VTC Tunnel Formwork Carriage

VARIOKIT system solutions for cut-and-cover and mining techniques

Product Brochure – Issue 04/2019

Content

Issue 04/2019

Publisher

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Important Information

All current safety regulations and guidelines applicable in those countries where our products are used must be observed.

The images shown in this brochure feature construction sites in progress. For this reason, safety and anchor details in particular cannot always be considered conclusive or final. These are subject to the risk assessment carried out by the contractor.

In addition, computer graphics are used which are to be understood as system representations. To ensure a better understanding, these and the detailed illustrations shown have been partially reduced to show certain aspects. The safety installations which have possibly not been shown in these detailed descriptions must nevertheless still be available. The systems or items shown might not be available in every country.

Safety instructions and load specifications are to be strictly observed at all times. Separate structural calculations are required for any deviations from the standard design data.

The information contained herein is subject to technical changes in the interests of progress. Errors and typographical mistakes reserved.


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VARIOKIT system solutions for cut-and-cover method and mining techniques

With the VTC Tunnel Formwork Carriage, based on the VARIOKIT Engineering Construction Kit, customised and material-optiszed solutions for cut-and-cover and mined tunnel construction can be realised. In the process, monolithic, semi-monolithic or separate casting methods can be executed. With rentable VARIOKIT system components, changing cross-sections in the project can be easily and cost-effectively constructed with only short modification times required.

As every tunnel structure has its own special requirements, the tunnel formwork carriage solution always requires project-related planning. With its extensive know-how and expertise, PERI provides not only the required materials but also the complete planning services from a single source. PERI solutions take into account building and assembly processes and provide the maximum functionality for the construction work. With well-engineered technical planning, PERI offers cost-efficient solutions that are optimised on a project-specific basis and are precisely tailored to meet the requirements of the jobsite. Whether it is access portals for trucks or single-sided wall formwork - such requirements can easily be fulfilled with VARIOKIT. Optimised technical project solutions with VARIOKIT and services from one source accelerate the work process enormously.

The optimised tunnel modular construction kit can be universally and conveniently configured for high-performance project requirements. The 125-mm grid arrangement of the core components allows easy adaptation to meet the requirements of the jobsite. The simple and site-specific installation with pin connections also accelerates the construction work. The statically optimised design facilitates reduced material use with the same or increased performance.

The PERI pre-assembly service allows quick and easy assembly of the formwork carriage. Formwork elements are delivered to the construction site already set up.

The improved economic efficiency and the great flexibility of the VTC Tunnel Formwork Carriage ensure easy and simple assembly procedures during tunnel construction.

Cut-and-cover, semi-monolithic construction method

Cut-and-cover, separate casting method

Mining, semi-monolithic construction method

VTC Tunnel Formwork Carriage

Thanks to its easy handling combined with PERI engineering expertise, the VTC Tunnel Formwork Carriage always provides a clever and tailored project solution. Due to the flexible VARIOKIT Modular Construction Kit and the VTC system components for tunnel construction, the system can be flexibly adapted to match a wide range of tunnel cross-sections and designs.

The VTC Tunnel Formwork Carriage is an optimised project solution that accelerates the work process enormously. Depending on the project, it is possible to choose between an entirely manual operation or one completely equipped with hydraulic equipment. With hydraulic equipment for shuttering and striking, the efficiency of the application can be increased. Workloads are minimised for positioning, striking and moving operations.

With a range of other optional features, the performance of the tunnel formwork carriage can be adapted to suit a diversity of requirements.

Clever solutions for different project requirements

Project-specific optimised, with rentable VARIOKIT components

Fast working operations

Simple shuttering and striking operations and easy positioning of the formwork carriage, as well as flexible options for moving procedures

Individually configurable – according to customer requirements

Various equipment combinations and assembly services

Lifting and lowering unit

The tunnel formwork carriage can be hydraulically lifted and lowered using the hydraulic cylinder or mechanically by means of the Hydraulic Bottle Jack.

The smooth-running Hinge Slide facilitates easy and fast positioning of the formwork carriage.

The automatic inclination adjustment in transverse and longitudinal directions always ensures vertical alignment without requiring any additional wedges.

Version 1
Easy and simple handling when using the lifting and lowering unit with the hydraulic cylinder.

Version 2
Comfortable and convenient use also with the manually operated Hydraulic Bottle Jack.

Heavy-duty wheels and hydraulic drive

Depending on requirements or project complexity, the formwork carriage can be moved mechanically using heavy-duty wheels or with hydraulic drive

High-quality heavy-duty wheels ensure quiet operating smoothness when moving the formwork carriage.

Version 1
A U-rail or a crane rail with a "wheel flange cage" attachment can be used as a travel profile.

Version 2
Simple operation through the hydraulic drive – no construction site vehicle is required for the moving procedure.

Telescopic Prop

When adapting to changes in the cross-section, the patented Telescopic Prop can be quickly adjusted to match the correct length in only a few simple steps.

The streamlined design reduces the dead weight of the formwork carriage with a high load performance still guaranteed.

Thanks to the Telescopic Prop, the main supporting structure can be retained also after changing to a much larger cross-section.

VTC application advantages and detailed solutions

The modular VARIOKIT system can be adapted to suit different site conditions and to accommodate various areas of application.

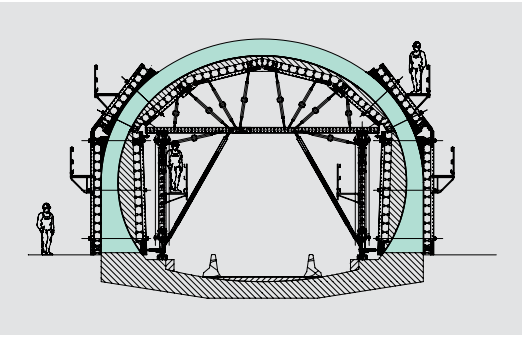
Smart engineering solutions with a folding mechanism allow PERI UP back-propping, resulting in early moving of the formwork carriage.

