e-mosty

ISSUE 02/2025 JUNE

GERMAN BRIDGES

LIST OF CONTENTS

Front Cover: Schorgasttal Bridge Photo Credit: BPR Dr. Schäpertöns Consult GmbH & Co. KG

Back Cover: Footbridge Mühlensteg in Besigheim Photo Credit: sbp

---

International, interactive magazine about bridges
e-mosty ("e-bridges"). Peer-reviewed.

It is published at www.e-mosty.cz. Open Access.

Released quarterly:

20 March, 20 June, 20 September and 20 December

Number: 02/2025, June **Year:** XI.

Chief Editor: Magdaléna Sobotková
Contact: magda@e-mosty.cz

Editorial Board

Publisher: BRIDGES ONLINE, s.r.o. (Ltd.)
Velká Hraštice 112, 262 03 Czech Republic
VAT Id. Number: CZ02577933

E-MOSTY ISSN 2336-8179

Dear Readers

This special issue is dedicated to ***German Bridges****.*

We prepared several articles about bridges in Germany, in which we focus on various aspects of their architecture, design, construction and maintenance. Some articles are accompanied by drawings, videos and Construction Galleries.

I would like to thank our Editorial Board, especially ***Richard Cooke,*** *for their assistance with this edition and review of the articles.*

We also thank ***our partners*** *for their continuous support.*

The September e-mosty edition will be about the ***Danjiang Bridge*** *in Taiwan, which is under construction. We will bring articles about its architecture, design and construction.*

The next e-BrIM will be released on 20th October.

In autumn 2025, we are going to publish one e-BrIM edition in Spanish and as of 2026, we are going to prepare at least ***one edition a year in Spanish****. If you are interested to cooperate with us and help us, especially with the review and language check of articles in Spanish, please contact me. I would very much appreciate some help with it.*

I am working on SEO and also rewriting content descriptions at both e-mosty.cz and e-brim.com so that the content can be more easily found on the websites and by search engines.

We welcome your articles for the e-mosty & e-BrIM magazines for publication in 2026, both in English and Spanish. You can find ***instructions for authors*** *on our website. You can contact me at magda@e-mosty.cz.*

Magdaléna Sobotková

Chief Editor

INTERNATIONAL ONLINE PEER-REVIEWED MAGAZINE ABOUT BRIDGES

e-mosty

SUBSCRIBE

The magazine **e-mosty** (“e-bridges”)
is an international, interactive,
peer-reviewed magazine about bridges.

It is published at www.e-mosty.cz and can be read
free of charge (open access)
with the possibility to subscribe.

It is published quarterly: 20 March, 20 June,
20 September and 20 December.
The magazines stay **available online**
on our website as pdf.

The magazine **brings original articles about bridges
and bridge engineers** from around the world.
Its electronic form enables the publishing
of high-quality photos, videos, drawings, links, etc.

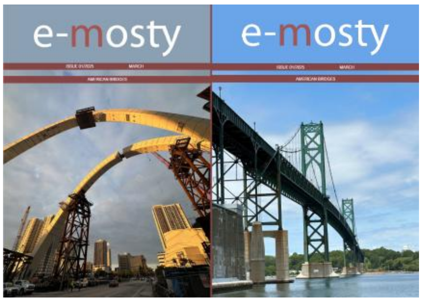
We aim to include **all important and technical
information** and show the grace and beauty
of the structures.

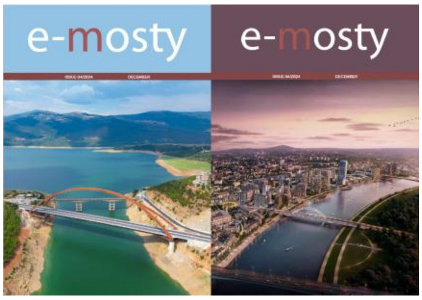
We are happy to provide media support for important
bridge conferences, educational activities, charitable
projects, books, etc.

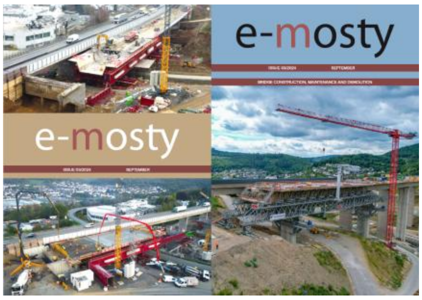
Our Editorial Board comprises bridge engineers
and experts mainly from the UK, US and Australia.

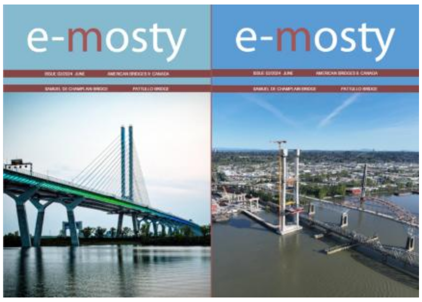
The readers are mainly bridge engineers, designers,
constructors and managers of construction
companies, university lecturers and students,
or people who just love bridges.

READ OUR LATEST EDITIONS









ISSN: E-MOSTY 2336-8179

OUR PARTNERS

AAS-JAKOBSEN

ALLPLAN
A NEMETSCHEK COMPANY

ARENAS
& ASOCIADOS

ARUP

BERD®
ONE BRIDGE, ONE SOLUTION

BRIDGE DRAINAGE

BSR | BPR
Dr. Schäpertöns Consult

BRUGG
Fatzer

Dlubal

DIAMANT
POLYMER SOLUTIONS

DYWIDAG

Leonhardt, Andrä und Partner
Beratende Ingenieure VBI AG

MAURER

ponting
bridges

Pipenbaher
Consulting Engineers
PIPENBAHER INŽENIRJI d.o.o., Slovenia

ROSALES+
BRIDGES AS STRUCTURAL ART

RÚBRICA®
BRIDGES

STRUKTURAS

TYLin

WE COOPERATE WITH

structurae

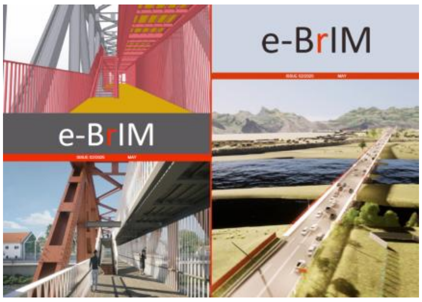
Frank Bauchspiess
steel bridges - engineering

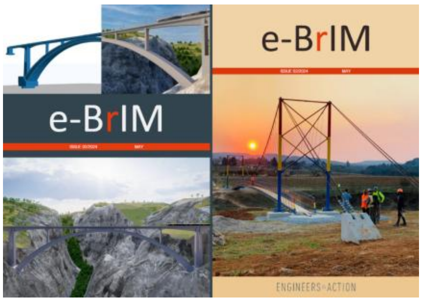
INTERNATIONAL ONLINE PEER-REVIEWED MAGAZINE ABOUT BRIDGE INFORMATION MODELLING

e-BrIM

SUBSCRIBE

READ OUR LATEST EDITIONS





The magazine **e-BrIM** is an international, interactive, peer-reviewed magazine about bridge information modelling.

It is published at www.e-brim.com and can be read free of charge (open access) with the possibility to subscribe.

It is typically published three times a year:
20 February, 20 May and 20 October.

The magazines stay **available online** on our website as pdf.

The magazine brings **original articles** about **bridge digital technology** from early planning till operation and maintenance**, theoretical and practical innovations, Case Studies** and much more from around the world.

Its electronic form enables the publishing of high-quality photos, videos, drawings, 3D models, links, etc.

We aim to include **all important and technical information, to share theory and practice, knowledge and experience** and at the same time, to show the grace and beauty of the structures.

We are happy to provide media support for important BIM and bridge conferences, educational activities, charitable projects, books, etc.

Our Editorial Board comprises BIM and bridge experts and engineers from academic, research and business environments and the bridge industry.

The readers are mainly bridge leaders, project owners, bridge managers and inspectors, bridge engineers and designers, contractors, BIM experts and managers, university lecturers and students, or people who just love bridges.

ISSN: 2788-0540

OUR PARTNERS

AAS-JAKOBSEN

ALLPLAN
A NEMETSCHEK COMPANY

ARUP

BRIDGE DRAINAGE

BRUGG Fatzer

BSR | BPR
Dr. Schäpertöns Consult

DIAMANT
POLYMER SOLUTIONS

Dlubal

GEN+

MAURER

ponting
bridges

Pipenbaher Consulting Engineers
PIPENBAHER INŽENIRJI d.o.o., Slovenia

ROSALES+
BRIDGES AS STRUCTURAL ART

RÚBRICA® BRIDGES

TYLin

WE COOPERATE WITH

structurae

Offer of partnership and promotion of your company in our magazines

e-mosty

e-BrIM

We would like to offer you a partnership
with e-mosty and e-BrIM magazines.

Depending on the type of a partnership – Platinum, Gold or Silver -
the partnership scheme typically involves:

- Your logo on all pages of the magazine website.
- Interactive presentation of your company which we can help you prepare (free of charge).
- Advertisement A4.
- Your logo and /or the name of your company on every publication and output we release.
- Continuous promotion of your company and projects on our social media.
- Publication of one technical article during the year (which we can help you prepare).

The Partnership can be arranged for either magazine separately,
or for both magazines – for a discounted price.

Both the price and the extent of cooperation are fully negotiable.

Please contact us for more details and partnership arrangement.

PARTNERSHIP OFFER - CONDITIONS

RHINE BRIDGE IN LEVERKUSEN, GERMANY DESIGN AND CONSTRUCTION

Isabel Ajjour, Martin Romberg

Leonhardt, Andrä und Partner, Beratende Ingenieure VBI AG

Figure 1: Old and new Rhine Bridge Leverkusen *Source: Die Autobahn GmbH des Bundes*

INTRODUCTION

The condition of the Rhine Bridge Leverkusen, completed in 1965, is deficient and no longer supports the increasing traffic load, necessitating its replacement. This bridge is a part of the A1 motorway, located between the Cologne-Niehl exit and the Leverkusen intersection.

The twin cable-stayed bridge features a main span of 280 m and a total length of 689 m, spanning the River Rhine. On the west side of the river, there is a pre-stressed concrete girder bridge that has a typical span length of 68 m and a total length of 378 m, which completes the crossing.

This technical paper discusses the unique aspects of the design and construction process of the cable-stayed bridge.

The A1 motorway is a traffic axis of European significance, forming part of the Trans-European Road Network TEN within the planning area. To accommodate the projected traffic volumes for 2030, this section is expanded to eight continuous lanes.

Between the Cologne-Niehl junction (AS K-Niehl) and the Leverkusen-West motorway junction (AK Lev-West), there will be continuous inter-connecting lanes in each direction, in addition to the four main lanes.

