfied with the reliability of PERI and appreciate the flexibility of the systems on the jobsite. Due to the perfect PERI formwork technology, the building could be efficiently and safely built."

Contractor
Oberhauser & Schedler Bau GmbH, Andelsbuch
Field Service
PERI Austria
Planning
Baumschlager-Eberle Ziviltechniker GmbH, Lochau

The realisation of this multi-functional building is the last step in transforming a former gravel pit on the shores of Lake Constance into a modern marina.

The 14 m high delicate architectural concrete building complete with a glass covering, has 3 levels which are used as a boathouse, entrance and sanitary areas as well as an almost 9 m high meeting and events room.

Construction of the distinctive structure was carried out with the help of TRIO panel formwork with double layer plywood climbed on FB 180 folding platforms. The original entirely irregularly planned box-outs were optimized by the architects into a cost-effective execution plan: concreting took place using only six formwork elements in ten sections whereby the formwork sets were used in rotated and mirrored positions.

Appearing very cathedral-like, the individual structural elements are characterised by high functionality and timeless clarity, also in the interior area.

From an architectural point of view, the concrete has been successfully showcased even for functional furnishings.

The tree-like openings in the 8.50 m high walls, as well as the advanced crystalline glass facade, give the interior a light-variable dimension.

Architectural concrete requirements

- Visibly remaining slab underside with a uniform formlining arrangement.
- 14 m high massive reinforced concrete walls with vertical, amorphous recesses.
- Cost-effective construction of the supporting structure.

Solution

- Girder slab formwork with a defined formlining size.
- Double prefabricated box-outs on TRIO panel formwork elements.
- The use of only 6 formwork sets with box-outs, used in rotated and mirrored positions.

Tunnel and Bridge Engineering

Viaduct Schleuse, Schleusingen, Germany

Sommerberg Tunnel, Hausach, Germany

In traffic route construction, for example, bridges, tunnels or retaining walls, architectural concrete is considered to be an essential design element.

The concrete surfaces are often only really noticed at great distances or when in vehicles passing by. In this respect, if conscious visual accents are to be set, clear design elements must be selected. For example, joints which result from the joining of formwork panels or from working sections, should be clearly visible.

It is to be noted, however, that many components on these structures are predominantly exposed to the direct effects of the weather. This means that they age rapidly and can also strongly undergo a change in appearance over the course of time.

The following pages feature a selection of projects which were successfully realised by construction companies supported by PERI know-how as well as formwork and scaffolding technology.

Muldetal Bridge, Wurzen, Leipzig, Germany

VARIO for the highest concrete and geometrical requirements

For the twelve pairs of piers in the foreshore area, PERI delivered completely pre-assembled formwork sets on the basis of the VARIO GT 24 girder wall formwork.

Formwork elements covered with rough-sawn board formwork provided the characteristic surface structure.

Pre-assembled PERI raised formwork units delivered to the jobsite supported the girder formwork for the superstructure cantilver and safely carried the loads into the steel structure.

Architectural concrete requirements

- Boarded formlining with a pre-determined board direction.
- Sharp edges.
- Difficult component geometry of the piers.
- Neat tie arrangement.
- No offsets in the joint area of the formwork.

Solution

- Pre-assembled board formwork.
- PERI VARIO GT 24 for the complicated geometry.
- Two formwork sets for the different pier heights.
- VKS coupling for offset compensation in the area of the joints.

With an overall length of 528 m, the four-lane Muldetal Bridge replaced the almost 50-year old bridge construction which was heavily damaged as a result of the catastrophic flooding in August 2002. It connects the Wurzen and Bennewitz town bypasses on the B6 federal highway from Leipzig to Dresden, and serves to improve the flood protection measures for the Mulde river in this area.

The complete bridge project comprised of two bridge constructions: one across the river and one on the foreland. The 215 m long main bridge is carried on two massive river piers and is a steel composite construction with a middle span length of one hundred metres. The 313 m long pre-

The river piers were constructed with different heights. Nevertheless, only one formwork set as well as a minimum of filler elements were sufficient for the construction.

The result: sharp edges, a neatly arranged tie pattern as well as a compact board structure.

Architecture
Arand, Architekten, Berlin
Contractor
Porr Technobau Berlin GmbH
Field Service
PERI Berlin and Weissenhorn, Germany

Hubert Bähr
General Foreman

"With the PERI formwork solution, we could maintain the tight schedule and fulfil the high architectural concrete requirements in the best possible way. PERI ready-to-use pre-assembled formwork elements brought us considerable savings in both time and labour costs."

stressed concrete foreshore bridge is supported by twelve sets of piers positioned with 25 m spacings in each case. A dividing pier supports and connects the two different sub-structures.