The VTC Tunnel Formwork Carriage can be flexibly adapted to suit individual project requirements of cut-and-cover, semi-monolithic construction. Thanks to modular VARIOKIT core and system components, tailored configurations of tunnel geometries and boundary conditions, e.g. drive-through access openings, are possible.

The combination of proven systems, such as VARIO GT 24, SRU Steel Walers, RCS Rails or the Diagonal Strut, result in cost-effective formwork carriages Different supporting structure systems can be realised according to the occurring loads.

The advantages of the PERI VARIOKIT Formwork Carriage:

- load-optimised supporting structure thanks to the flexible VARIOKIT modular system
- fewer anchors in the wall areas
- easy modification to accommodate different cross-sections
- optional with hydraulic support for shuttering and striking as well as lifting and lowering
- hydraulically self-propelled or manually movable solutions to move complete units



Circular cross-sections are just as possible as separate individual formwork carriages for walls and slabs.

In accordance with the occurring loads, it is possible to realise supporting structures with diagonal struts or trusses with the Vertical Post.

Project examples

A96 Gallery, Germering-Gilching, Germany
Realisation of a tight construction schedule through safe and efficient handling of the formwork systems used

The foundations for the two structures were concreted using a specially designed VARIOKIT Foundation Formwork Carriage while the architecturally striking V-piers were constructed by means of the VARIOKIT Engineering Construction Kit and specially made timber formers.

In the Germering section, 76 casting segments with lengths of 12.50 m were realised with three VARIOKIT Tunnel Formwork Carriages. After the concreting sections were completed in Germering, two VARIOKIT Tunnel Formwork Carriages were re-located to Gilching in order to construct 41 casting segments, each of which is also 12.50 m long. Due to the local conditions, mobile external formwork was assembled using the VARIOKIT Engineering Construction Kit for the Gilching jobsite in the direction of Munich. The weekly cycle on the construction sites was shortened by movable temporary support using PERI UP Heavy-Duty Props, which facilitated early striking operations.

The CB160 Climbing Formwork System was used to form the northern cantilevered parapet efficiently. Construction progress of the southern cantilevered parapet was optimised by the advanced-positioned PERI UP Reinforcement Carriage and the top-running VARIOKIT Cantilevered Parapet Carriage.

The short jobsite lead time required pre-assembling the tunnel formwork carriages, V-piers, niche formwork, internal elements for the portal formwork and the cantilevered parapet formwork using PERI's ready-to-use service.

Enclosure Structure for the A10 Motorway, Zederhaus, Austria
Smooth operations using PERI solution specifically modified for the project

With standardised, rentable VARIOKIT system components and construction-compliant connecting means, supporting structures can be cost-effectively erected and adapted geometrically to suit the respective structure. The double-arch tunnel tube was constructed using the cut-and-cover method. For this, PERI provided a cost-effective formwork solution on the basis of rentable VARIOKIT standard and special components.

Heavy-duty wheels on crane rails facilitated fast moving operations for the centre wall formwork carriage. Hydraulic equipment for shuttering and striking reduced the workload when raising, lowering and folding up the wall elements. Thus, a total of 125 concreting sections - each with a length of 12.50 m per tube were mastered effortlessly. Two standard casting segments could always be concreted in one working step.

Project examples

Reinertshof Tunnel, Füssen, Germany
Alternating sequential concreting accelerates construction progress

One of the most important highway connections in Europe is the A7 motorway. It runs for almost 1,000 km from Denmark to Austria and through Germany in a north-south direction. With the construction of the Reinertshof Tunnel near Füssen, the final gap leading up to the Austrian border was filled.

The 645-m-long tunnel with a double-tube rectangular cross-section was constructed using the cut-and-cover method. With two formwork sets, the advanced section - which was three cycles ahead – was concreted at the same time as closing the remaining gap, with a length of 8 m in each case. This accelerated the construction progress and reduced the actual site length from the foundations to the finished tunnel to a maximum of 48 m. Walls and slabs could be constructed semi-monolithically in one working stage with the PERI Tunnel Formwork Carriage.

The VARIOKIT Modular Construction System with mostly rentable standard components was used here. Vertical support was provided by HD 200 Heavy-Duty Props. SRU Steel Walers and RCS Climbing Rails were used very cost-effectively as wall steel walers and slab beams. VARIOKIT Diagonal Bracing functioned as pressure joints.

The wall formwork could be hydraulically retracted on both sides by 10 cm. By means of the raise and lowering equipment, the complete carriage could also be hydraulically lifted into the required concreting position and subsequently lowered again. Electric drive units from the VARIOKIT range of accessories ensured fast moving operations to the next cycle. The fact that only three rows of ties were needed in the walls resulted in an additional time advantage.