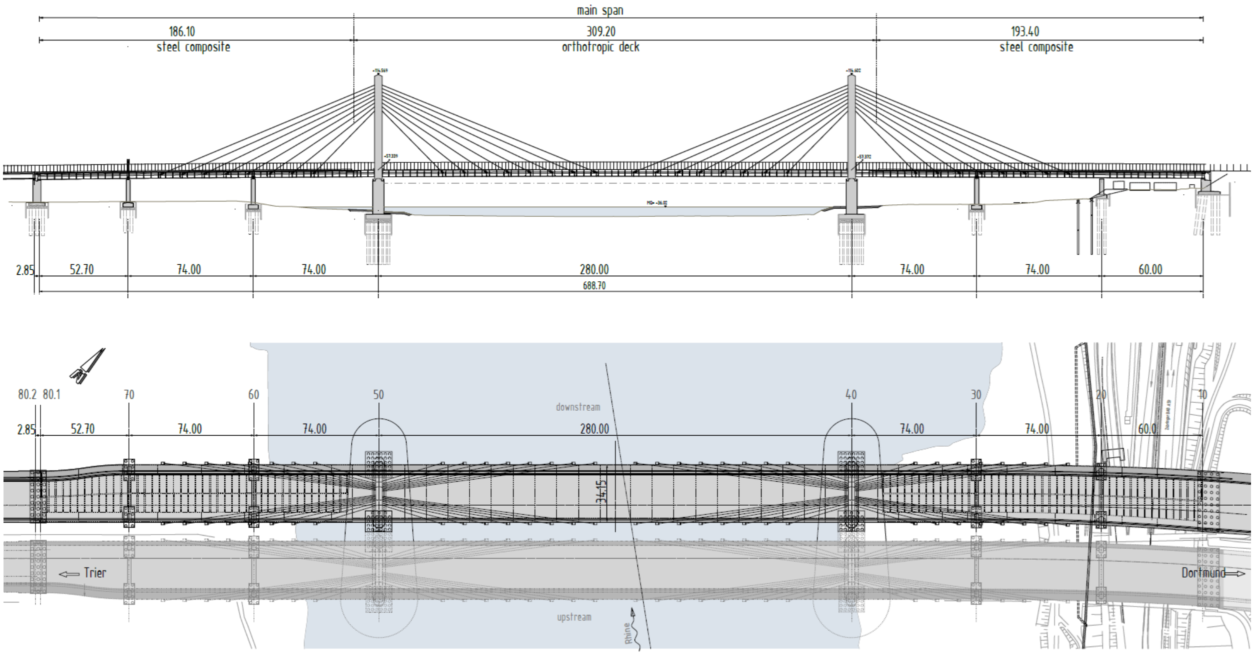


Figure 2: View and plan view Source: Leonhardt, Andrä und Partner

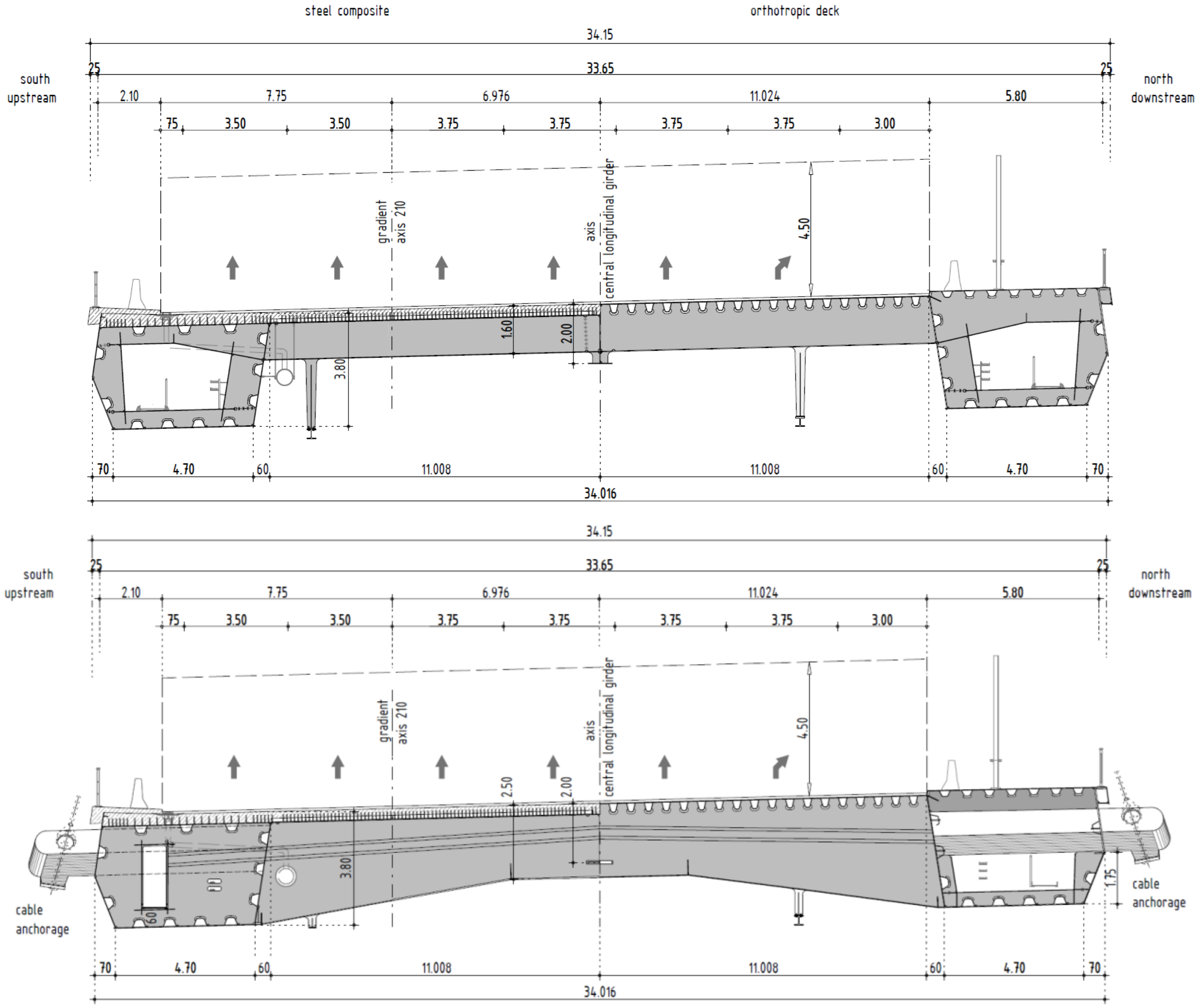


Figure 3: Composite and orthotropic deck section at regular part and stay cable anchorages
Source: Leonhardt, Andrä und Partner

This expansion will result in widths of over 34 m for the two main structures.

The Leverkusen Rhine Bridge, completed in 1965, incurred serious structural damage. The bridge, originally designed with two lanes and a hard shoulder in each direction to accommodate a capacity of 40,000 vehicles per day, was closed to trucks weighing more than 3.5 tons in 2013. This decision came after the bridge experienced an overload of more than 120,000 vehicles daily, including 15,000 trucks, which exceeded its load limits.

As a response to the increasing traffic load, the hard shoulder was converted into a third lane in each direction as early as 1986. This change shifted the heavy traffic to the outer areas of the bridge, which had detrimental effects on its structural integrity. [1]

Due to the unexpectedly rapid progression of damage, there was a need for a quickly constructed replacement for the Rhine crossing and the related sections of the route. The preferred proposal was determined as part of a procurement process in which four planning teams were commissioned in parallel.

DESIGN

Overall scheme

The new bridge is a twin cable-stayed bridge with a main span of 280m and a total length of 689 m (60 m + 74 m + 74 m + 280 m + 74 m + 74 m + 74 m + 52.7 m). The superstructures, measuring 34.15 m in width, are decoupled from their substructures using spherical bearings. The two outer rows of the four rows of bearings are held in the transverse direction. To minimize constraining forces, all bearing axes in the first row of columns in the side span are free. The fixed point in the longitudinal direction is located at the left-hand river pier in axis 50.

Substructure

The substructures are founded on Ø1.5 m bored piles, extending up to 27 m in depth. In the side spans, the pier cross-sections are designed at 4 m x 2.4 m with rounded edges (radius = 0.5 m), allowing for jacks for bearing replacement to be mounted on both sides adjacent to the spherical bearings.

In the stream pier axes, the two central piers are separated only by a compression joint.

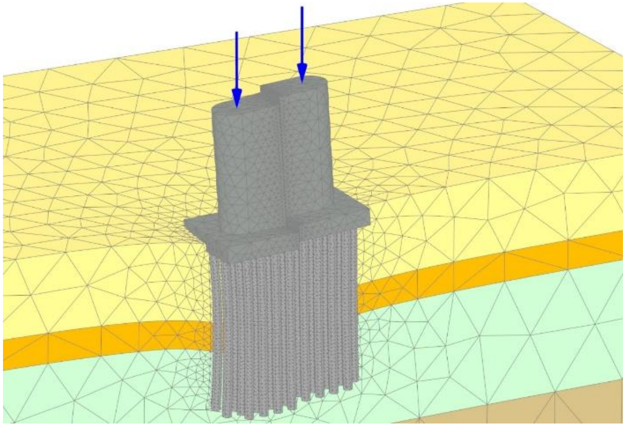


Figure 4: 3D calculation model of the stream pier foundations
Source: ICG GmbH

Due to the successive construction of the two carriageway structures, settlement calculations were carried out on a 3D model, Figure 4.

Because of the settlements from the second structure, larger entrainment settlements were initially determined in the first structure using simplified calculation methods.

Findings from the 3D calculations indicated that the two pier cross-sections lean against each other in the upper area, thus preventing opposing rotations of the foundations that were previously considered possible. The results also informed spring stiffness calculations for the piles for further dimensioning.

Superstructure

The superstructure consists of a girder grid system. The two rigid edge girders, in which the cables are anchored, are constructed as box girders, each measuring 6 m in width and 3.8 m in height. The cross girders are spaced generally 4.3 m apart and are interconnected in the centre of the bridge by a central longitudinal girder measuring 2 m in height.

In the cable anchorage area, two cable cross girders are positioned, which share the same construction height in the connection to the box girders and reduce the construction height to 2.5 m in the middle of the bridge.

The standard cross girders in the remaining area have a constant construction height of 1.6 m. In the main span and approximately 15 m into the two side spans, the cross-section is designed as a pure steel cross-section with an orthotropic deck.

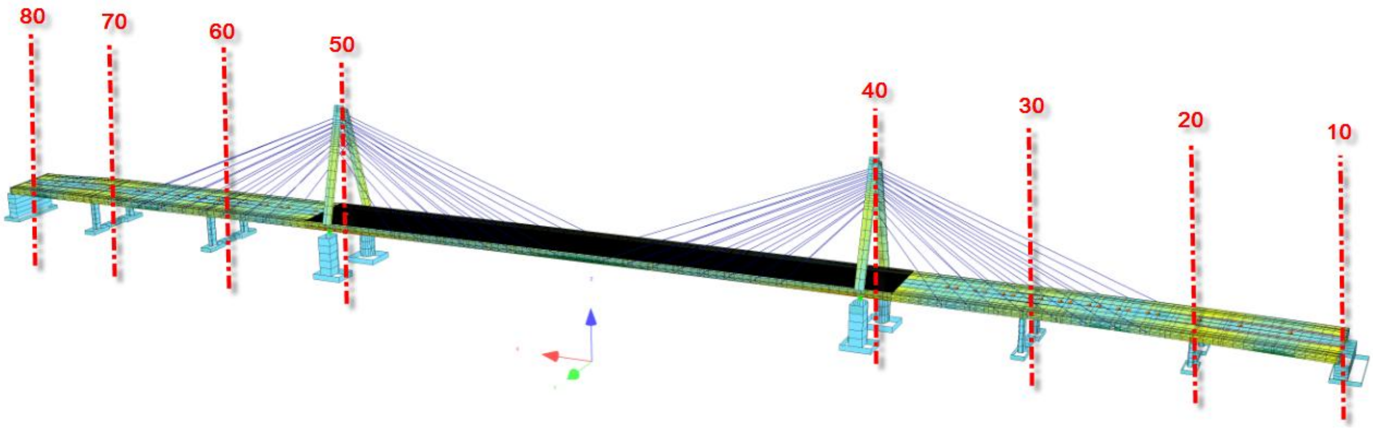


Figure 5: Single spine model *Source: Leonhardt, Andrä und Partner*

In the adjacent areas, the roadway consists of 12.5 cm thick precast concrete elements with a 22.5 cm thick in-situ concrete supplement. This configuration was selected to prevent uplifting bearing forces in the side spans.

In the pier axes, the bearing points are centrally placed in the box girders, which are tied together with a cross girder of the equivalent height. In the roadway transition areas, the cross girders are encased in concrete to minimize noise.

To avoid uplifting bearing forces, the cross girders in the first column axes from the pylon are filled with concrete.

Static and dynamic analyses were conducted using finite element models. Two global models were developed: one featuring a single spine for the superstructure and the other configured as a grillage model which includes three longitudinal girders, cross beams and horizontal truss elements.

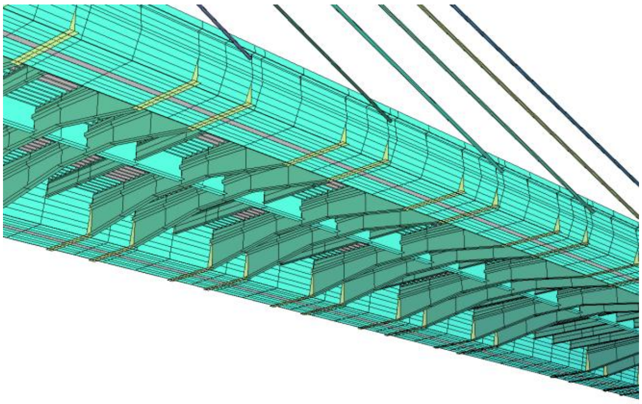


Figure 6: Three girder model
Source: Leonhardt, Andrä und Partner

Figure 6 displays a section of the superstructure from underneath, showing the arrangement of regular and cable crossbeams in the cable anchorage area.

In addition to the two global models, various local models were developed. For example, for the local design of the roadway, a distinct model of the superstructure was developed, as illustrated in Figure 10.

This model was constructed parametrically to investigate various configurations of cross-beam types and their spacing.

To minimize calculation time and file size, only the most relevant components were modelled with higher accuracy, including the incorporation of the cut-out for the stiffeners.

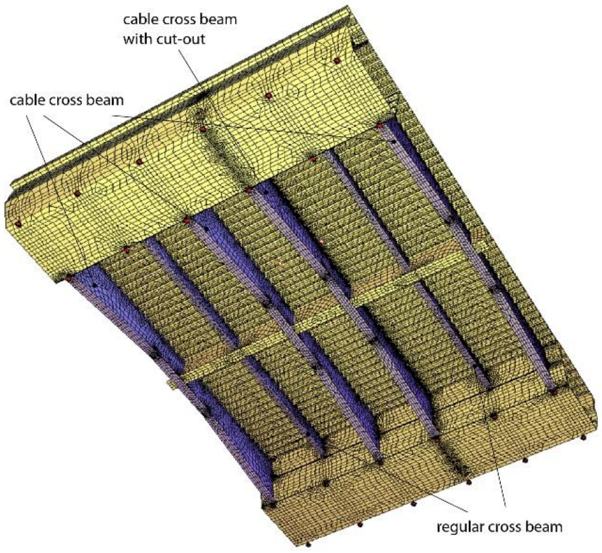


Figure 7: Orthotropic deck model
Source: Leonhardt, Andrä und Partner

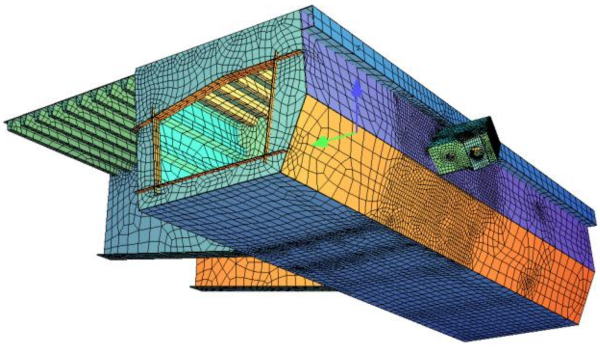


Figure 8: Local model of the cable anchorage area
Source: Leonhardt, Andrä und Partner

The local effects caused by the cable force in the anchorage area were analysed using a different local model, as shown in Figure 8.

The 3D model includes a longitudinal girder with all stiffeners, parts of the cross girders, and one anchorage box. The model has a length of four cross-girder spacings, ensuring that both cable cross girders beneath the cable anchorage are represented.

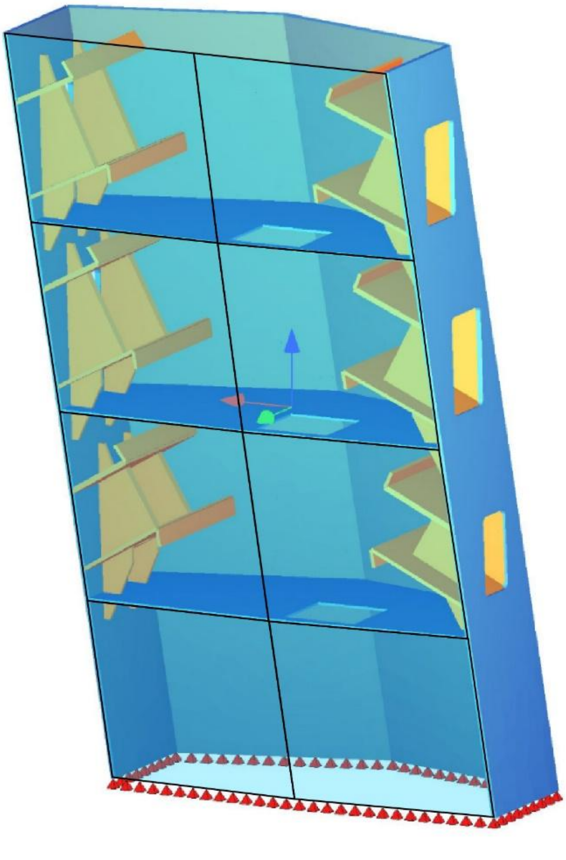


Figure 9: Local model of cable anchorage area in the Pylon
Source: Leonhardt, Andrä und Partner

Additional local models were utilized for dimensioning the control girder and pylon cross girder, among others.