In spite of the very tight schedule, high concrete requirements still had to be fulfilled. For the complicated and technically demanding pier constructions, a convincing formwork concept could be submitted. The difficult geometrical forms with the best quality surface finishes – in part with sharp edges as well as flush and tight formwork joints throughout – were able to be cost-effectively realised.

Trmice Motorway Bridge, Aussig, Czech Republic

27 m high, Y-shaped piers formed with system components

PERI system components for 59 bridge piers in architectural concrete and PERI fomwork carriage for the steel composite superstructure

For constructing the pier heads, PERI´s team of Czech engineers developed an efficient formwork solution with horizontally-positioned SB brace frames and VARIO GT 24 girder wall formwork.

Architectural concrete requirements

- Smooth, light coloured architectural concrete.
- Neat formlining joint pattern and tie pattern.

Solution

- Customised and prefabricated VARIO GT 24 elements.
- Climbing scaffold comprised of standard elements whose anchoring points were matched to the requirements.

Ing. Pavel Kouba
Project Manager

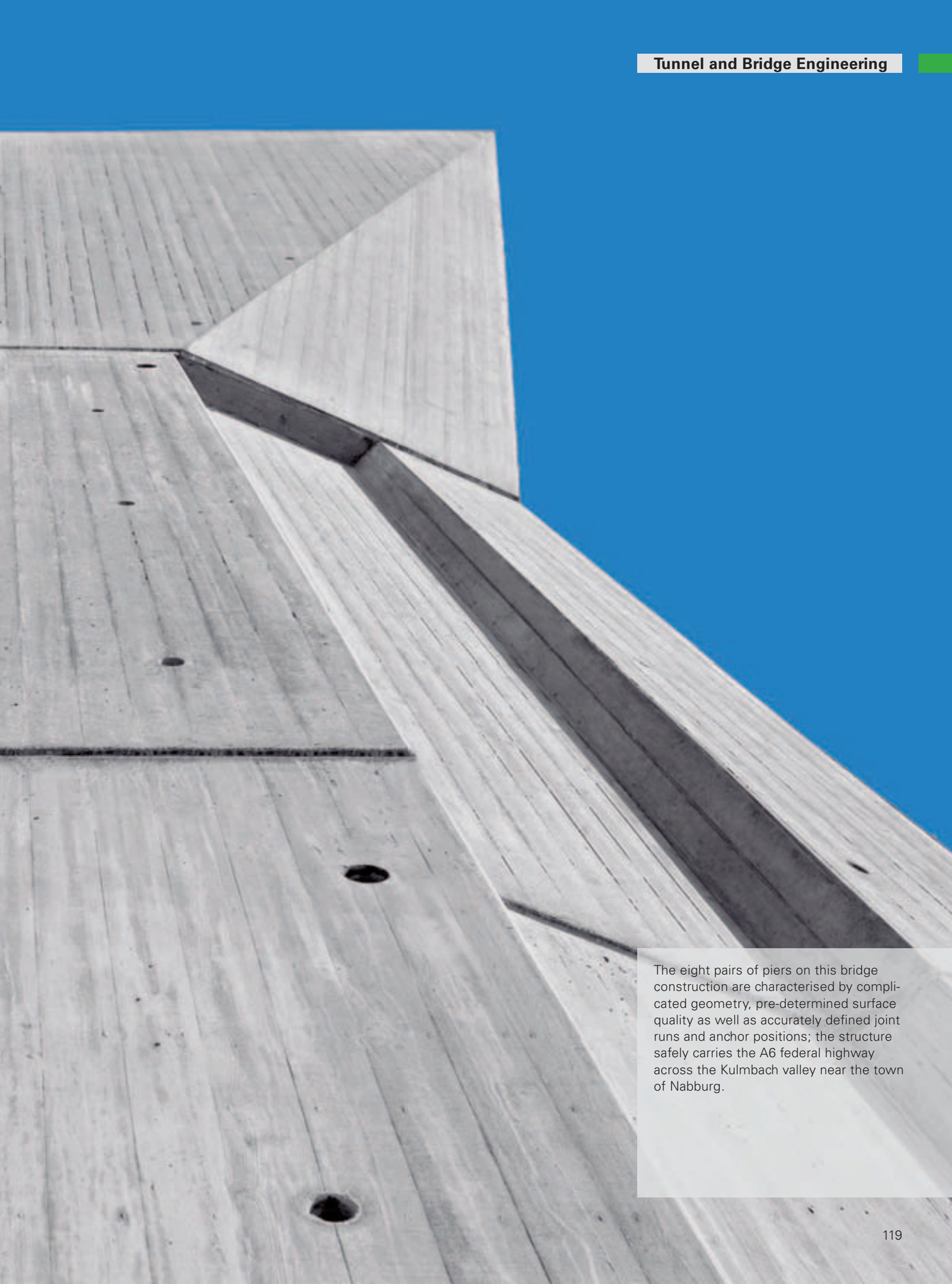
"PERI provided the most cost-effective formwork solution for constructing the columns and superstructure. Using the PERI composite formwork carriage resulted in considerable cost savings for us. In addition, normal rail traffic operations could be maintained during the entire construction period."