U4 Subway Tunnel, Hamburg, Germany

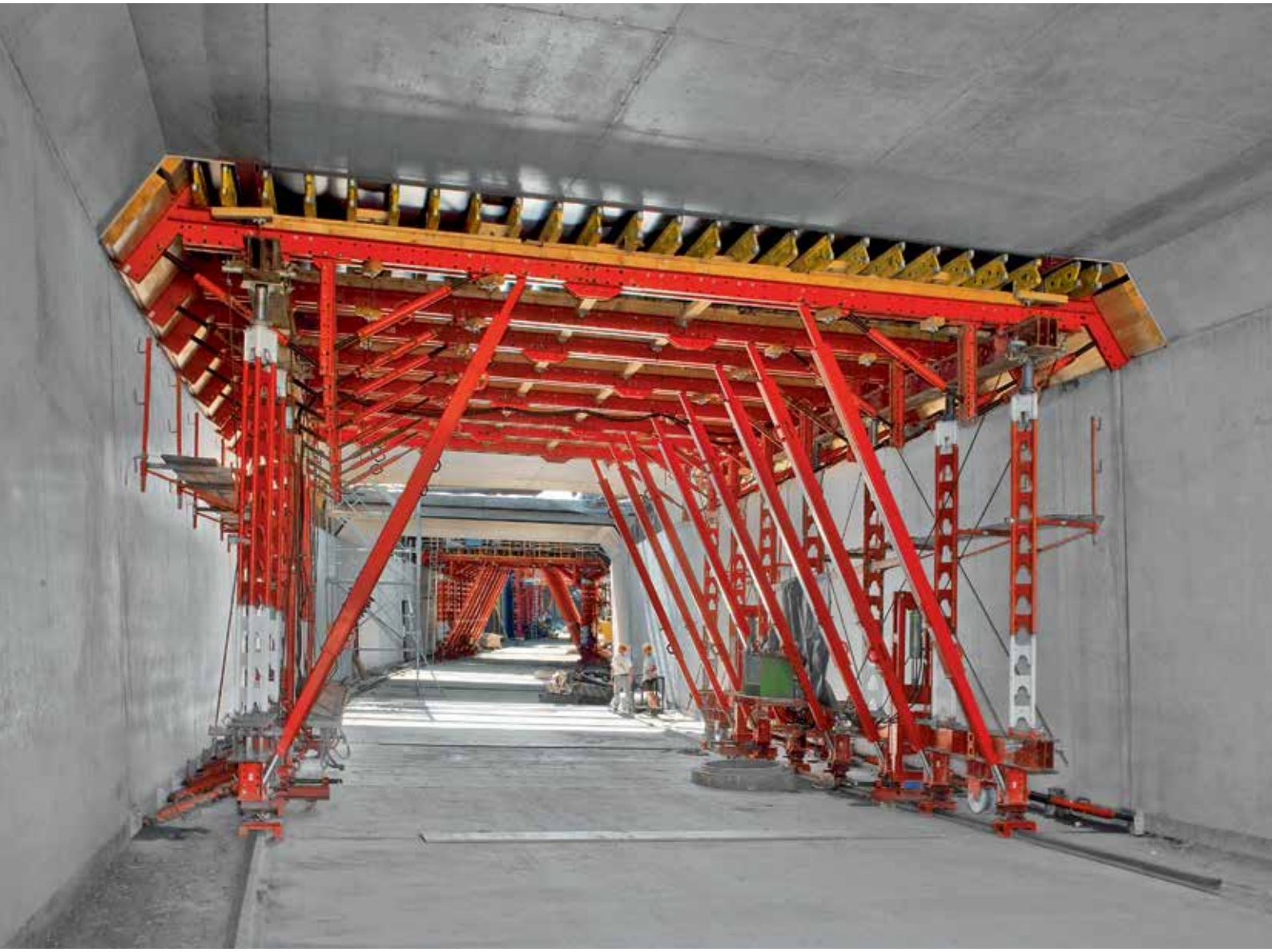
Hamburg's longest construction site: from HafenCity to the Elbe Bridges in weekly cycles

With Hamburg's longest construction site, the U4 line was extended by 1.3 km from the HafenCity University in the direction of the Elbe Bridges. The 710-m-long tunnel was constructed using the cut-and-cover method by the skeleton construction and special civil engineering team of the Max Bögl Group. Trough and tunnel construction took place up to depths of 20 m within a diaphragm wall excavation pit.

With the help of a VARIOKIT Tunnel Formwork carriage, the 71 sections were formed and concreted in weekly cycles – walls and slab in one pour.

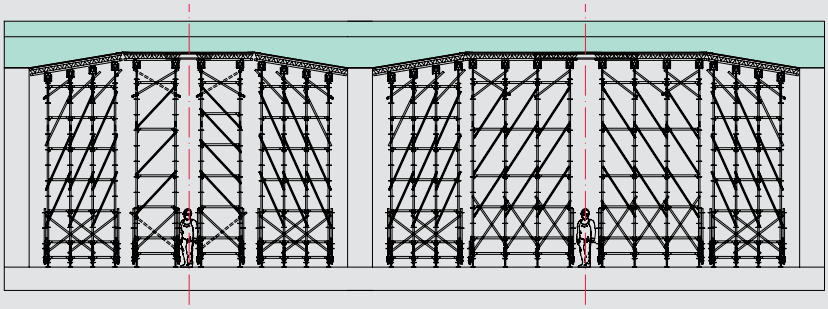
PERI engineers created a customised project solution based largely on system components. As the walls had to be concreted single-sided against the diaphragm walls, transferring the high loads within the formwork carriage construction was required. In addition, the formwork carriage could be adjusted to match the variable cross-section widths and heights.

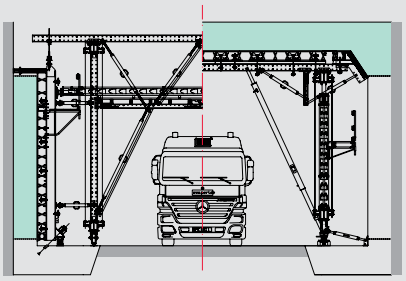
VTC application advantages and detailed solutions



With the separate casting method, the simplest way of constructing tunnels using the cut-and-cover procedure, the advantages of the VARIOKIT Construction Kit really come into their own. Through the possibility of being able to rent the system, a mobile moving unit pays off even if only a few cycles are required.

Cost-effective formwork solutions, as well as tunnel cross-sections with variable dimensions, are the standard applications of the separate casting method. All PERI wall and slab formwork systems can be used here. Mobile solutions are normally realised with VARIOKIT components.





Clearly visible are the 2 separate concreting cycles: the wall on the left and the slab on the right. Both sets of formwork are designed as mobile units.

Technical processing
Well-engineered technical planning allows economical and efficient solutions which are precisely tailored to meet the requirements of the construction site. Whether it is access portals for trucks or single-sided wall formwork with overhead support, such solutions are problem-free with VARIOKIT.

Wall formwork
The wall formwork is comprised of components such as waling, girders, accessories and anchoring systems, which are available in the PERI VARIOKIT standard programme. Thereby, the wall formwork offers considerable design possibilities and can also be configured to accommodate high concrete pressures. This allows fast concreting operations with high form stability.