Pylons

The A-shaped pylons with a bevelled tip are designed with a constant cross-section with external dimensions of 4.4 m by 2.2 m. The cross-section tapers to 1.4 m at the crossbar.

A key factor in determining these dimensions was the requirement to accommodate an elevator in the cable anchorage area. The cable anchorages were initially planned for fully locked cables with hammer heads, which required the cable heads to be inserted from the outside through large trapezoidal openings in the outer walls.

After installation, the hammer heads were to rest on anchor bars slid underneath. When the design was changed to the parallel strand bundles, only the anchor bars were replaced by thick anchor plates reinforced with flat steel stiffeners, which could be placed on the anchor structure without further welding work.

For the second carriageway, the cable anchorages were planned directly for a cable system consisting of strand bundles. Consequently, the openings in the pylon walls were made significantly smaller and the anchor plates were made thinner due to a reduced span width. The pylons are modelled as a spine in the same global model which is also used for the superstructure. The model is utilized not only for the final design but also for the construction stages. Specifically, during the construction stages, the analysis focused on the vortex-induced vibrations of the free-standing pylons, which are initially without cables.

Due to the presence of numerous load introduction stiffeners, the buckled cross-sectional shape, and the large openings for inserting the cable heads, an additional local model is required for the anchorage area within the pylon. The model illustrated in Figure 9 is used to design the anchorage box at the centre.

To accurately capture the stress distribution in the pylon walls, both a lower and an upper box are considered. Along with the cable forces, the stresses derived from the global model are applied at the upper free end. Additional local models were also utilized to design the crossbar and the anchor bar.

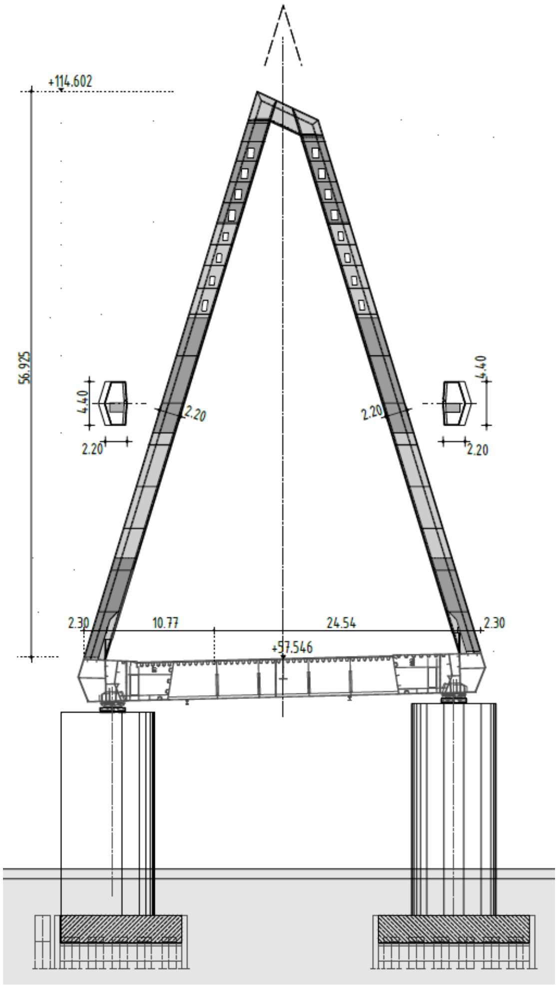


Figure 10: Pylon layout
Source: Leonhardt, Andrä und Partner

Stay Cables

The original system was based on a locked coil rope system, selected during the tender design when modern parallel strand systems were rarely used in Germany and did not qualify for the necessary German technical approval.

The German technical delivery specification and technical testing regulations for fully locked coil ropes (TL/TP-VVS) requires testing of the cables for each individual project.

As the fatigue tests of the cables repeatedly failed, the contractor decided to switch the cable system to a parallel strand system even though the construction of the deck segments in the side spans was already underway and the pylons had been fabricated.

By that time, two suppliers had gained the German technical approvals for parallel strand systems, eliminating the need for additional cable testing, and resulting in use of parallel strand systems.

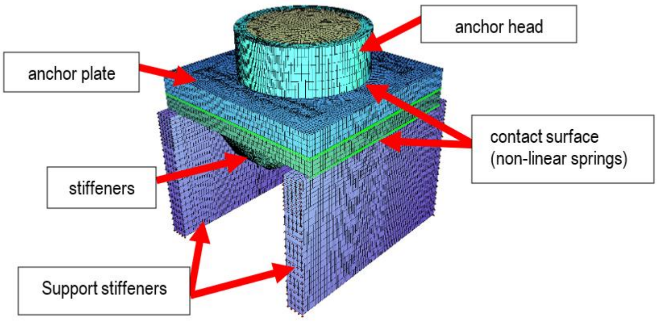


Figure 11: Local model of the adapter plates
at the anchorage head
Source: Leonhardt, Andrä und Partner

Changing the cable system required a re-assessment of the overall design and modifications to the cable anchorages at both the deck and the pylons. The designer was able to demonstrate that this change could be implemented with minimal on-site alterations to the existing steelwork.

To conduct a more comprehensive analysis of the impact of the cable change on both the pylon and the superstructure, the global model was utilized.

Additionally, the local effects on the anchorage area of the superstructure and the pylon were examined.

A separate localized model is necessary to design the adapter plate at the anchorage head of the pylon. As a result, the 3D model shown in Figure 11 was created.

CONSTRUCTION

Fabrication and logistics

The steel components of the superstructure and the pylons were manufactured in parallel in four of the steel construction partners' plants. The aim was to be able to start the steel construction assembly as quickly as possible.

Assembly began in September 2021, just 7 months after the contract was awarded to the steel construction partners. As all steel construction partners had access to a waterway, the logistics concept envisaged that as many steel components as possible could be delivered to the construction site by water.

Only the smaller transverse and central longitudinal beams of the side bays were delivered to the construction site by truck.

Side Span

In March 2022, the first side span on the right-hand side of the Rhine, with a total weight of 1,115 tons, was moved into position with the help of SPMTs (Self-Propelled Modular Transporters). The assembly concept in this span differed from the other side spans, as it crosses a highway access road, which could only be closed for a short time.

The other side spans, in which auxiliary supports could be placed, were assembled with the help of a 700-ton crawler crane. First, the box girders of the two edge beams with lengths of up to 24 m and weights of up to 180 tons were lifted into place. The transverse and central longitudinal girders between the box girders were lifted in using smaller mobile cranes due to their smaller dimensions.

Figure 12: Side span construction with crawler crane
Source: Die Autobahn GmbH des Bundes

The laying of the semi-precast concrete parts of the composite roadway began at the same time as the steel structure was being installed.

Pylons

Installation of the pylons began in September 2022, parallel to the construction of the composite roadway slab in the side spans. A pylon consists of a total of eleven segments, five per pylon stem and the pylon tip.

The segments, which were up to 12.6 m long and weighed up to 107 tons, were assembled using the same crawler crane that was used to assemble the side spans.

During assembly, the inclined pylon stems were short-circuited using horizontal bracing. In order to avoid vortex-excited vibrations. Inclined steel tubes also had to be arranged between the pylon legs and the superstructure.

The purpose of these was to increase the natural frequencies of the pylons and thus get out of the critical range for vortex excitation.

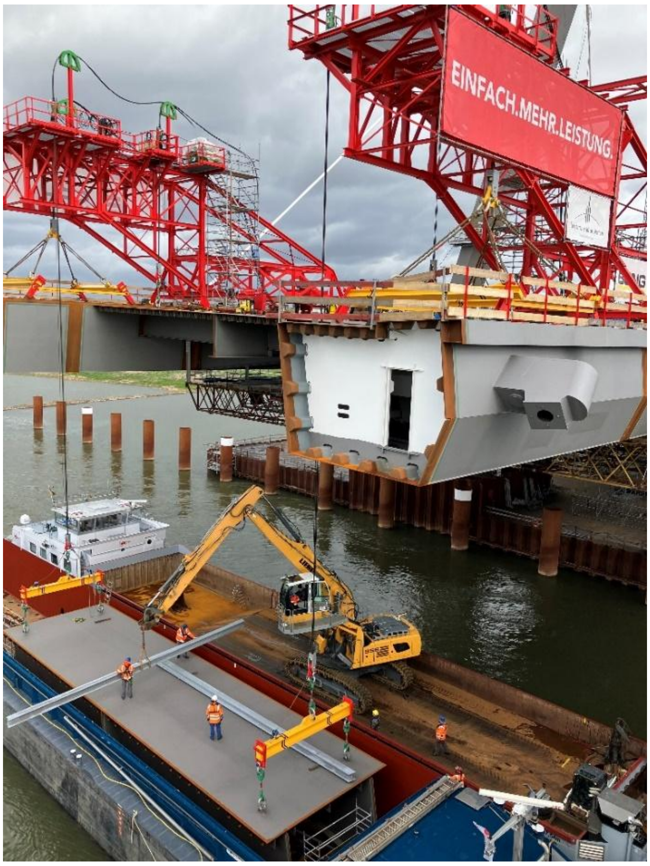


Figure 13: Lifting of main span segment with derrick crane
Source: Leonhardt, Andrä und Partner

Main Span

Except for the first segments on each side in the main span, which were already assembled during the assembly of the side spans with the crawler crane, the superstructure was assembled starting in December 2022 using a 2 x 75 tons heavy derrick crane. The segment lengths correspond to the distances between the cable entry points of 12.90 m.

The segments, which weigh up to 280 tons, were divided into four sub-segments for transportation and lifting.

First, the two box girders were assembled using strand jacks and then the two roadway sections between the box girders.

Once the four parts had been assembled, they were aligned and then welded while suspended in the derrick. An approximately 41 m wide, 17 m long and 52 tons heavy undercarriage carried out the welding and corrosion protection work.

Including the subsequent two-stage cable assembly and geometry check, the assembly of one superstructure segment takes approximately 25 days.

For the 17.9 m long and 310 tons heavy final segment, the roadway was divided into three parts. The hollow sections and two roadway sections were lifted in from one side in September 2023 and welded to the cantilever.

The last roadway section was then lifted into place using the opposite derrick and the cantilevers were aligned to the same height using the strand jacks of the same derrick.

Finishing

A great achievement was that the waterproofing and the first layer of mastic asphalt pavement were installed on approximately two thirds of the main span parallel to the superstructure installation and even before the gap was closed.

The final survey of the superstructure to determine the geometry of the road surface, which is usually only carried out after completion of the supporting structure, was divided into a total of five overlapping individual surveys, thus successively determining the alignment gradient.

This was the only way to ensure that the completion date of December 2024 could be met.

Traffic has been running on the first section of the structure since the end of January 2024 and demolition of the existing structure is nearly concluded.

The second carriageway structure is to be completed by the beginning of 2028.

PROJECT PARTNERS

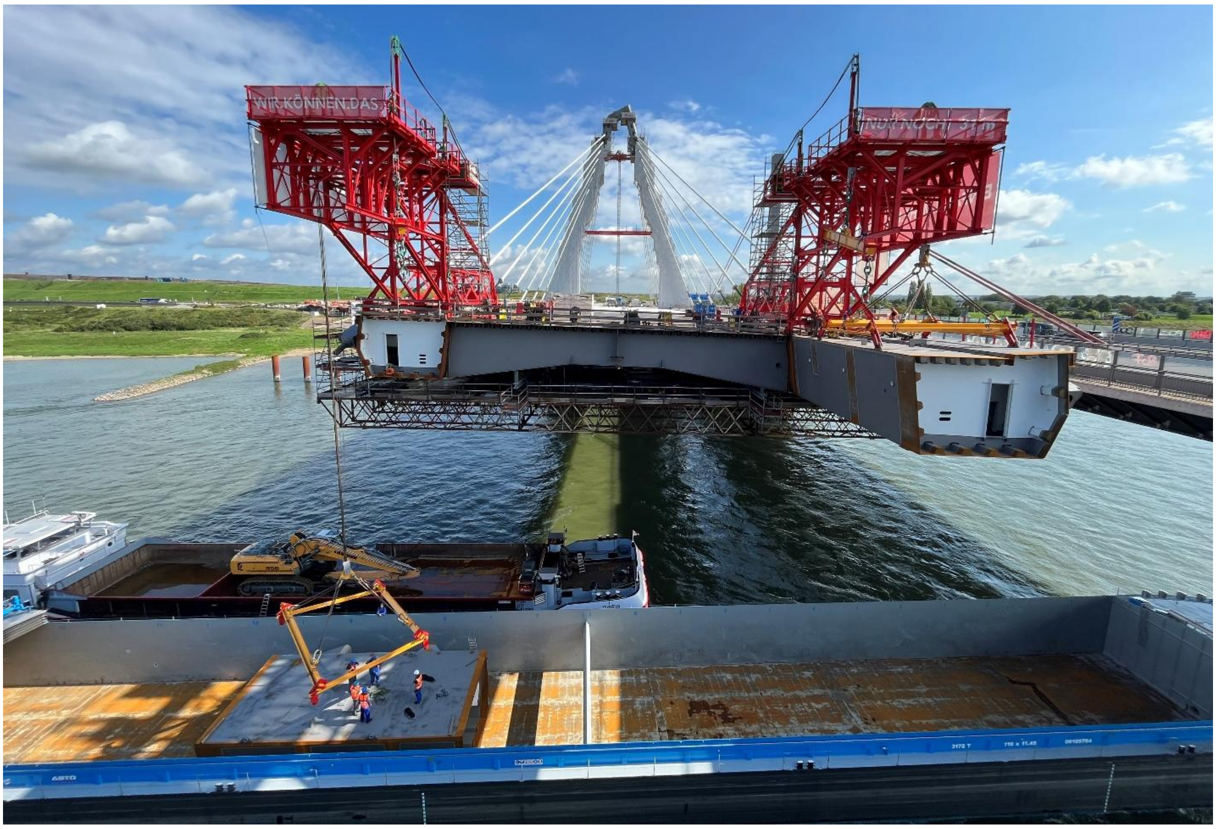
The Client:	Die Autobahn des Bundes GmbH
Tender Design:	Ingenieurbüro Grassl GmbH with Kocks Consult GmbH and Firmhofer+Günther Architekten Part-GmbH
Detailed Design:	Leonhardt, Andrä und Partner Beratende Ingenieure VBI AG
Checking Engineer:	Prof.Dr.-Ing. Weyer and Dr.-Ing. Jürgen Uhlendahl
Construction:	SEH Engineering GmbH, Hochtief Infrastructure GmbH, Porr Deutschland GmbH