Contractor
METROSTAV, Division 4, Prague
Field Service
PERI Prague, Czech Republic
and PERI Weissenhorn, Germany

The 1,083 m long motorway bridge for the E55 on the outskirts of Aussig/Trmice closes the gap in the European highway network between Dresden and Prague. The steel composite construction with counter-positioned and changing radii, snakes its way across a wide plain.

The two separate superstructures, with widths ranging from 14.20 m to 15.40 m, are carried by a total of 59 Y-shaped piers up to 27 m high. The pier shafts were formed by the construction crew with VARIO GT 24 girder wall formwork on CB 240 climbing brackets using concreting cycle heights of 5.70 m. The formwork and scaffolding could be moved as a complete unit resulting in considerable time savings. For the V-shaped 9,75 m wide and over 7,25 m high pier heads which widen in a transverse direction, suspended SB brace frame systems provided an optimal support and load-bearing surface for the formwork Filler boxes on the VARIO elements made it possible that the 1.00 m thick shear wall in the pier head could be formed together with the 2.35 m thick main support members (Y-shaped) and concreted in one pour. This meant material utilisation as well as the time and effort for moving could significantly be reduced to a minimum.

Kulmbachtal Bridge, Nabburg, Germany



The eight pairs of piers on this bridge construction are characterised by complicated geometry, pre-determined surface quality as well as accurately defined joint runs and anchor positions; the structure safely carries the A6 federal highway across the Kulmbach valley near the town of Nabburg.

Kulmbachtal Bridge, Nabburg, Germany

Piers in variable geometry and special surface quality

For the pier heads, completely pre-assembled PERI VARIO GT 24 wall formwork elements were delivered to the construction site. The high loads were safely transferred via SKS climbing formwork into the structure.

The 515 m long Kulmbachtal Bridge is supported on a total of eight pairs of piers which reach heights of up to 33 m.

The pier shafts
are featured in the ground plan as irregular octogons and taper on their way to the top. Four sides of the shafts have vertical grooves. The height of the work sections was set at 5.00 m. As formlining, coated individual boards without longitudinal joints were to be used in the formwork panels.

In concreting cycle heights of 5.00 m, the shafts were climbed up to a height of 30 m. In the process, the construction crew accentuated the individual joints between the concreting sections by inserting trapezoid borders. The formwork elements, consisting of VARIO GT 24 standard panels combined with customised elements and covered with the required board formwork, were delivered prefabricated to the jobsite.

With the help of the proven CB climbing technology, the pier shaft formwork and climbing scaffold could be moved together using only one crane lift resulting in considerable time savings. Using a concreting sequence which had been adapted to suit the construction progress, all pier shafts could be constructed with only two sets of formwork.

The pier heads
have an overall height of 5.00 m and likewise feature demanding geometries with the transition from an octagonal to a rectangular-shaped ground plan. Here, too, the formwork elements were delivered to the site completely pre-assembled and were then positioned on SKS bracket scaffold. With the help of the high load-bearing SKS single-sided retractable climbing formwork, forces from the fresh concrete pressure were transferred via the brackets into the construction-approved scaffold anchoring and then safely into the pier shafts. With only one formwork set, all 16 pier heads could be accurately constructed in the required architectural concrete quality. The anchor points for the formwork and scaffold brackets were symmetrically arranged and clearly visible.

Architectural concrete requirements

- Structured, light coloured, porous concrete surface.
- Constant board widths without horizontal joints over the entire concreting height.
- Trapezoid borders for horizontal joints between the concreting sections.
- 5 m high working sections.

Solution

- VARIO GT 24 elements completely preassembled covered with coated board formwork.
- Only two formwork sets due to adapted concreting sequence.
- Pier head formwork made of VARIO GT 24 for special ground plan change from octagonal to rectangular.

Contractor
DYWIDAG Bau GmbH, Nuremberg
Field Service
PERI Nuremberg, Germany

The octagonal pier shafts changed to a rectangular form in the area of the pier heads. With the PERI formwork and scaffolding solution, the piers could be constructed very accurately and in architectural concrete quality.

Aesculap Pedestrian Subway, Tuttlingen, Germany

Prefabricated 3D formwork turns concrete into a special form

Architectural concrete requirements

- High surface quality with sharp edges and pre-determined tie pattern.
- Special design with defined joint runs.

Solution

- Use of the PERI VARIO GT 24 girder wall formwork.
- Use of pre-fabricated 3D formwork units.

On the construction site, ready-to-use pre-assembled 3D formwork from PERI is accurately positioned and joined together via measuring points.