Slab formwork
A project-related slab formwork carriage usually consists of one VARIOKIT load-carrying system and the formwork level. VARIO GT 24 Girder Wall Formwork is frequently used for the formwork level.

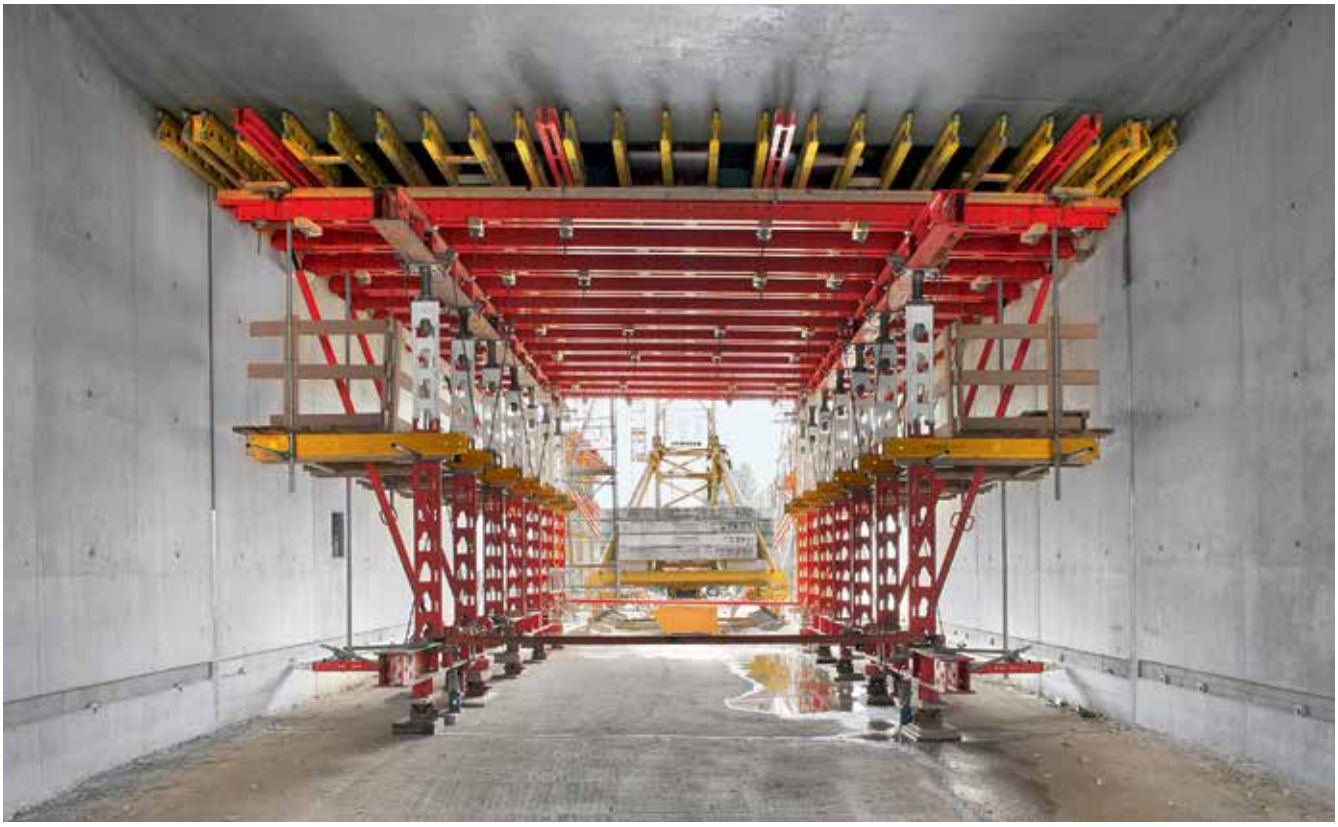
Project examples

Marieholm Tunnel, Gothenburg, Sweden
100-m-long segments based on the modular design principle

The steadily increasing volume of traffic in Sweden's second-largest city has significantly calmed down due to the new underground road. The tunnel under the Göta älv river consists of 3 segments, each 100 m long, 10 m high and 30 m wide. They were realised with the help of the VARIOKIT Engineering Construction Kit in an upstream dry dock. For these segments and the tunnel exits, PERI and Züblin Scandinavia AB jointly planned project-specific formwork solutions based on the VARIO GT 24 Girder Wall Formwork. The internal wall was formed using TRIO Panel Formwork.

When forming the arches and slabs, two PERI Tunnel Formwork Carriages ensured fast and cost-effective procedures. Heavy-duty wheels and crane rails were used to move the almost 25-m-long formwork carriages, whereby the advantages of the flexible, lightweight and separable VARIOKIT formwork carriage were ably demonstrated in the narrow working space.

For the rounded arches in the upper area of the tunnel, the PERI team developed special elements. Here, the SCS Climbing System supported the external wall formwork. PERI UP Flex Stair Towers and reinforcement scaffolding guaranteed safe and easy access to the dry dock, as well as various working areas. Last but not least, the PERI option regarding material rental really paid off. As a result, it was possible to plan the specific project requirements accurately and cost-effectively. Construction site operations were on schedule and always with the correct quantities of materials.



Zwickau Tunnel , Germany
Adaptable, easy to handle and quick to move – with VARIOKIT in weekly cycles in both directions.

A 380-m new tunnel for an inner city underpass on the B93 motorway relieves the residents of noise and exhaust fumes while also optimising local flood protection measures. The four-lane expansion also allowed the creation of open green areas between the city centre and Mulde river.

Starting from Construction Phase 14, the construction crew worked in weekly cycles in both directions using the separate casting method. Thereby, the bottom plate, walls and slab were constructed one after another, with each concreting section being 10 m long. Four VARIOKIT Formwork Carriages were used to form the tunnel slabs – one for each tube and direction respectively.