REFERENCES

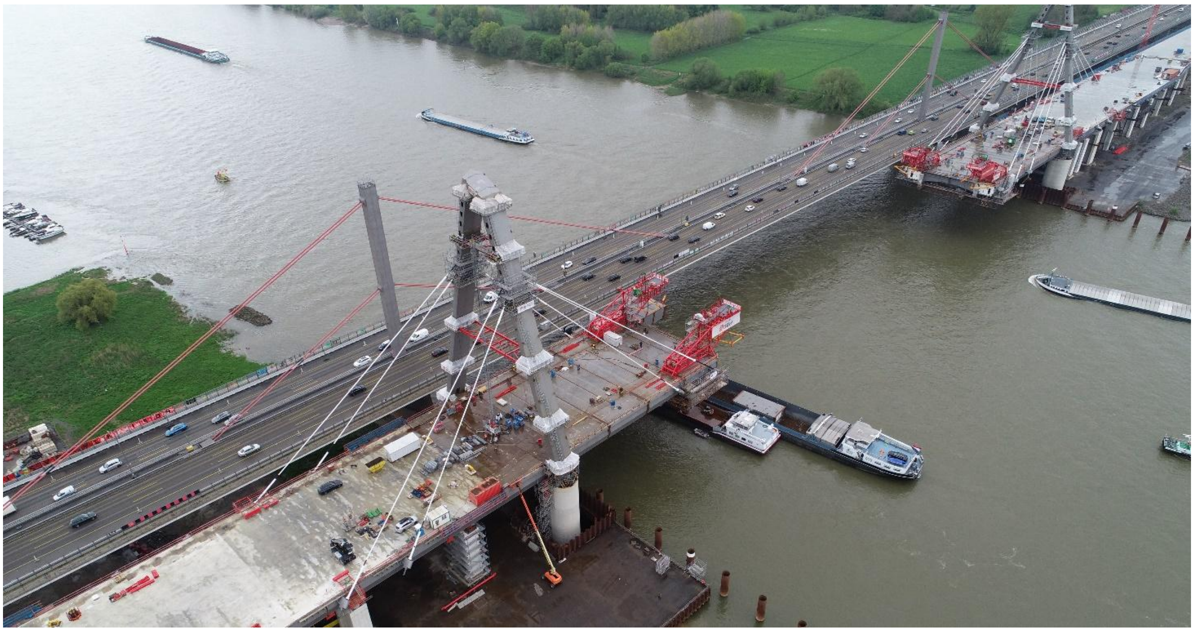
[1] Ritterbusch N. (2019) Errichtung der Rheinbrücke Leverkusen und anderer Ingenieurbauwerke - Ausbau der A 1 zwischen Köln-Niehl und Leverkusen-West. Brückenbau Construction & Engineering, Issue 1/2, pp. 46-51.

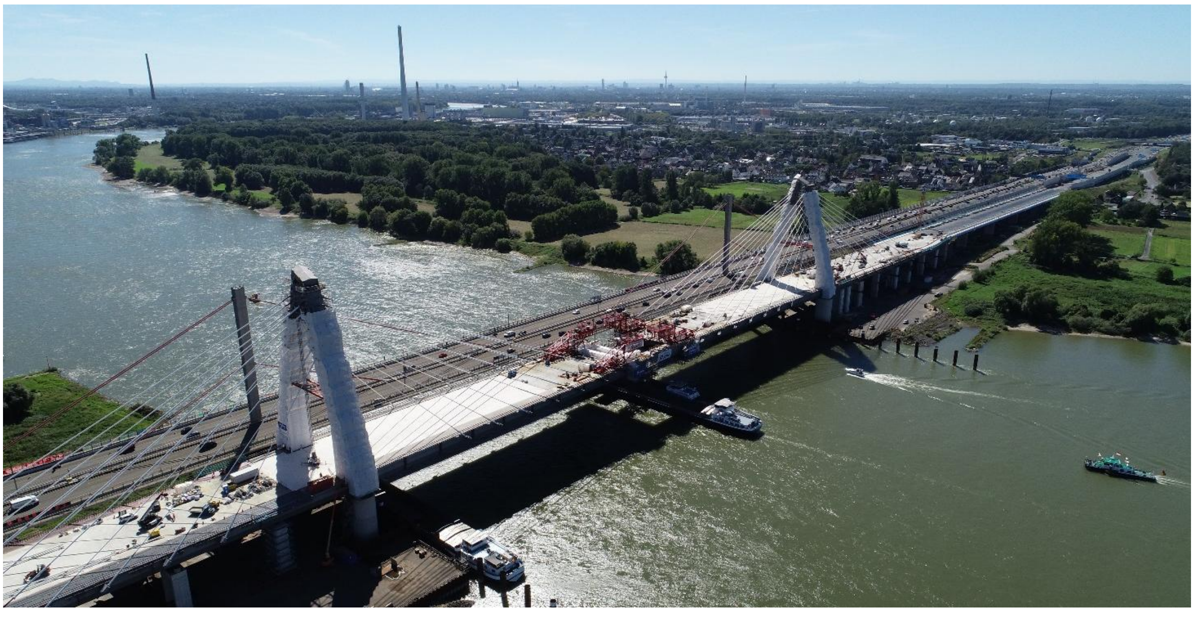
[2] Romberg, M. (2024). Rhine Bridge Leverkusen: Design and construction. In Electronic Proceedings of Papers: Steel Bridges 2024 Prague, pp. 16-22.

CONSTRUCTION PHOTOS



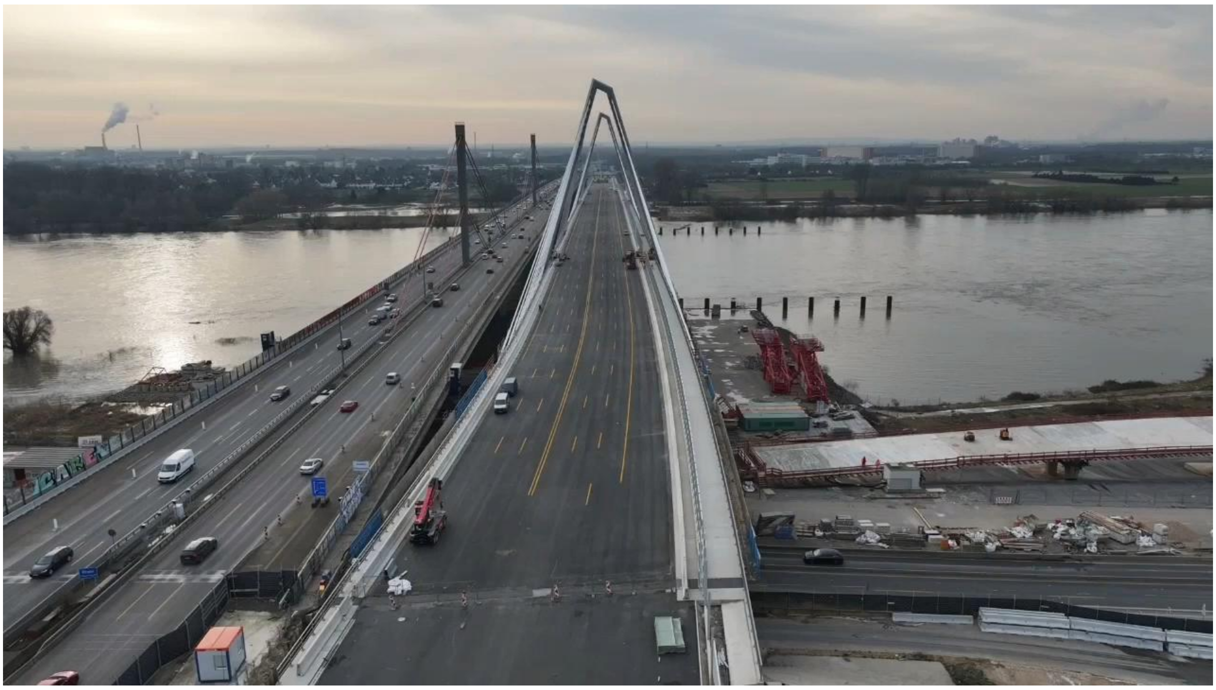
e-mosty





02/2025

Video 1: Animation of the deck closure



Video 2: Crossing the complete bridge

Photos and Videos Credit: SEH Engineering GmbH

Leonhardt, Andrä und Partner

unique structures

Leonhardt, Andrä und Partner


Arch Bidges


Pedestrian Bridges


Cable-Stayed Bridges

MOBILITY IN TRANSITION

Andreas Keil, Boardmember
schlaich bergermann partner, Stuttgart, Germany

Figure 1: Night View of the footbridge Mühlensteg in Besigheim   Credit: Conné van d´ Grachten

INTRODUCTION

Many of the world's major cities are experiencing significant population growth. The urban population is projected to increase by four billion people by 2100. This is partly due to overall population growth (around three billion) and partly because more and more people are moving from rural areas to cities in search of better job opportunities and living conditions.

This urbanization leads to population density, which brings economic benefits due to the proximity of jobs, educational institutions, and cultural facilities, but also presents cities with enormous challenges such as housing shortages, congested transport systems and higher levels of environmental pollution.

Sustainable urban planning must therefore aim to manage this density while promoting quality of life and environmental protection.

In the long term, it will be crucial to find innovative solutions that allow efficient use of available space without compromising and potentially improving the living conditions of city dwellers.

The car is one of the dominant forms of mobility in modern societies, associated with a high degree of personal independence and convenience. While cars will remain indispensable in rural areas, where they are more economical and no other fast (public) transport is available, the role of cars in cities is changing. The 'car-friendly city' propagated and often realized since the late 1940s is outdated, although it is still being pursued in many parts of the world.

The disadvantages of private motorized transport are obvious: on the one hand, high CO_2 emissions that accelerate climate change and, on the other, the enormous amount of space required for parking cars (33 hours of parking time for every hour of driving), roads, crossings, etc. Banning cars from cities would free up a lot of space for much-needed housing and green spaces.

Dealing with the unpopular legacy of the car-friendly city is a major task for modern urban planning. The redevelopment of urban motorways, elevated roads and thoroughfares, main roads, major intersections, and traffic distributors is an essential key to regaining urban quality.

However, in addition to these structural changes, a cultural change is needed that challenges the use of the private car as the default mode of transport.

Fundamental change will only occur when we stop using public space primarily for cars. This will only happen if, on the one hand, there is a well-functioning public transport system and, on the other hand, the infrastructure for slower moving traffic, such as bicycles or scooters, is so attractive that giving up the car means saving time and reducing stress.

In addition, car-sharing services should always offer the "fallback" option of making individual trips/journeys like before, just not with one's own car.

The infrastructure of cities will change to encourage slow traffic and make it safer. Some cities have already gone through this process and are proving the effectiveness of the measures taken. Copenhagen is a prime example. Here, half the population, about 300,000 people, already cycles to work.

As part of this shift towards slower traffic, existing bridges that no longer meet current and future requirements need to be replaced or new bridges built. These will either cross individual obstacles, such as roads, railway lines or rivers and will be built as stand-alone solutions, or long bridge buildings will be needed that provide connections across multiple obstacles. Such solutions provide good connections to squares or the existing transport network by means of ramps and stairs and, where necessary, lifts.

However, the design of the ascents and descents and their integration into the cityscape is often more challenging than the design of the bridge itself.

Accessibility is a principal issue for ramps, as they only allow for low gradients (max. 5.1%). With the usual clearance profiles (approx. 5 m), this results in ramps whose lengths (approx. 100 m) make integration even more difficult.

Transforming cities requires bold planning that looks beyond today's needs. For example, the width of a bridge should be based on future needs rather than current ones. This depends a lot on how attractive the cycle network is.

An attractive cycle network will encourage more people to cycle. Cities such as Copenhagen and Bordeaux confirm the pull effect of attractive facilities.

In the case of bridges used by both pedestrians and cyclists, consideration should be given to whether separate path systems can prevent conflicts and accident risks.

Separation can be purely visual (e.g., different colours of surfaces) or mechanical, but the latter must not create a risk of accident. Intersections must also be clearly signposted and danger spots marked.

In several cities, the concept of creating a second level with a continuous network of high bridges to separate bicycle and car traffic is being discussed.

However, this approach has been criticised from an urban planning point of view because it does not replace car traffic with bicycle traffic and therefore does not reduce it, nor does it promote an equal mix of different transport systems.

Another option for creating new crossings for slow traffic is to use existing or newly built bridges for road and rail traffic. Where structurally feasible, paths can be added to the sides of existing bridges or suspended underneath them. Elevated solutions are also possible but require sufficient height to keep the roadway below clear.

Additions to existing bridge structures always require intensive structural and design work on the existing structure to ensure that loads can be safely transferred and distributed. This is much easier with new bridges, as they can be designed holistically from the outset, rather than in an additive manner.

BRIDGES

Although solitary bridges are often easy to design, the same applies to them as to other bridges: they are part of our environment and need to be well designed. This is not just a matter of beautifying the cityscape or landscape, but also of showing appreciation for the people who must "live" with the bridge. Intensive discussion of the project by those responsible is appreciated by the population and thus increases acceptance later. This is demonstrated by planning processes that include public participation. These include competitions, especially two-stage competitions where the public participates in the shortlisted designs with their opinions and questions after the first stage.

This can be illustrated with a number of projects described below.

Rathausbrücke Tuttlingen

The Rathausbrücke (Town Hall Bridge) is an important pedestrian and cycle route across the Danube between the residential areas in the north and the centre of Tuttlingen.