Gerd Jäger
Site Manager

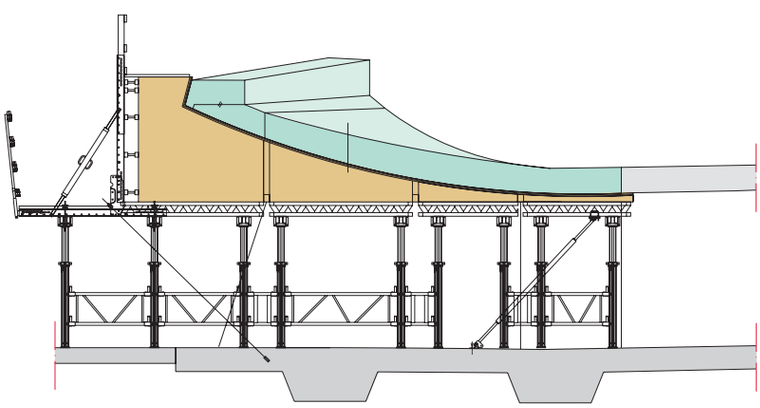
"Even with sudden operational sequence changes on the construction site, PERI always provided us with a reliable solution within a very short time. This meant we could hand over an accurately-built reinforced concrete structure with optimal concrete quality to the owner."

Contractor
Karl Heim GmbH & Co. KG, Tuttlingen
Field Service
PERI Weissenhorn, Germany

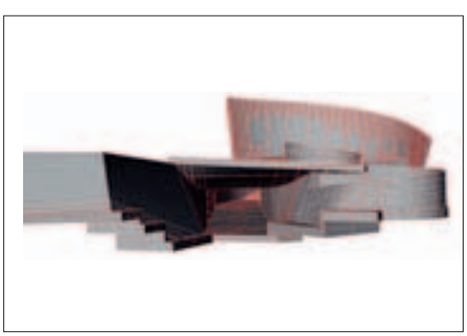
This pedestrian subway serves to provide safe access to the company premises for staff members of the medical technology specialist Aesculap and has also been designed to enhance the Aesculap Plaza at the same time.

For the realising the up to twelve-metre high retaining walls with twisted surfaces in the wall and slab areas, a 3D construction model was designed by the engineering office. Based on this, PERI developed a formwork construction consisting of statically supporting basic elements and form-giving 3D formwork units. The rentable basic elements were comprised mainly of the VARIO GT 24 girder wall formwork system. For the safe transfer of loads, SLS heavy-duty spindles and the lightweight aluminum MULTIPROP system were used as load towers.

For constructing the 3D formwork units, the building data was further processed with PERI CAD software. Taking into consideration the maximum transportation dimensions, PERI designed honeycomb-like geometrical bodies. In addition, a geometry database was set up which served for CNC production of the individual timber formers and assembly of the formwork units in the PERI assembly hall. On the construction site, the pre-assembled formwork elements could be joined together and positioned with millimetre precision. Formlining which overlapped the individual elements was subsequently installed.



The design principle of the PERI 3D formwork consists of three-dimensional formwork units and statically supporting basic elements.