Based on the jobsite requirements, PERI engineers used the VARIOKIT Engineering Construction Kit to develop customised formwork solutions using rentable standard components from the PERI product range, including HD 200 Heavy-Duty Props and RCS Waling. The side slab elements were moved mechanically – this reduced the width of the formwork carriage while simplifying and accelerating the striking and moving operations.

VTC application advantages and detailed solutions

As a general rule, a formwork carriage for mined tunnels using a semi-monolithic construction method must fulfil very high requirements regarding wet concrete pressure and dimensional accuracy.

For shorter tunnels (up to approx. 40 sections), and in the area of widened sections, formwork carriages assembled from rentable system parts are used. It is particularly with the use of these standard components that the advantages are clearly demonstrated with short operating times or very few sections. Rentable components, also for high loads, hydraulic control elements and electric drive units make the standard carriage very easy to use.

For mined tunnels, access portals are an important prerequisite for use.

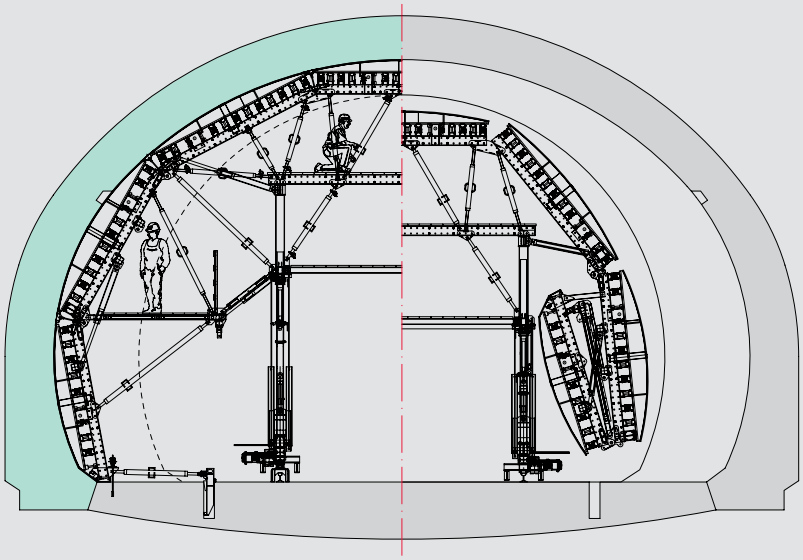
The PERI UP Scaffold System offers all possibilities - from a simple stair tower through to a complete post-treatment carriage.

High permissible concrete pressure

Mined tunnel formwork carriages safely accommodate wet concrete pressures of up to 120 kN/m².

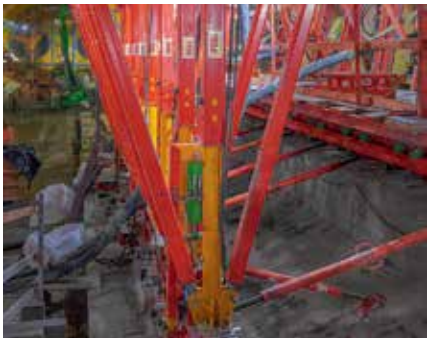
Project-specific adaptation to accommodate a wide range of geometries

PERI Formwork Carriages are also suitable for use in special tunnel areas such as emergency bays or subway stations.



This tunnel formwork carriage can fold itself in order to match the passage dimension of the standard cross-section, move laterally along the correct axis (with the help of the lifting and lowering unit) and subsequently move forward. After this, it is moved sideways again and brought into the concreting position.

Optional VARIOKIT accessories such as the hydraulic drive, lifting and lowering unit, as well as hydraulic cylinders for operating the wall and slab formwork elements, are available in the VARIOKIT Construction Kit and are planned according to project requirements as needed.



The VARIOKIT Telescopic Prop facilitates easy length adjustment.

Project examples

Bypass Tunnel, Sochi, Russia
Load-bearing tunnel formwork carriage with flexible construction

The bypass circumvents the city centre and is one of the infrastructure construction measures for the 2014 Olympic Winter Games at the Black Sea health resort of Sochi. This required construction of the 2.6-km-long tunnel using mining methods. The standard cross-section of the tunnel was designed for two lanes and is 10.80 m wide and 7.95 m high. Six emergency parking bays, each 54 m long, require an alternately arranged widening of the tunnel by 3.50 m to 14.30 m. For striking and the rail-guided moving procedure to each subsequent casting segment of a parking bay, the side formwork of the VARIOKIT Tunnel Formwork Carriage was folded hydraulically and the complete carriage was lowered. In this way, each of the emergency parking bays was constructed in six 9-m-long concreting sections in weekly cycles. To move the formwork carriage forward from one emergency parking bay to the next, the VARIOKIT construction had to pass through the substantially smaller standard cross-sections. This required a significant decrease in the maximum external dimensions. The width of the formwork carriage had to be reduced from 14.30 m to 10.10 m and the height reduced from 8.70 m to 7.60 m. For this procedure, PERI engineers developed an accurately defined working sequence by which the formwork segments could be hydraulically folded and lowered before being moved. The alternating arrangement of the bays for the right and left lanes required an additional lateral offset of 1.75 m from the tunnel cross-section axis. Therefore, a horizontal adjustment unit mechanism was integrated in the lifting and lowering unit which served to move the carriage sideways onto a second track.

In addition to the hydraulic control system, the processes chosen for concreting and compressing the concrete also accelerated the construction process: use of the PERI Concreting Stud greatly reduced concreting times, while the use of external vibrators resulted in excellent surface quality. Although all the technology was completely new to the construction crew, striking and the moving process was still carried out safely and quickly.