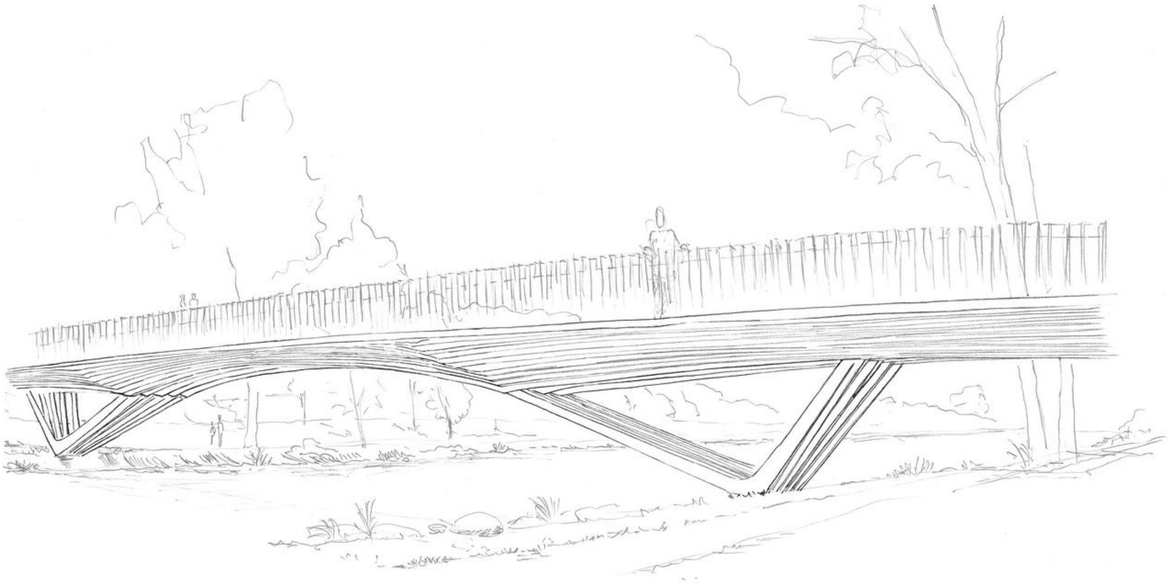


Figure 2: Rathausbrücke Tuttlingen, drawing *Credit: sbp*

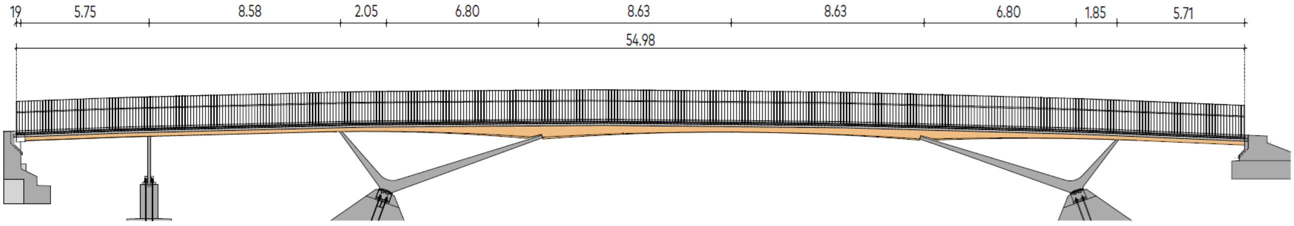


Figure 3: Longitudinal elevation *Credit: sbp*

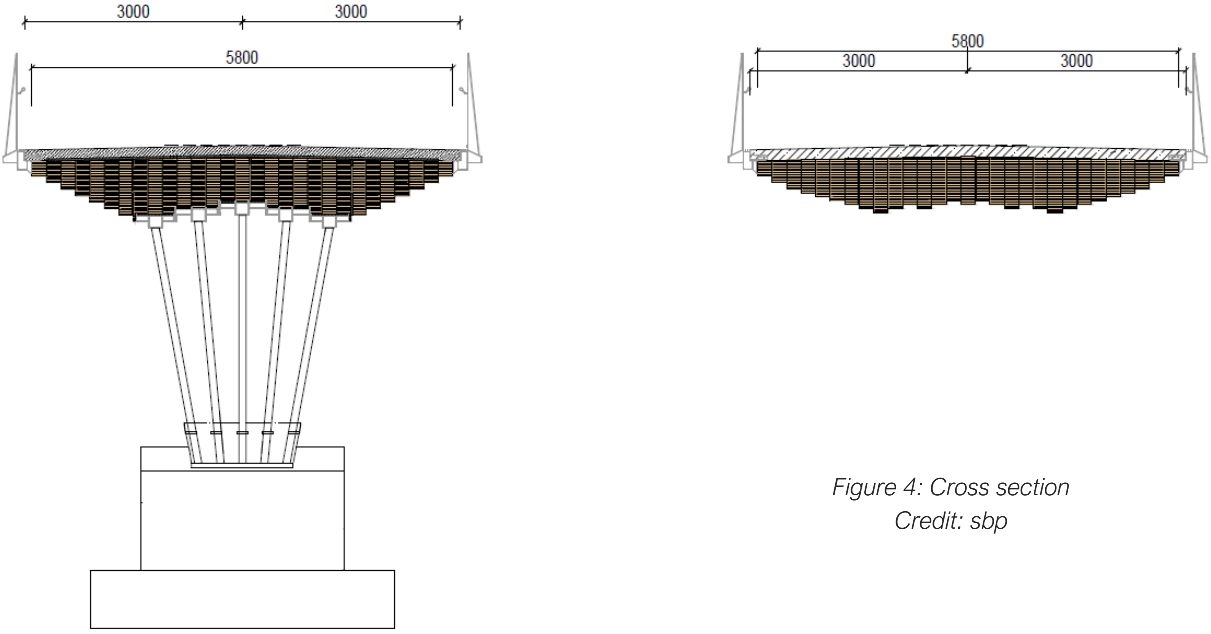


Figure 4: Cross section
Credit: sbp

As the old timber bridge, built in 1982, was an urban bottleneck, a replacement was planned. In addition to the competition for the design of the bridge, a call for ideas was launched to ensure barrier-free access from the bridge to the city centre.

The bridge width was increased from 4 to 6 m to meet future needs.

A structure above the walkway was not considered suitable in order to keep the view open to the surrounding urban landscape and the river and riverbank landscape that runs through the centre of Tuttlingen and gives it its distinctive character.

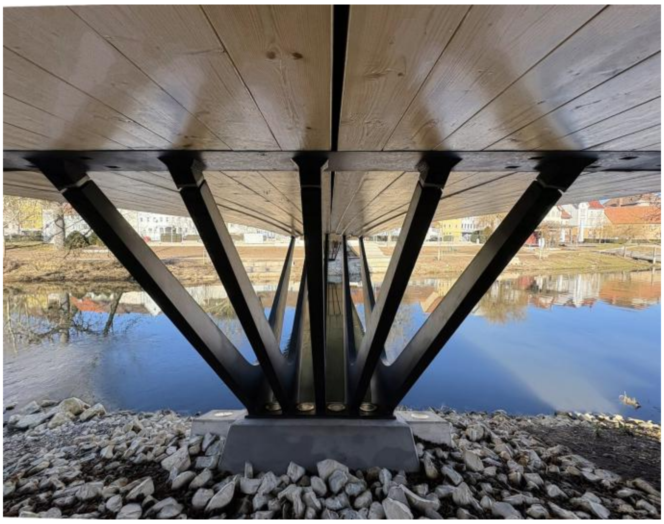


Figure 5: View from below with fanned-out girder
Credit: sbp

The experience of the space under the bridge in the Donaupark area is enhanced by the high-quality design of the underside.

Furthermore, the design restrains itself to functional qualities and leads to an innovative semi-integral structural solution, material-appropriate detailing, and a robust, low-maintenance construction.

The bridge consists of a hybrid structure of timber, steel, and concrete. The superstructure of the bridge is a triad of these materials.

Figure 6: Hybrid structure of Rathausbrücke Tuttlingen

Credit: sbp

Each material is used according to its properties: concrete forms the deck surface in combination with the timber structure underneath, creating a robust composite cross-section. The concrete acts as a durable walking surface and protects the timber reliably and permanently from the elements.

A thin coating in the walking area protects the concrete and acts as a maintenance layer.

In the weather-protected space above the clearance of the river, the beam is made of a solid, block-glued laminated timber structure.

Lightweight railing elements with a minimalist appearance convey the concept of an elegant and dynamic design language, which can also be felt when crossing the bridge.

The slender steel girders form a formal unit with the fan-shaped girders, fulfilling their role as a defining element of the landscape.

In view of transport and local fabrication capabilities, the segment lengths of the glulam block girders were limited to a maximum of 24 m.

Careful design of the material interfaces between timber, concrete and steel is crucial for a permanently robust structure. Simple and easy-to-assemble connection techniques form the basis for the high-quality workmanship of the innovative semi-integral hybrid structure.

Sustainability aspects have been considered as well as the goal of creating a delicate and modern bridge design.

Bicycle and pedestrian crossing over the river Neckar in Heidelberg

The new bridge connects two urban development areas on either side of the Neckar River and is an essential part of Heidelberg's further development into a future-oriented, bicycle-friendly city.

Figure 7: Bridge layout and ramps *Credit: sbp/LAVA/Latz+Partner*

Figure 8: View of the bridge with existing weir and weir bridge in the background

Credit: sbp/LAVA/Latz+Partner

Figure 9: Bridge over the B37, leading into Gneisenau Park

Credit: sbp/LAVA/Latz+Partner

Figure 10: Old weir with weir bridge, new bridge with old town in the background

Credit: sbp/LAVA/Latz+Partner

Figure 11: Support-free overpass over the B37 and continuing into Gneisenaupark (right)

Credit: sbp/LAVA/Latz+Partner

With its generously curved lines, it forms a continuous link between the railway station and the southern districts to the Neuenheimer Feld and creates a connection to the fast cycle path on the north bank of the Neckar.

The focus is on a direct and smooth north-south connection for cyclists and pedestrians. However, its contribution to urban development goes far beyond the functional task of a connection from A to B.

By creating a direct connection and, in particular, a special quality of stay on the bridge for pedestrians, it gives the surrounding area a new lease of life.

The curved bridge, including earth ramps, is 714 m long. The actual bridge is divided into seven spans of approximately 60 m each between small ramps at the ends. It crosses the shipping channel with a span of 105 m.

A haunched, torsion-resistant box girder follows the shape of the load and spans the entire length of the bridge as a continuous girder without any joints.

Between the zero points of the bending moment curve of the two large spans over the Neckar and the B37, the box girder rises above the deck in the centre of the cross-section to achieve the necessary bending and torsional stiffness.

The bridge passes through a sequence of urban spaces, whose qualities and contrasts are enhanced by its design: it accompanies the urban development in the different areas and provides space and tranquillity above the Neckar and is an integral part of the landscape on the north bank.

Bridge and landscape design work together to create new and, depending on the location, different qualities of stay: subtle interventions accelerate or slow down users and encourage them to pause, linger, and look around.

At the same time, the flat underside of the freely formed continuous girder appears almost inert thanks to its large spans and reduced detailing.

It calms the hectic situation around Gneisenaupark and allows views and tranquillity over the Neckar to remain as before.

As an integral bridge, it is bearing-free over its entire length. All structural components are rigidly connected to each other, requiring only minimal maintenance.

This support principle allows for a slim and graceful silhouette even at the large spans, which blends discreetly into the urban context without any structural high points. The bridge thus continues the tradition of Heidelberg's Neckar bridges in an innovative way and with impressive slenderness.

Footbridge Mühlensteg in Besigheim

In the small village of Besigheim, north of Stuttgart, a footbridge over the river Enz was built just in front of the historic, listed cityscape.

The design concept for the new Mill-bridge is to guide cyclists arriving from the southeast on the right side of the Enz River in a user-friendly sweep across the Enz River and to continue to the northwest on the left side of the Enz River. The bridge should also provide a direct connection between the old town and the newly built multi-storey parking lot in the Enzaue, as well as allowing walkers to cross the Enz protected from road traffic and linking the new Enzpark to the old town.

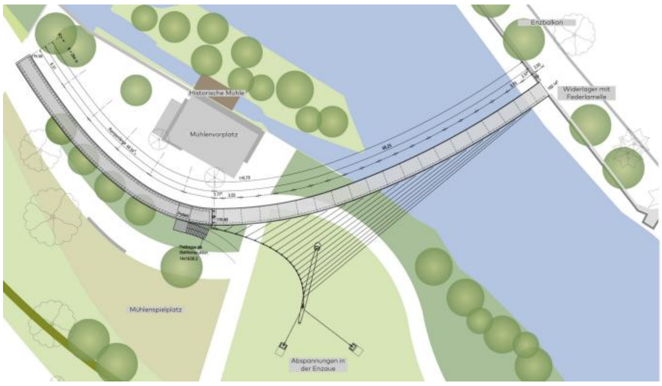


Figure 12: Overview of main architectural and structural elements

Credit: sbp

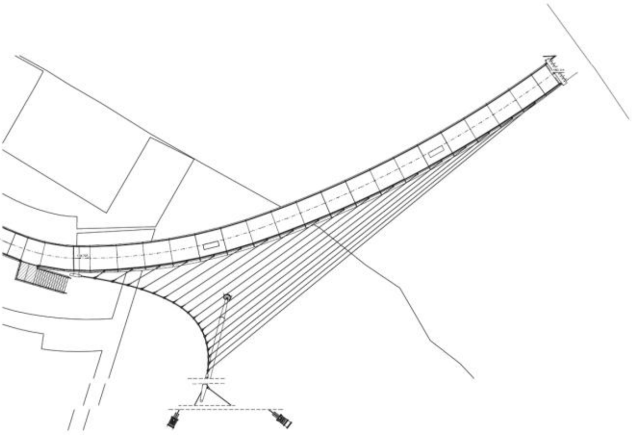


Figure 13: Bridge layout and arrangement of tuned mass dampers

Credit: sbp

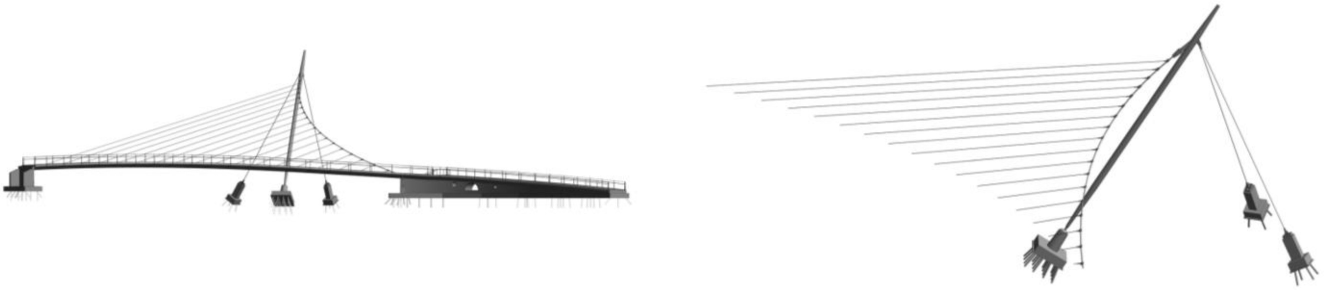


Figure 14: General view and pylon detail

Credit: sbp

Figure 15: Overview over the riverbank, Enzpark and Mühlensteg with ramps

Credit: sbp

With a curved span of approximately 70m and inclined hanger cables just connected to the outer edge of the superstructure, the one-sided suspension bridge offers pedestrians a direct connection from the new-built park and garage to the medieval city-centre, and cyclists to smoothly transfer from one riverbank to the other.