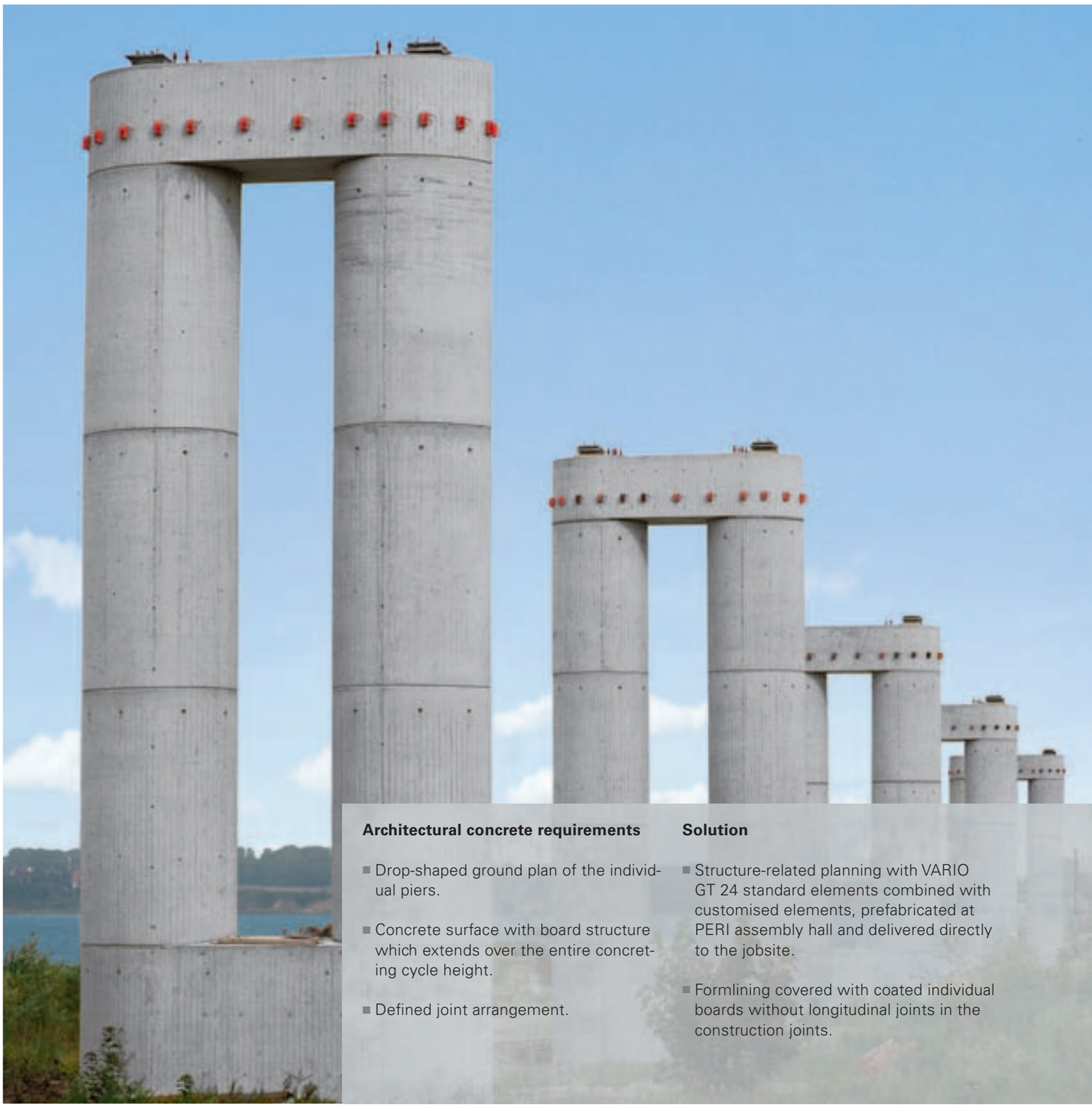
The north portal has three-dimensional curved and twisted surfaces in the wall and slab areas. The building data served as the basis for the construction of the 3D formwork units.

The pre-assembly of the 3D formwork elements in transportable dimensions was carried out by specialists from the PERI assembly service team.

Successful result: accurately executed forms with a high surface quality. The pre-assembled 3D formwork from PERI is joined together and positioned with millimetre precision on the construction site.

Strelasund Bridge, Stralsund-Rügen, Germany

53 pairs of piers up to 40 m high with board structure



Architectural concrete requirements

- Drop-shaped ground plan of the individual piers.
- Concrete surface with board structure which extends over the entire concreting cycle height.
- Defined joint arrangement.

Solution

- Structure-related planning with VARIO GT 24 standard elements combined with customised elements, prefabricated at PERI assembly hall and delivered directly to the jobsite.
- Formlining covered with coated individual boards without longitudinal joints in the construction joints.

The 126 m high distinctive bridge pylon is constructed in reinforced concrete up to the carriageway, the remainder is in steel.

Klaus Schmitt
Site Foreman

"Our target of constructing the pairs of piers in weekly casting segments could be achieved without any problems due to the PERI climbing formwork. The high load-bearing PERI GT 24 formwork girder in the VARIO wall formwork system guaranteed extremely rigid large-sized formwork elements with a high permissible concrete pressure. The versatile VARIO GKZ articulated coupling proved to be particularly advantageous for dealing with the different edge connections."

Since autumn 2007, Rügen – Germany´s biggest island with the famous chalk cliffs – has been connected with Baltic Sea A 20 motorway via the Rügen link road. The centrepiece of the 4,100 m long Strelasund Crossing is comprised of six bridge structures with an overall length of 2,830 m. One section features the 583 m long Ziegelgraben Bridge, a cable-stayed bridge with a 42 m high clearance height for vessels using the port of Stralsund.

In the ground plan, the individual piers of the altogether 53 pairs have a drop-shaped construction. The design reminds the viewer of a ship´s hull and a sailing boat mast. The distinctive pylon of the Ziegelgraben Bridge is constructed in reinforced concrete up to the carriageway and the remainder is in steel.

For this, the Neumarkt-based building contractor Max Bögl GmbH used variable VARIO GT 24 girder wall formwork on KG climbing scaffold. As a result, the construction crew was able to construct the pairs of piers in weekly concreting sections.