"Place de Martyrs" Metro Station, Algiers, Algeria

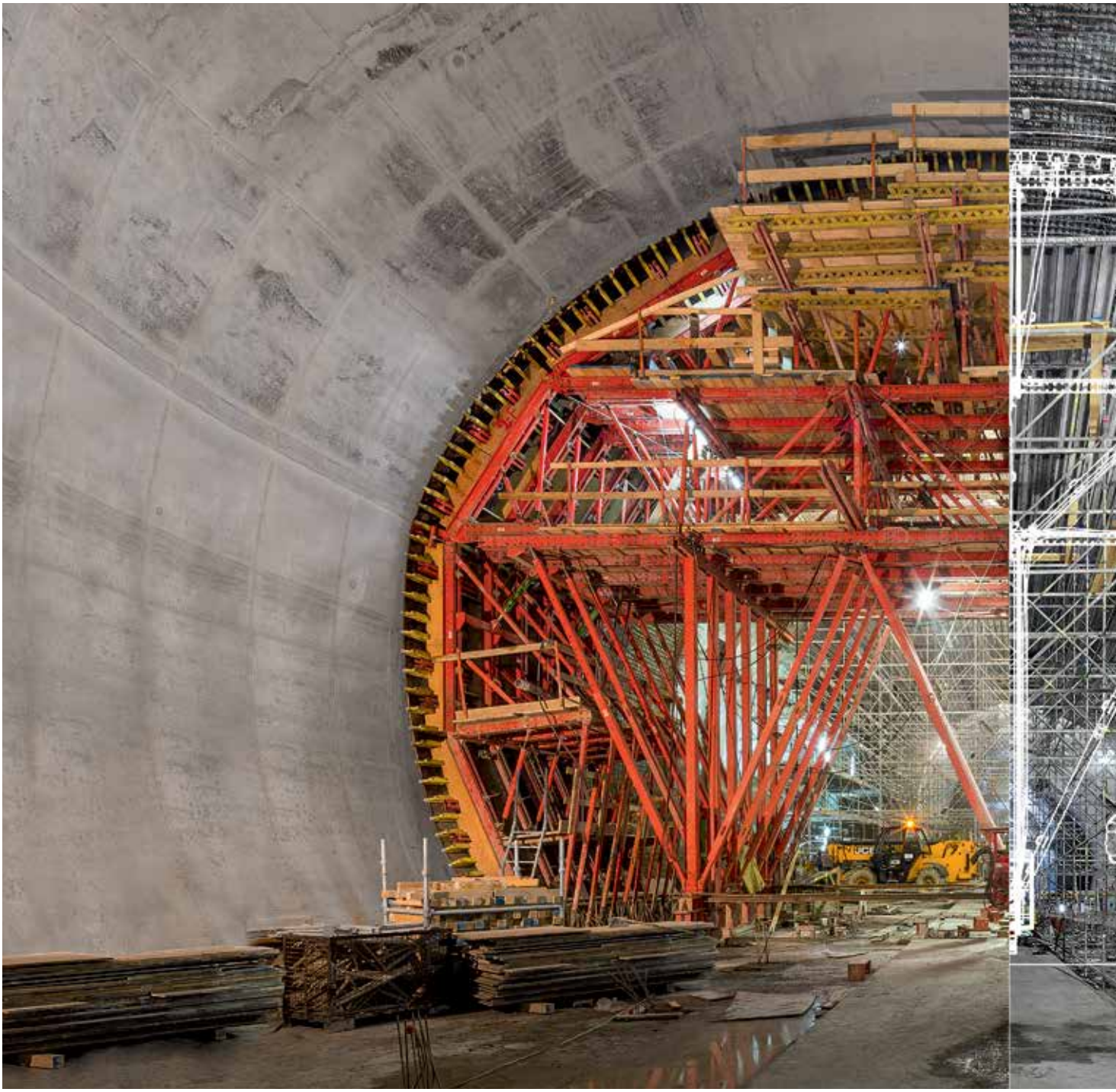
Tunnel formwork with record-breaking dimensions

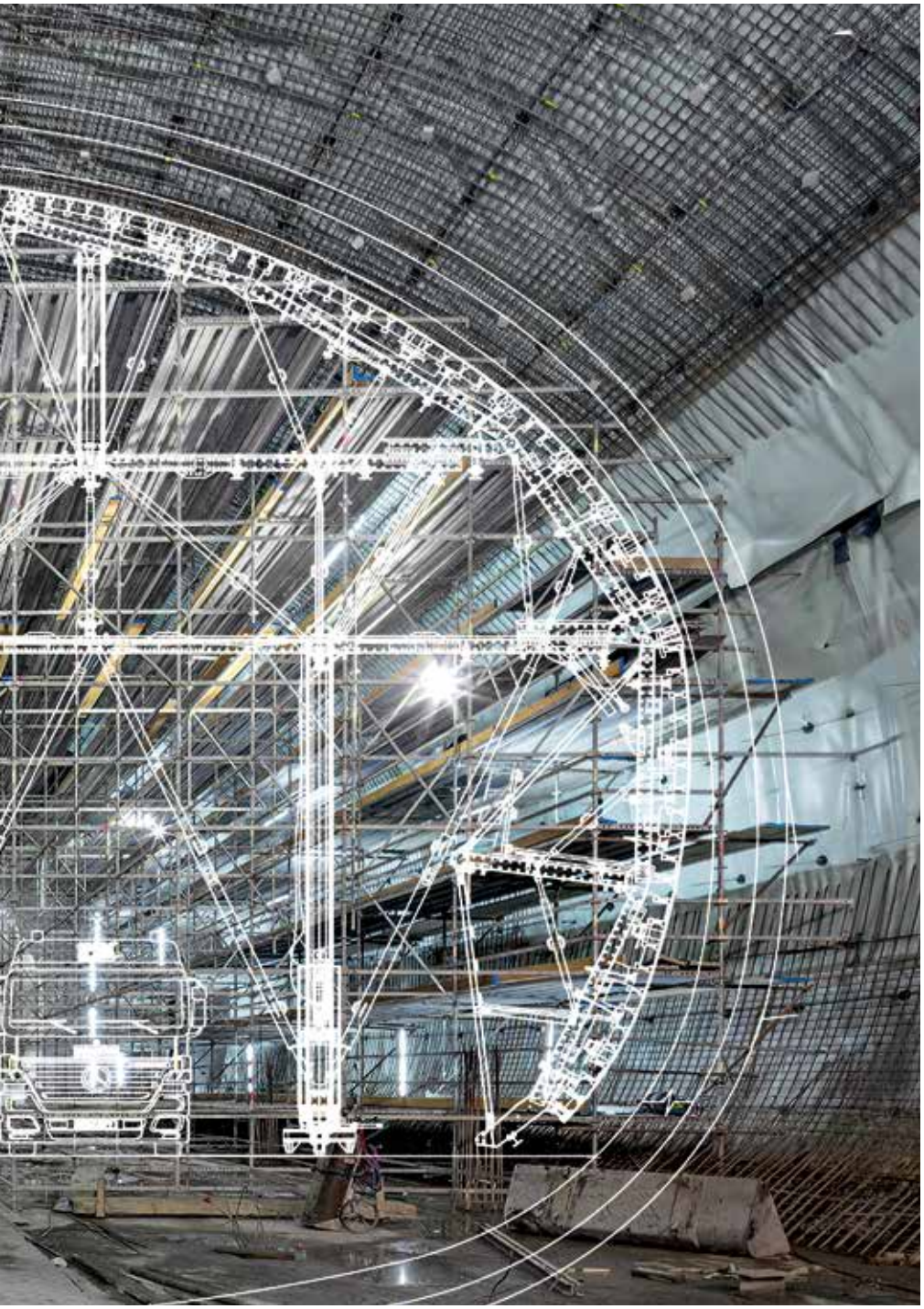
The "Place de Martyrs" metro station in the Algerian capital boasts some very impressive dimensions. For the construction, the PERI formwork carriage solution based on the VARIOKIT Engineering Construction Kit was customised to create an optimal solution for the specific jobsite requirements, and was operated hydraulically.