The new footbridge, despite being a highly technical lightweight structure, respectfully considers the local context and carefully embraces the adjacent listed water mill.

Bridges in the Regional Garden Exhibition, Wangen im Allgäu

The 2024 State Garden Exhibition in Wangen im Allgäu saw the redevelopment of a former spinning mill and its industrialized and later neglected surroundings into an area for local recreation, and at the same time return them into a more natural state.

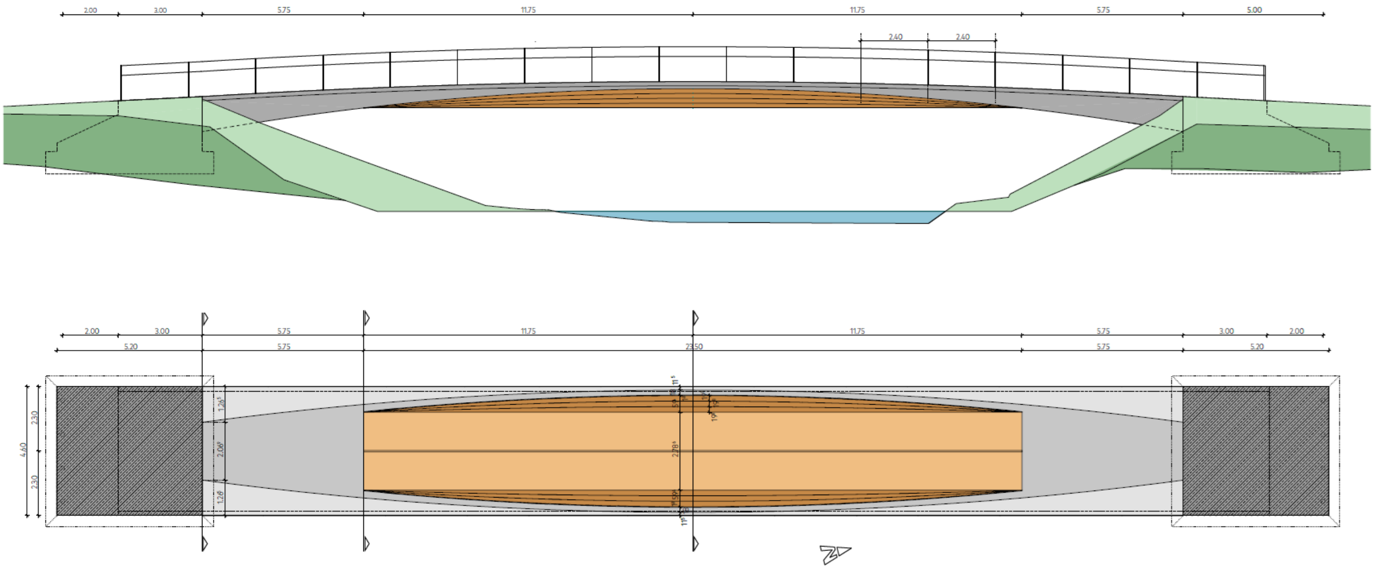


Figure 16: Longitudinal view, view from below

Credit: sbp

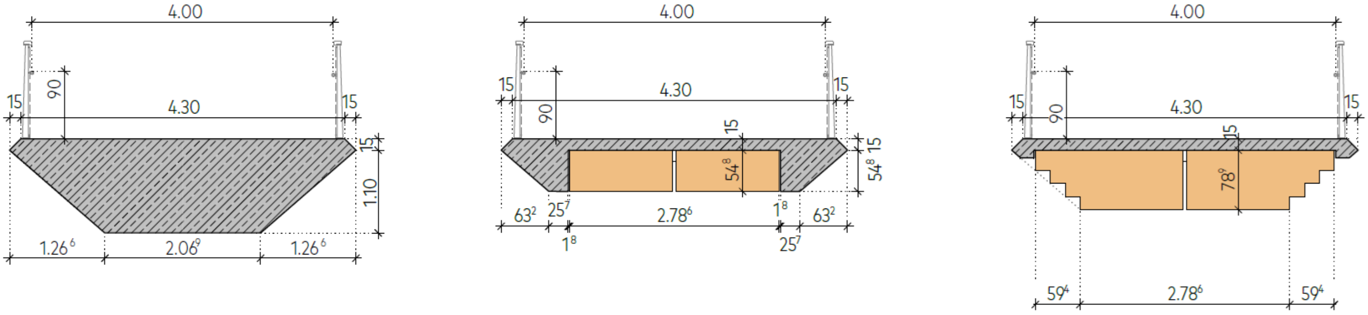


Figure 17: Cross sections *Credit: sbp*

Several bridges were built as part of the garden exhibition. A pair of twin bridges (Dornierbrücke and Zeppelinbrücke) cross the rediscovered wetlands of the river Argen with a single span of approx. 35 m. Located only a short distance from one another, building the same design twice seemed an obvious choice, yet each bridge possesses and shares with its site a unique character. The idea of reclaiming nature extended to bridge design. First, untreated timber was chosen as the primary material from a pool of materials investigated.

Secondly, the bridges initially served construction traffic only to be "returned" to their permanent use as pedestrian and cycling crossings. This established an immediate relationship with the evolving site, where nature was quick to reclaim the riverbanks and surroundings.

For the structure, glued laminated beams act in composite with the concrete deck. At the abutments, the concrete wraps around the structural timber and continues monolithically into the foundations.

Figure 18: Zeppelinbrücke

Credit: Conné van d´ Grachten

Like an inlay on the concrete and away from the moist abutments, the timber is carefully protected from the elements. Fully integral, longevity is all but assured.

Life-cycle assessments were continuously performed throughout the design process and upon completion showed very favourable results when compared to similar span bridges.

Figures 19: Dornierbrücke

Credit: Conné van d´ Grachten

Bridge Lindach, Schwäbisch-Hall

The design of the new foot and cycle bridge in Schwäbisch Hall, which emerged as the winning entry in a competition, is reminiscent of 1950s architecture in its elegance and simplicity – except that at that time, such a structure would probably have been built exclusively in concrete.

However, as timber was chosen as the main construction material for the Lindach Bridge over the Kocher River from the outset, the bridge, which is just under 3.9 m wide, was designed as a two-span timber-concrete composite structure.

Figures 20 and 21: Inclined central support designed as trapezoidal hollow steel box (left) / bridge view with theatre in the background (right)

Credit: sbp

Its superstructure is rigidly braced into the block foundation at the southern abutment on the Lindach side.

On the northern side of the Kocher Island Unterwöhrd, where the bridge meets the existing embankment wall at an oblique angle, it is supported by a spring lamella that allows longitudinal movement. The abutment on the Lindach side thus forms the fixed point.

The filigree bridge structure now provides pedestrians and cyclists with a direct connection from the train station to the city centre, where the new open-air theatre is also located.

Since access was also required for the latter, it was necessary to ensure that, in addition to service vehicles, including a 22-ton wheeled excavator, delivery and fire trucks could also drive up to the theatre.

The resulting additional or maximum load had a corresponding influence on the cross-sectional dimensions of the components in the structural calculations. Nevertheless, the variable cross-sectional thickness of the approximately 31 m long bridge is only 35 cm to 90 cm.

A real innovation here is the central support. No timber-concrete composite bridge with a sloping central support has ever been built before. As a result, around 21 m of the total bridge length of 31 m spans the river unsupported.

The elegant structure blends harmoniously into its urban surroundings and, thanks to its innovative technological character, adds an accent that gives it a distinctive identity.

To ensure traffic safety at night, the walking surface is illuminated by lighting discreetly integrated into the handrails.

CONCLUSION

In large cities, mobility will change to cope with enormous population growth and to maintain or develop cities as places to live.

As will be shown, this will have a significant impact on transport systems and their infrastructure, including bridges.

Outside cities, autonomous driving and digitalization will change the way people travel.

As digitalization progresses, we will be able to significantly increase the capacity of our existing infrastructure.

It is important that urban planners, architects and engineers succeed in maintaining the mobility that people have come to value, while at the same time improving quality of life (e.g. less time wasted in traffic jams) and taking care of our built and unbuilt environment in the interests of a climate-friendly lifestyle.

THE SCHORGASTTAL BRIDGE – FROM COMPETITION TO COMPLETION

Dr. Bernhard Schäpertöns

BPR Dr. Schäpertöns Consult GmbH & Co. KG

Figure 1: Aerial View of B 289 Bypass Untersteinach *Photo Hajo Dietz*

INTRODUCTION

When the competition for the Schorgasttal Bridge was announced by the Bayreuth State Building Authority in 2010, we at what is now BPR Dr. Schäpertöns Consult, SRP Schneider & Partner from Kronach, and architects Otto Schultz-Brauns and Armin Reinhart, formed the design team.

During the Planning Approval phase, the State Building Authority in Bayreuth had previously submitted a bridge design for an eight-span deck-bridge with downstand beam cross sections that crossed the Schorgast River in its seventh section with a larger span in order to emphasize that river crossing.

Additionally, the main span deck comprised haunches to the neighbouring sections.

The competition invited proposals for a well-designed structure which achieved an optimum

Figure 2: Visualisation of the future Schorgasttal Bridge

balance between cost, sustainability, functionality, structure, innovation and construction technology – though it was clear that these criteria could not all be fulfilled to the same degree.

Our design team quickly realized that the task could be divided into two largely independent parts: a gallery structure crossing the railway line, and a major bridge crossing the Schorgast Valley as the more prominent structure.

A further insight that emerged from this first consideration of the task was that the spans across the valley could be spaced more generously so that they could be equidistant with shorter end spans between the final piers and abutments.

Client:	Free State of Bavaria represented by State Building Authority Bayreuth
Design, Planning and Construction Supervision:	SRP Schneider & Partner Ingenieur-Consult GmbH, Kronach BPR Dr. Schäpertöns Consult GmbH & Co. KG, Munich SB Schultz-Brauns Planung GmbH, Munich
Approval:	Dr.-Ing. Erhard Garske, Munich
Construction:	Consortium Talbrücke Schorgast consisting of Ed. Züblin AG, Dresden Züblin Stahlbau GmbH, Hosena
Subcontractors:	
Piles:	DEMLER Spezialtiefbau GmbH + Co. KG, Netphen
Cables:	Fatzer AG, Romanshorn, Switzerland
Expansion Joints:	Maurer SE, Munich
Bridge Bearings, Cable Dampers and Cable Collars:	BT Bautechnik GmbH, Norderstedt

CONCEPT DEVELOPMENT

In the beginning, our team came up with different, competing ideas.

A further variant, though more conservative, would have been a multi-span bridge with cable-stayed sections, suspended either from central pylons along the middle of the road – a kind of "Mini-Millau" in the style of Foster + Partners – or with pylons arranged on both sides as seen in Christian Menn's design of the Sunniberg Bridge.

The first variant was deemed unsatisfactory due to its division of the traffic lanes, while the second, as our architects rightly noted, would produce inelegant views resulting from overlapping cable sections on either side as the bridge crosses the valley diagonally and in a sweeping curve.

For the team, it was clear that to have a chance of winning the competition, we needed an outstanding design that united optimal function and construction with absolute innovation.

Our designs so far had not fulfilled that promise: they were too "rigid" and lacked elegance and lightness.

My idea of arranging the pylons serially only along the inner side of the curving bridge, i.e. of determining the central axis of symmetry through the centre of the circle spanning the arc and no longer through the curving path of the superstructure itself, was the breakthrough we needed.

This change made it possible for the bridge section to be asymmetrical, at once making it stronger to resist the extreme torsional forces but also lighter as it could taper at the outer rim.

Our winning design proposed a multi-span cable-stayed bridge crossing the valley in a curving arch. Six pylons were arranged along the inside edge of the curve and inclined radially inward. Each pylon had ten stay cables to support a slender composite steel girder with a torsionally stiff box section as the bridge superstructure.

In their synopsis, the jury praised the self-assured presence of the bridge across the Schorgasttal valley that through its poise enters into a harmonious synthesis with the sensitive landscape. The bridge's substructure affords the greatest possible transparency while the superstructure above asserts a significant presence.

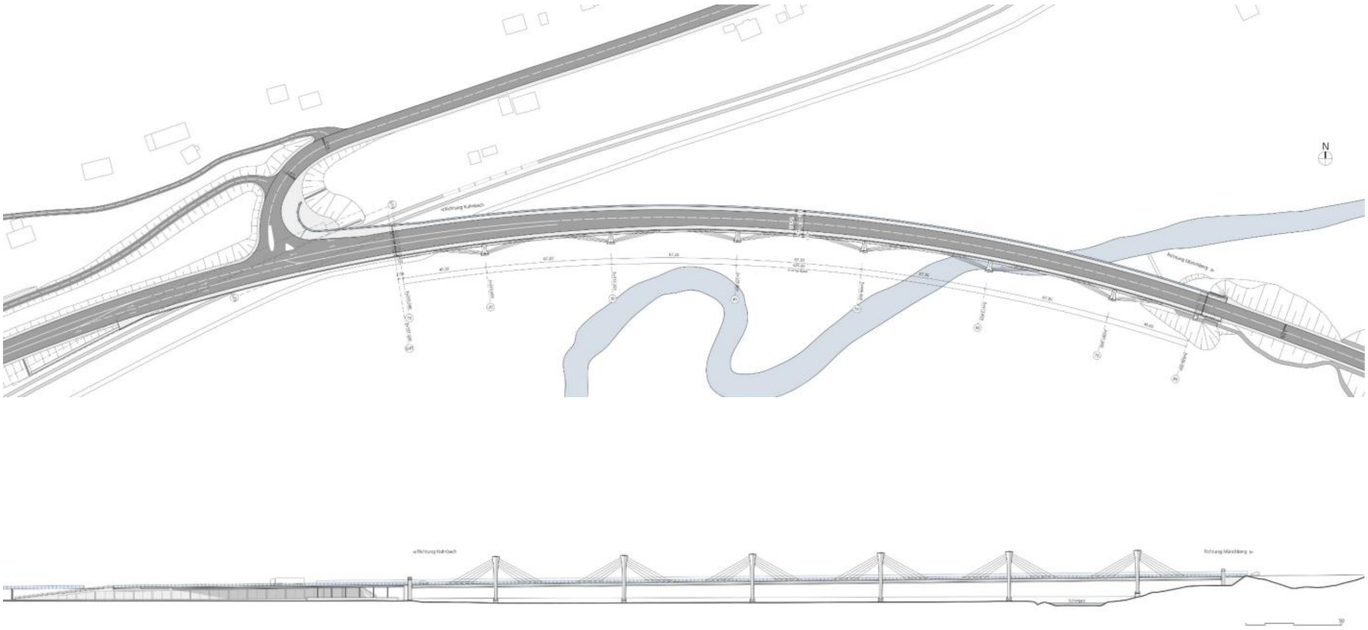


Figure 3: Ground Plan (above) and Elevation (below)

Click on the image to open it in a higher resolution

Overall, the design represents a worthy contribution to building a culture that is both innovative in its concept and expressive in its design. The jury awarded the design first prize, expressly acknowledging that this was the most elaborate solution.