Architecture
André Keipke, Rostock; Schüßler-Plan
Contractor
Max Bögel GmbH, Neumarkt
Field Service
PERI Hamburg, Nuremberg, Weissenhorn, Germany

Pre-assembled at the PERI assembly facility and delivered to the jobsite, the VARIO GT 24 elements ensure the accurate form of the drop-like pier design.

Detail: concrete surface in board structure.

Near the town of Millau, around 120 km to the west of Avignon in the south of France, an impressive bridge construction was realised based on the designs of the English architect, Lord Norman Foster: the Viaduc de Millau.

Motorway Viaduct, Millau, France

Motorway Viaduct, Millau, France

The highest bridge pier worldwide in the best architectural concrete quality

The complicated pier geometry placed high requirements in formwork terms on the construction crew. It was divided into three sections.

The ACS self-climbing scaffold was used as a working level, for supporting the formwork as well as incremental, crane-independent moving of the formwork.

The working platforms formed a platform around the pier cross-section. In the absence of any leading edges, this meant construction crews could work effectively and in complete safety at all heights.

This very spectacular bridge construction in the south of France was designed by the English architect, Sir Norman Foster. Eight sections, with lengths of 2 x 204 m and 6 x 342 m, span the River Tarn valley. A total of seven reinforced concrete pylons with heights of between 78 and 245 m were to be built. These support the steel superstructure and the steel pylons carrying the cable stay construction.

PERI's formwork and shoring concept was based on customised steel formwork, which was designed to handle the large areas to be formed as well as producing the required high quality concrete surface finishes.

The complicated shape of the structure required adapting the exisiting formwork or producing new elements for the next pour. This was achieved through special 142 mm compensation panels, with additional filler elements for each cycle and using telescopic steel walers in the areas of compensation. The formwork was designed to handle up to 100 kN/m² of concrete pressure. In spite of the difficult joint and anchor configuration, the customised steel formwork produced an excellent surface finish.

Architecture
Foster and Partners, London
Contractor
Eiffage TP, Neuilly-sur-Marne
Field Service
PERI Weissenhorn, Germany

Architectural concrete requirements

- Smooth surfaces, sharp-edged corners, no visible formlining joints within the concreting sections.
- Low number of tie points, defined positions.
- Variable concrete element geometry from cycle to cycle.

Solution

- Customised special steel formwork.
- Only one tie position in the concreting sections, second tie position above the construction joint.
- Adapted formwork elements for each cycle with special compensation and filler elements as well as telescopic steel walers.

Phillippe Blondeau
Quality Assurance

"The results we achieved with the ACS self-climbing formwork completely fulfilled our expectations. Taking into account the extremely complex construction geometry, we could produce a concrete surface of the highest quality."

Complicated pier geometry
From the foundation slabs, the piers taper upwards from 27 to 14 metres in the first section. This is followed by a Y-shaped segment where the single piers split into double box piers. At 90 metres below the road surface, the double box piers begin to taper upwards from 14.40 m to 11.13 m at the top. This means that the pier cross-sections changed from cycle to cycle.

Saaletal Bridge, Hollstadt, Germany

Special pier head design and concrete surface in board structure

Architectural concrete requirements

- Concrete surface in board structure according to architect´s specifications.
- Accentuated horizontal joints in accordance with concreting cycle heights.
- Special pier head geometry.

Solution

- Formlining comprised of board formwork, jointed, rough-sawn and untreated.
- Profiled strips inserted into the concreting joints.
- Customised formwork elements pre-assembled at PERI assembly facility and delivered ready-to-use to the construction site.

Exact and with the required board structure – one of altogether 16 pier heads after completion.

As part of the A 71 Erfurt – Schweinfurt motorway project, a new 690 m long bridge spans the Saale valley in the picturesque Franconia region. Eight pairs of reinforced concrete piers, each with a special head construction, support the twin superstructures carrying the carriageways.

PERI was commissioned to deliver the pre-assembled pier head formwork to the construction site. Designed by PERI engineers at the technical office and put together by a specialist assembly team at the company´s headquarters in Weissenhorn, this cost-efficient solution allowed very accurate pier head construction to take place and completely fulfilled the requirements regarding the quality of the concrete surfaces.

Pier head formwork with climbing scaffold and concreting platforms ready for casting.

The completely pre-assembled pier head formwork consisted of two bulkhead and two longitudinal elements. For transporting, the longitudinal elements were divided into three sections which were then put together again on the jobsite by means of universal couplers.

Contractor
J.G. Müller GmbH, Wetzlar
Field Service
PERI Weissenhorn and Ebersgöns, Germany

Marian Koscielniak
Site Manager

"A lot of positive things can be said about PERI. Apart from the excellent technology, the company engineers were prepared to solve the vast majority of problems on-site. Deliveries were also carried out on schedule even at shortnotice!"

Architectural concrete requirements

- Triple change of the pier ground plan over the entire height.
- Change between smooth and structured architectural concrete surfaces.
- Minimisation of the suspension points.