144 m long and 23 m wide, the "Place de Martyrs" is one of the largest subway stations in the world. It is the northernmost but also the most central station - as well as being the closest to the harbour area - of the extensive metro expansion project within the city centre with numerous mosques and palaces, as well as being directly below the historic old town (Kasbah). In a period of 10 years, the metro network of the Algerian capital is to be expanded and modernised from the current length of 9 km to a total of 55 km.

The imposing arch width of 23 m in the middle section, tapers in the northern and southern directions resulting in 16.50-m widths respectively. PERI engineers developed a formwork carriage construction based on the VARIOKIT Engineering Construction Kit to realise both cross-section variants cost-effectively, while using the same system components and formwork segments. Due to the relatively short 5.10-m concreting cycle lengths, special attention was paid to the design of the bracing measures. The VARIOKIT tunnel formwork solution was customised to create an optimal solution for all jobsite requirements:
easy to use because it can be operated hydraulically with a control panel;
cost-effective due to rentable system components, as well as quick to assemble or adapt by means of standardised bolted connections. Supplementing this was PERI UP working scaffold. This was optimally adapted to match the cross-sectional geometry of the arch and ensured rapid and safe execution of the waterproofing and reinforcement work in advance of the tunnel formwork carriage.

VARIOKIT system solutions and services from one source





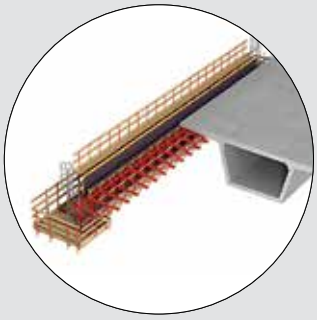
All bridge and tunnel constructions require project-related planning. With its extensive know-how and expertise, PERI not only provides the required materials but also the complete planning services from a single source.

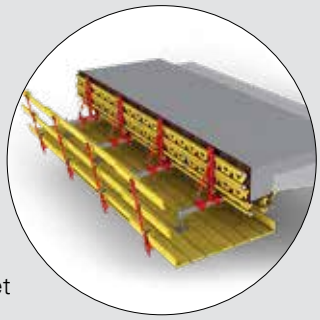
PERI solutions take into account building and assembly processes along with the maximum functionality for the construction work. With well-engineered technical planning, PERI provides cost-efficient solutions that are optimised on a project-specific basis and are precisely tailored to meet the requirements of the jobsite. Technical project solutions with VARIOKIT and services from one source accelerate the work process enormously.

Applications with the VARIOKIT Engineering Construction Kit

VARIOKIT solutions are typically comprised of around 95 % rentable core and system components. In order to fulfil specific project requirements, only a few special components are needed.