STRUCTURAL DESIGN

The final bridge design was developed from the initial proposal of the winning competition entry. At the site, the federal highway B 289 describes a curve with a radius of 900 m transitioning into a clothoid shortly before the end of the structure.

The bridge has a single lane in each direction and therefore a standard width of 8 m, widening between Axis 50 and 10 to accommodate a right-hand exit lane for the Untersteinach West turnoff. Therefore, the curb-to-curb width of the bridge pier comes to approx. 11.20 m.

The bridge is designed as a slender, semi-integral structure. Its superstructure consists of a steel-concrete composite structure suspended on one side from six pylons, each with two sets of five 110 mm diameter fully locked stay cables.

The pylons and inclined supports are monolithically connected to the superstructure. The bridge spans differ slightly from the originally submitted design for planning approval: the final structure has five equal spans of 67.20 m for the inner spans and two 45 m end spans. In total, the overall length of the bridge comes to 426 m.

The superstructure is a composite structure: reflecting its one-sided suspension from the inner side of the curve, the cross section of the bridge superstructure is a torsionally stiff, asymmetrical steel box with a maximum construction height of 1.60 m.

On top of the steel box girder is a 25 cm thick concrete slab, making a total construction height of approx. 1.85 m. This results in a span-to-construction-height ratio (l/h) of 36.30 for the centrally located longer spans.

The approx. 24 m high pylons incline upwards towards the centre of the curving road at an angle of about 18˚ (3:1).

The steel box girder of the superstructure is rigidly connected to the pylon on one side, and on the other, it rests on a steel support with a 14˚ incline in the reverse direction.

The hollow circular support has a diameter of 1.20 m and is rigidly anchored to the same foundation as the pylon.

The cable anchorages are integrated into the superstructure at stressing chambers which hide them from view in elevation. The fixed anchorages are located at the pylon heads. For the suspension we chose fully locked coil cables which are now a standard and well-proven solution for this kind of bridge design.

The cables were installed and tensioned after the steel construction had been erected. This has the benefit of preventing cable sag or failure under unfavourable load conditions.

Finally, the entire supporting structure is dimensioned to accommodate the failure or replacement of a cable under full traffic load.

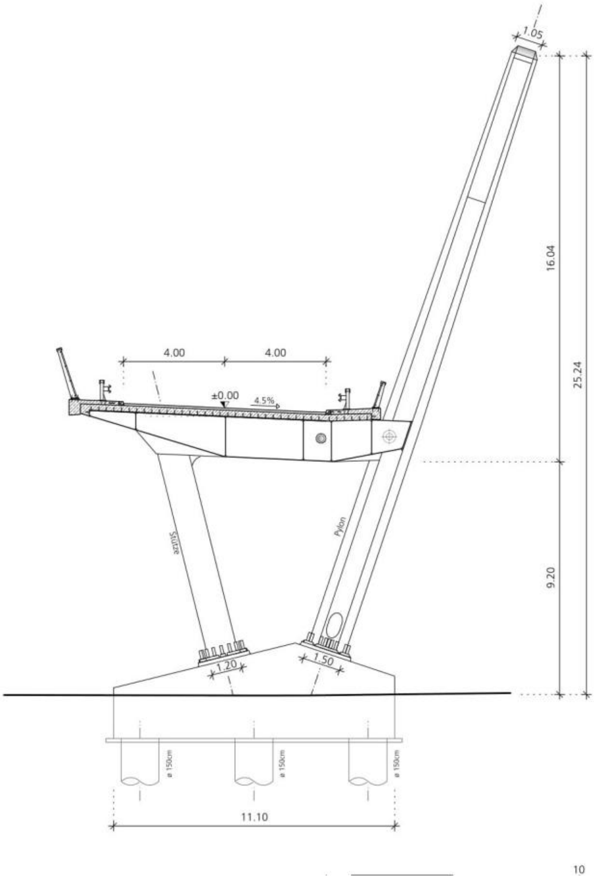


Figure 4: Cross Section with Pylon and Round Support

Click on the image to open it in a higher resolution

GEOLOGY AND GROUND CONDITIONS

The Schorgast Valley, the municipality of Untersteinach and thus also the town's bypass road are located at a place of special geological interest and historical significance, the Upper Franconian fault-block zone. This runs diagonally from southeast to northwest across the Central European continent. It is here that bedrock and overlying rock collide at the surface, with the bedrock thrusting several kilometres over the foreland. Over the course of approx. 100 million years, the area northeast of the Franconian Line was uplifted tectonically to an elevation of up to more than 2000 m.

This tectonic and geomorphological fragmentation is evident on the surface of the Schorgast Valley, where hill chains of Keuper, shell limestone and sandstone ridges can be seen in close proximity to one another. Due to the geological-tectonic processes described above, the subsoil conditions around the site of the Schorgasttal Bridge are highly variable.

Beneath the topsoil lies alluvial loam with a thickness of 2 to 3 m. This is followed by medium-dense valley gravel with a layer thickness ranging from about 4 m in the valley to 16 m on the outer bank of the Schorgast River (axis 80 of the bridge).

Underneath are thick, silty-sandy weathering layers of Keuper and shell limestone of a mostly soft to stiff consistency. In some places, semi-solid to solid consistencies were found.

As the drilling depth increased sharply toward the southeast, the exploratory borings also encountered weakly to moderately weathered Keuper and shell limestone formations.

The limestone horizon, which is suitable as a foundation, unfortunately dips steeply towards the southeast and by construction axis 70 was only reached at a depth of over 50 m. On one of the pier axes, artesian groundwater was pierced while drilling. The groundwater horizon was assumed to reach ground level and when the Schorgast River floods, the valley floor and site overflow.

So, both the gallery and the bridge construction rest on large-diameter pile foundations. The bored piles have a diameter of 150 cm. They are sunk to a depth of between 24.50 m and up to 54 m.

Each end of the bridge where it meets the abutments is a laterally constrained sliding spherical bearing. The second bearing at each end of the bridge is a pinned column due to the considerable upward forces that occur at these points. Each end support has a modular expansion joint.

The gallery on the other side has no bearings due to its design as a fully integral structure. Here only an asphalt expansion joint absorbs any small movements without damaging the structure.

CONSTRUCTION

Construction was carried out by ARGE Talbrücke Schorgast consortium under the leadership of Züblin AG from Dresden.

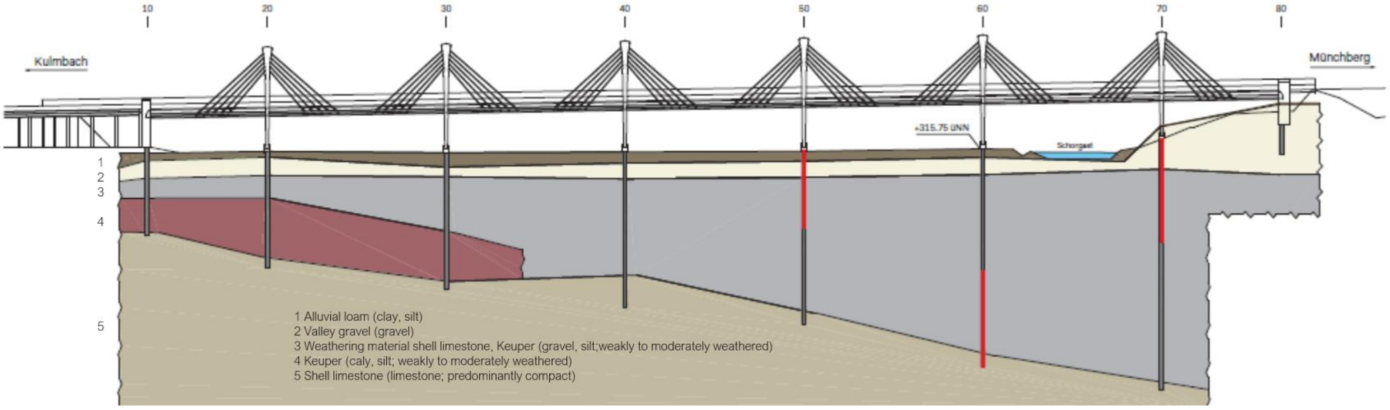


Figure 5: Longitudinal Section showing subsoil Conditions, inflated

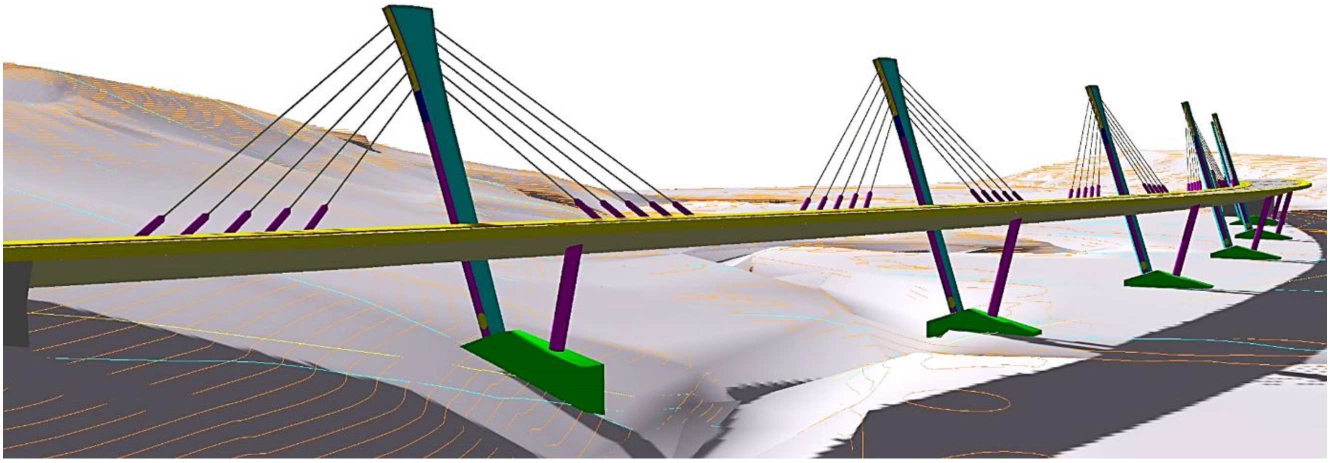


Figure 6: 3D Coordination Model

The construction contract was awarded in September 2017. The contract value for the bridge and the gallery was 42 million euros incl. VAT. As the execution planning was well advanced by that time, construction of the gallery and bridge could start immediately.

The piles were bored from February to May 2018, and the pile heads, abutments and dividing piers of the viaduct from April to July 2018.

Factory prefabrication of the steel structure began in Spring 2018, and assembly started in Summer 2018 and was completed in Summer 2019.

Cable fabrication took around a year, with the subsequent mounting of the cables following in summer and autumn of 2019. In Spring 2020, the roadway slab was constructed. After a five-year construction period, the Untersteinach bypass was opened to traffic on 10 December 2020.

Figure 7: Steel Works Erection *Photo: Reinhard Feldrapp*

Figure 8: Concreting Deck *Photo: Reinhard Feldrapp*

Figure 9: View from the hill *Photo: Oliver Kleinschmidt*

Figure 10: View to the West
Photo: Oliver Kleinschmidt

Figure 11: Pylon and Cables
Photo: Oliver Kleinschmidt

UNDERSLUNG MOVABLE SCAFFOLDING SYSTEM FOR THE NECKAR BRIDGE ON A6 MOTORWAY, GERMANY

Filipe Pinto, Project Manager

BERD

Figure 1: Aerial view of the construction site

INTRODUCTION

This article showcases one of BERD's reference project where a MSS Movable Scaffolding System was used for the construction of the remarkable A6 Neckar Bridge. It is located on the A6 motorway in Heilbronn, Germany and has two parallel decks with a typical TT cross section. Each 21m wide deck has 22 spans, with a typical span of 38 m, resulting in a total building length of 1644 m.

For the construction of these twin viaducts, we redesigned and refurbished a self-launched gantry M38-I with Organic Prestressing System (OPS). The equipment was prepared for industrialised cycles and to comply with the bridge's design specifications. We also implemented protective measures to ensure safe operation.

M38-I MOVABLE SCAFFOLDING SYSTEM (MSS)

The M38-I is an underslung self-launched Movable Scaffolding System, conceived for span-by-span construction of cast-in-situ concrete bridges with decks with a span length of up to 38 m. Its moving part has a total length of 93 m and a weight of about 450 tonnes (including all metallic structure, formwork, hydraulic equipment and other components).

The main M38-I load carrying structure comprises three steel truss girders (two lateral and one central in the middle). Each girder is equipped with a set of prestressing cables which are during the concrete pouring stage actively controlled by an Organic Prestressing System (OPS).

Figure 2: Underslung movable scaffolding system M38-I

ORGANIC PRESTRESSING SYSTEM (OPS)

The OPS, worldwide patented and used exclusively by BERD, is a deflection control system that helps ensure lighter, safer and more functional operation.

It also includes several safety systems, such as redundant components, monitoring systems and alarm warning.

The OPS is an adaptive prestressing system in which the forces applied are automatically adjusted to the acting load, reducing strains and minimising stresses to compensate for the deflection.

During the launching stage, the cables are not active, and the structure behaves as a simple truss structure.

Main Girders

The Main Girders are the most important structural element of the MSS. They support the transverse structures that carry the load from the formwork.

During the concrete pouring stage, in which maximum vertical loading occurs, the MSS is supported in 2 different sections: in the front tower and in the rear deck frame.

Figure 3: The deck construction

The front support section is nearly the same for all the spans (it varies slightly due to the plan curvature radius).

Each of the Main Girders is composed of the front nose, the main body (where the transverse structures are assembled) and the rear nose.