Solution

- VARIO GT 24 with box-outs and double layer of 9 mm formlining.
- Individually cut VARIO elements for each concreting cycle and the use of profiled trapezoidal matrixes.
- VARIO special walers with standard perforation. Formwork elements on PERI SKS brackets. Load transfer via special scaffold mounting rings on measured positions.

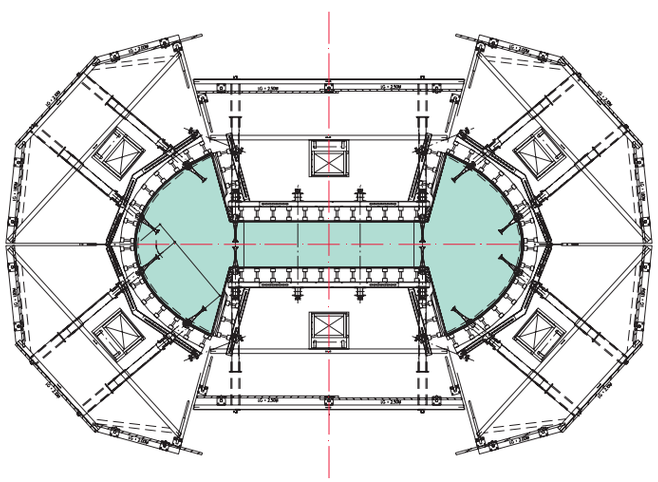
Motorway Viaduct, Souillac, France

Geometrically demanding and with changing surface structure

In the context of the new construction of the A20 motorway between Orleans and Toulouse near Souillac, a 363 m long bridge structure with a maximum height of 35 m over the bottom plate was developed using a so-called hybrid construction.

The architectural design of the six pairs of piers featured a number of characteristics regarding their geometry and the required concrete surfaces which placed high demands on the formwork. As a result, the triple change of the pier ground plan along the entire height as well as the change between smooth and structured architectural concrete surfaces were to be taken into consideration. It was also necessary to reduce the suspension points of the climbing brackets to a minimum and ensure they were positioned as accurately as possible in a vertical line throughout all three ground plan designs. Any additional tie points were not permitted due to the formation of visible markings in the concrete finish.

In the bottom massive cross-section area of the piers, the VARIO GT 24 girder wall formwork with box-outs and double layer of 9 mm formlining was used. For the central elements in the "double pier area" and for those in the "single pier area", the construction crew used VARIO special walers with standard perforations. For each concreting cycle, the VARIO elements were individually cut to suit the required cross-sectional form and were all supported on PERI SKS brackets. Loads were transferred to accurately measured suspension points (anchor sleeves) via special scaffold mounting rings, with a bearing capacity of 250 kN, into the previous concreting sections.



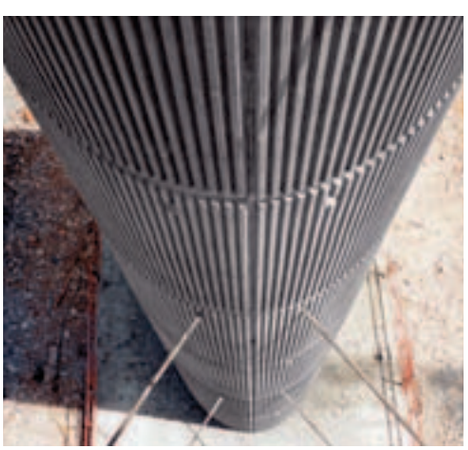
Ground plan of the middle pier area. The use of VARIO GT 24 girder wall formwork with special walers and standard perforations allow the ground plan design to be followed exactly.

Contractor
Bisseuil, Toulouse
Field Service
PERI Bordeaux and Meaux, France

Philippe Boisrobert
Site Foreman

"Our expectations were fully met with this formwork solution. In only 110 working days, the two formwork sets recorded 50 uses in each case. All dimensional specifications were kept and we succeeded in realising the required concrete finish."

With on-site material requirements of two formwork ses which were used altogether 50 times, the six pairs of viaduct piers could be constructed on time.



The result: the 30 mm high profiled and curved trapezoidal matrixes in a radius of 1.58 m, resulted in a clean and uniform concrete structure.

Viaduct Schleuse, Schleusingen, Germany
Complex cubatures for piers in excellent concrete quality

With two formwork sets for the shafts and two sets for the heads, architecturally challenging piers were constructed which carried the BAB A73 motorway in a circular arc with a 1,500 m radius over the Schleuse Valley.

Tom Schittek
General Foreman

"With the PERI climbing formwork, we were able to concrete the piers with only 3 men in a 3-day cycle. PERI provided us with the most cost-effective solution due to requiring only a minimum of system components."