VGB Parapet Track





VGK Cantilevered Parapet Bracket

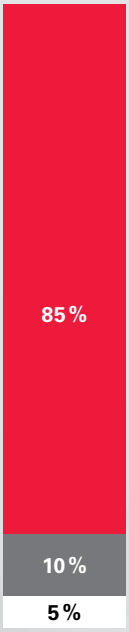
VGW Parapet Carriage

VCB Cantilever Brackets

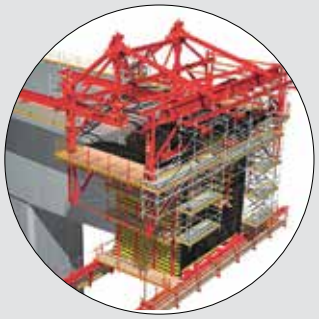
VTC Tunnel Formwork Carriage

VRB Heavy-Duty Truss Girder

VST Heavy-Duty Shoring Tower



85 % core components
10 % system components
5 % special components



VBC Balanced Cantilever Equipment

VIL Incremental Launching Facility

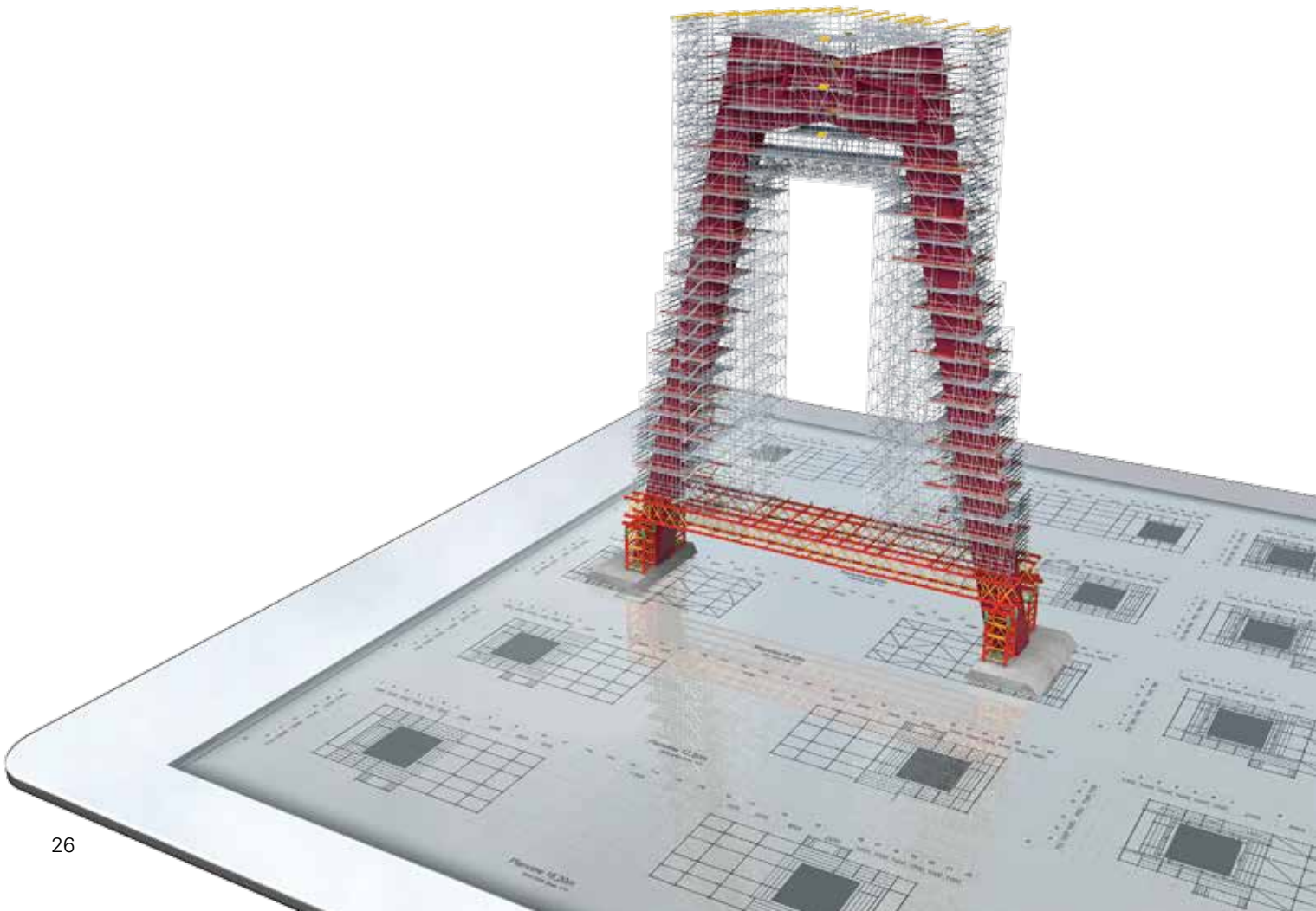
VCC Composite Formwork Carriage

Individual services for customised bridge and tunnel construction

In addition to the required materials, PERI also provides a comprehensive range of expertise, as well as the complete planning services from a single source. PERI solutions take into account building and assembly processes along with the maximum functionality for the construction work. For the planning, PERI pays great attention to maximising utilisation of the rentable core and system components, in order to provide customers with particularly cost-effective solutions.

Around 1,300 PERI engineers worldwide plan and design formwork and scaffolding solutions for cost-effective executions. All PERI Engineering planning services are aimed at ensuring that PERI formwork and scaffolding systems in construction operations are always used in line with time, cost and quality standards. The basis for this is the execution plan records, which are based either on 2D-views and sections or realistically visualised 3D building models. As a result, technical solutions are developed with customers that optimise the use of materials and the construction process itself.

These planning-related services from PERI Engineering are supplemented by verifiable, static calculations as proof of stability for formwork and scaffolding operations, as well as by project-specific installation and assembly plans for the professional implementation of special applications. Construction site personnel can use the plans to assemble the individual PERI components correctly and prepare them for use.



A consistent CAD planning process is realised by bundling the formwork and scaffolding planning.

Implementation plans are coordinated, and it becomes much easier and quicker to organise subsequent plan changes and put them into practice.

PERI supervisors also explain plans and parts lists along with providing information on the maintenance, cleaning and storage of PERI materials. If required, they will provide the construction team with comprehensive on-site support to ensure efficient use of PERI system equipment from the very start.

In order to minimise on-site assembly times and maintain tight construction schedules, PERI also provides – if required – pre-assembled units to the construction site. VARIOKIT is extremely cost-effective, especially with short utilisation times, thanks to the rentable components and assembly advantages.

When it comes to BIM, PERI has been one of the leading companies in the industry for many years now and can already show a number international project references that have been successfully developed with customers using BIM principles.

Through the additional integration of the time and cost factors, the 3-dimensional visualisation of the planning gradually turns into a 4D or 5D model.

Additional process data relating to formwork and scaffolding technology, such as required plan changes, automated collision checks, safety checklists and QR codes for object navigation, is documented and tracked in a mobile building information management system. All relevant data is available on the construction site via tablet solutions for day-to-day operations.

The optimal System for every Project and every Requirement

Wall Formwork

Column Formwork

Slab Formwork

Climbing Systems

Bridge Formwork

Tunnel Formwork

Shoring Systems

Construction Scaffold

Facade Scaffold

Industrial Scaffold

Access

Protection Scaffold

Safety Systems

System-Independent Accessories

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