Supporting planning structure
IWS Beratende Bauingenieure, Idstein
Contractor
Ed.Züblin AG, Chemnitz
Field Service
PERI Chemnitz and Weissenhorn, Germany

The 680 m long bridge over the Schleuse Valley in Thuringia, Germany, runs radially by means of two separate superstuctures. A total of nine Y-shaped pairs of piers with heights of up to 40 m were to be constructed.

Each pier splits into two legs with trapezoidal cross-sections. The legs are connected to a 1.50 m wide web whose surface was to be formed with a profiled structure. The outer sides of the trapezoidal-shaped legs are constructed with a small inclination in both longitudinal and transverse directions, while the web width is a constant 1.50 m.

The 7.50 m high pier heads are spread outwards in a V-shape and change their cross-sections from trapezoidal to rectangular.

In spite of the difficult geometrical and aesthetic requirements, a cost-effective 3-day climbing cycle using the VARIO GT 24 girder wall formwork on SKS climbing brackets delivered directly to the construction site could be achieved which resulted in outstanding concrete results.

Structured matrixes inserted into the VARIO GT 24 formwork elements by the construction crew ...

... resulted in excellent detailed concrete surfaces.

The vertical profiles which run over the height of the piers enhance the visual appearance.

Architectural concrete requirements

- Complicated, upward-tapering pier form with defined anchor pattern.
- Pier head with octagonal cross-section which widens below the superstructure into two rectangular cross-sections.
- Changing concrete surface structure, partially grooved, otherwise smooth and light coloured.

Solution

- Prefabricated VARIO GT 24 girder wall formwork delivered to the jobsite.
- Pre-determined positioning of the anchoring points for the climbing brackets.
- Structured matrixes inserted into the formwork by the construction crew.

Canal Bridge, Waterway Intersection, Magdeburg, Germany

A total of 17 piers – rounded like ships bows – carry the so-called river bridge. It carries the waterway with the help of two pairs of riverside piers for a length of 228 m across the Elbe. The main supporting members of this masterpiece of construction were to be constructed in smooth industrial architectural concrete with defined formlining joints and tie arrangements.

Canal Bridge, Waterway Intersection, Magdeburg, Germany

Massive piers for water-carrying bridge construction

The foreland piers were realised in carefully conducted concreting cycles using VARIO girder wall formwork ...

... resulting in a very accurate construction as well as in the required surface quality.

As part of the complete waterway intersection, the longest canal bridge in Europe forms a direct connection between the Elb-Havel canal and the Mittelland canal. The spectacular structure consists of two main structural elements: the 690 m long and 34 m wide foreland bridge that rests on 17 piers – rounded like ships bows – as well as the so-called river bridge that leads the waterway over the Elb with the help of two pairs of riverside piers with a length of 228 m.

For the pier front sides, VARIO GT 24 elements were brought pre-assembled directly to the construction site and could be adapted very quickly on site to the required concreting height via extension splices. Reliable support was provided by RS push-pull props. The decision to work with VARIO was taken not least because of the specified architectural concrete quality. 27 mm acid-free solid birch panels were selected, which were partially supplemented with coarse-grained plaster-structured matrixes for softening the appearance of the subsequent visible concrete surfaces. At the same time, the effect of a small number of tie points on the architectural concrete finish is insignificant as the VARIO system allows appropriate positioning of the ties to be carried out.

Architectural concrete requirements

- Long-term resistance against enviromental influences, therefore no bleeding from the tie points.
- Industrial architectural concrete with a smooth and light coloured surface.
- Exact positioning of the tie points.

Solution

- Project-related VARIO GT 24 girder formwork with 27 mm acid-free solid birch panels.
- Partial use of coarse-grained plaster-structured matrixes with sealed form-lining joints using sealing tape.
- Customised and pre-assembled VARIO elements with anchor positions taken into consideration.

Contractors
Arge Kanalbrücke Magdeburg
Bilfinger + Berger Bau AG, Dillinger Stahlbau GmbH
Bilfinger + Berger, Schalungsbau Roxheim
Field Service
PERI Magdeburg and Stuttgart, Germany

Under operating conditions, the four piers have to accommodate around 13,000 t of steel bridge in each case. After careful sheet piling and subsequent flat foundation, the river piers quickly rose above the surface of the water using VARIO GT elements on SKS climbing brackets. Adapting the formwork to the current-optimised and upwardly-tapering cross-section was carried out by cutting back the elements from cycle to cycle.

The original plan to connect the Rhine and Oder rivers to each other by a navigable waterway was conceived in 1934. The plan was taken up again and, after being redesigned to suit modern-day requirements, was put into effect.

By means of the VARIO GT 24 system, KG climbing brackets, MULTIPROP system and TRIO panel formwork, the construction team accurately realised the abutments of the river bridge and in the required concrete quality.

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