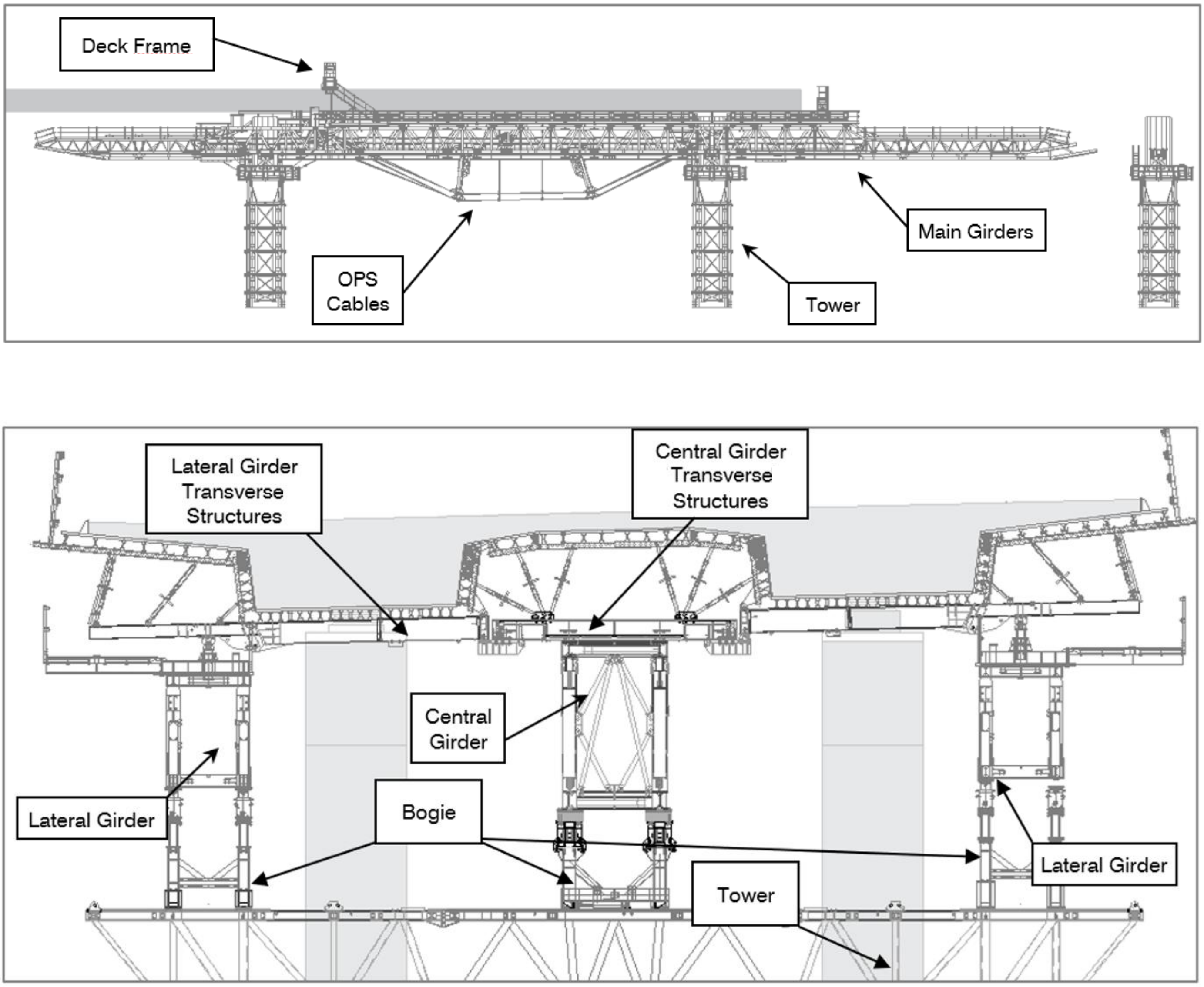
Transverse Structures

The transverse structures support all the MSS formwork. They are located on the central and lateral girders. They are composed of eight interlinked panels that give support to the formwork.

The ones on the lateral girders are supplied with a rotation mechanism (with hydraulic cylinders) in order to allow MSS launching with minor transverse movements of the lateral girders.

They are equipped with spindles on their interface with the lateral girders which allows the transverse structures to be levelled in altimetry to promote the transverse slope of the bridge deck.

During the concreting stage, they are supported on the three girders. During the launching stage, they are separated and each girder transports its own transverse structure.



Figures 4 and 5: Description of the M38-I

Figure 6: The MSS operating under the deck

Bogies

Bogies are the components that form the interface between the main girders and the towers. They give support during both the launching and concreting stages.

During the launching stage, they support the weight of the main girders using the roller devices. These rollers have a low friction factor to promote the longitudinal movement on each main girder.

At the concreting stage, the front support of the girders is made on the bogies. There are 6 sets of bogies for the lateral girders and 3 for the central girder.

Towers

The towers give support to the whole MSS during the launching and concreting stages.

They are equipped with transverse sliding rails that allow the main girders to be adjusted transversely during concreting and launching using hydraulic cylinders.

The top level of the towers is a full working platform equipped with safety handrails.

The MSS disposes of 3 sets of towers. Special anchorages on top of the pile cap need to be previously installed before each assembly.

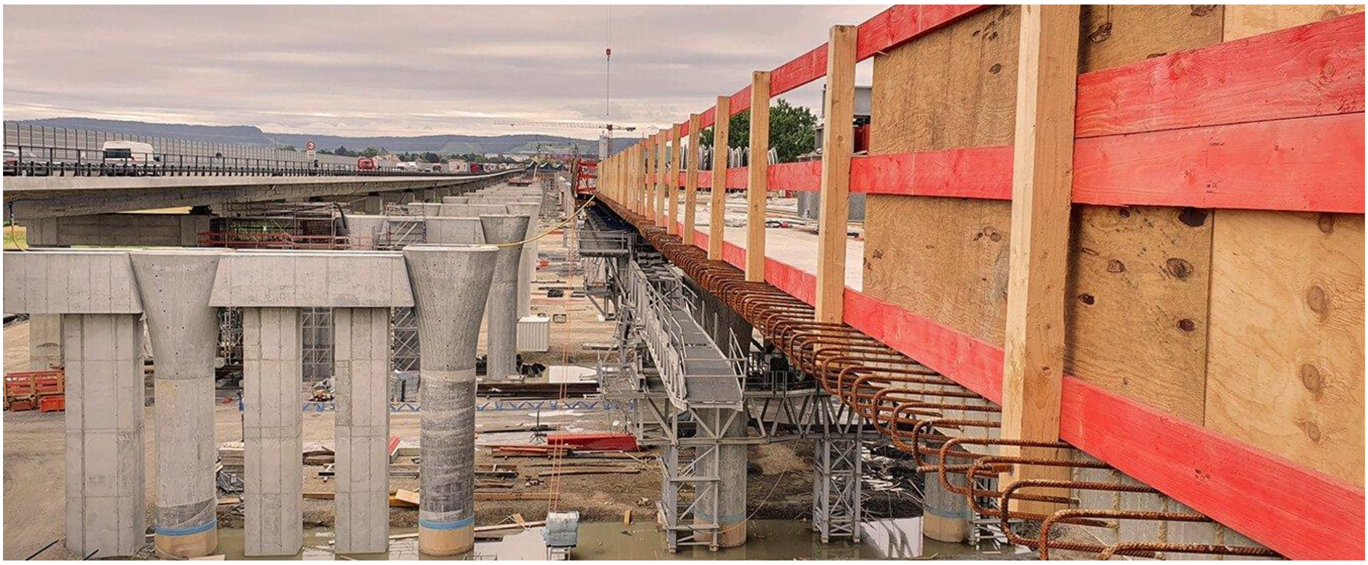


Figure 7: View of the MSS from the side of the bridge

For horizontal load transmission, special spindles on the top level of the tower need to be leaned against the pier.

All the bracing systems of the MSS are assembled directly to the towers.

Bracing System

The bracing system guarantees the stabilisation of the main girders for horizontal loads (longitudinal and transverse ones). It is a blocking measure that shall be used when the MSS is in operation.

These elements are also especially important in the case of high-speed winds or storms.

Formwork

The formwork is generally composed of plywood panels, timber and steel beams, spindles and other accessories. For this particular project wood boards were used as a surface and visual finishing requirement of the client.

The formwork is placed directly on top of the transverse structures. For the cross-beam concreting, we developed a specific solution.

READ ABOUT THE PROJECT ON OUR WEBSITE

MAIN CHALLENGES

For the construction of the bridge, we had to face several challenges:

- For the assembly of the MSS we had a limited space;
- The MSS was disassembled under the built deck;
- The deck was very heavy;
- The bridge crosses a crucial road open to traffic; the operation had to be absolutely safe;
- The work cycle was demanding;
- The first span was built over the existing road, which meant a limited time for the operations during overnight road closure.

Apart from that, the project required a turnkey solution and operation, and also a technical solution that ensures a high construction quality and control of deck deformations.

CONCLUSION

The underslung movable scaffolding system we used for the construction of the A6 Neckar Bridge ensured fast construction with cycles of nine days. It also enabled a highly industrialised construction process and ensured high construction quality and deformation control.

During all the construction, high safety levels were observed, taking into account that the first spans were built over a road open to traffic.

Figure 8: The MSS ensured fast construction within cycles of nine days

MM1018 – THE LIQUID-SHIM® SECURES LONG-TERM INTEGRITY OF GERMANY'S HIGHEST STEEL RAILWAY BRIDGE

Carsten Vogels, Key-Account Manager

DIAMANT Polymer GmbH

Figure 1: The Müngsten Bridge is the highest steel railway bridge in Germany with a height of 107 m

1. INTRODUCTION

Historic bridge structures are not only engineering marvels but also vital components of transportation infrastructure, often exposed to extreme mechanical and environmental stress.

Their sustainable refurbishment demands the seamless integration of traditional engineering expertise with modern materials.

A prime example of such a fusion is the Müngsten Bridge - Germany's highest steel railway bridge. This structure has faced growing operational demands, necessitating a technically sophisticated refurbishment. A central challenge involved achieving a precise, load-bearing, and full-surface connection between newly designed bearings and reinforcement profiles and the over 100-year-old steel structure.

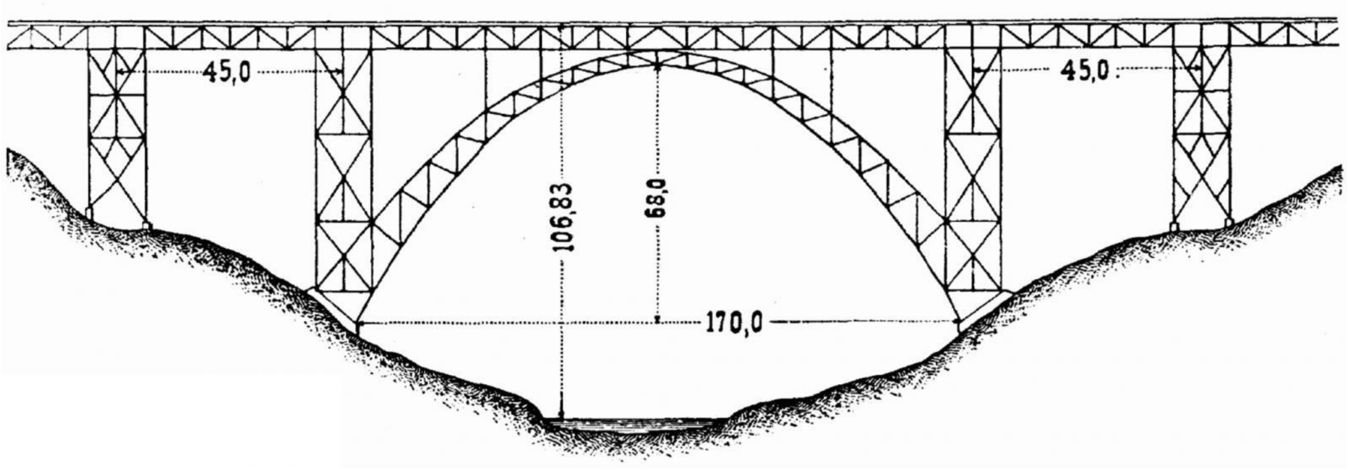


Figure 2: Sketch of the Müngsten Bridge with its dimensions

The use of MM1018, a metal polymer developed by DIAMANT Polymer, provided a safe and simple solution. This innovative material proved to be a critical enabler for the successful long-term rehabilitation of the bridge.

2. THE MÜNGSTEN BRIDGE: A CENTURY-OLD ICON OF GERMAN ENGINEERING

Opened on 15 July 1897, as the “Kaiser Wilhelm Bridge,” the Müngsten Bridge spans 465 m across the Wupper Valley between Solingen and Remscheid, rising 107 m above the ground. Composed of 4,978 tons of steel and joined by over 934,000 rivets, its structure includes six lattice piers and a central arch with a main span of 170 m.

This steel bridge has been an essential part of the Deutsche Bahn railway network for more than a century, reducing once the rail distance between the two cities from 44 to just 8 km - a milestone for regional development.

Preserving this landmark is of both logistical and cultural significance, as it is now a candidate for UNESCO World Heritage status.

In the course of its refurbishment, the bridge was completely refurbished for long-term use in route class CM2, whereby historical substance, structural safety and modern requirements had to be reconciled.

3. REFURBISHMENT REQUIREMENTS AFTER MORE THAN 100 YEARS OF USAGE

After more than 113 years of continuous use by trains and environmental exposure, a 2010 structural inspection revealed fatigue-related damage and increased structural deterioration.

Corrosion, stress-related wear, and material fatigue particularly affected critical components such as gusset plates and the original roller bearings, which required complete replacement.

The gusset plates connect load-bearing steel girders and are essential for the supporting structure. Their partial corrosive and structural weakening posed a long-term threat to operational safety.

Furthermore, all 28 original roller bearings and the 126 deck bearings mounted on gusset plates needed replacement.

The replacement of these bearings posed a particular challenge, as they had to be precisely adapted to the partially distorted and corroded historical structures of the gusset plates, which had been subjected to decades of stress, and required a force- and form-fit connection to the existing structure.

THE SOLUTION: MM1018 – THE LIQUID-SHIM® AS FLEXIBLE GAP COMPENSATION

To guarantee operational safety, the rigid and seamless connection of the new bearings to both the upper and lower bridge structure was an essential prerequisite for the operational safety of the Müngsten Bridge.

A complete, full-surface and form-fit gap compensation was essential for even load transmission - an extremely demanding requirement given the state of the historical components.

Considering these findings, the MM1018 metal polymer was identified as the optimal solution.

The composite material, which contains metallic fillers, was specially engineered for structural gap compensation in steel and bridge construction. It is the only product of its kind with official German building authority approval for such applications.

MM1018 can be applied directly on site - whether injected in liquid form or applied as a putty version - allowing it to fully adapt to irregular geometries while ensuring durable and stable connections between structural elements.

Its outstanding compressive strength, creep resistance, and chemical durability make it a superior alternative to conventional shims, lining and wedge plate - particularly for heritage structures with individually shaped geometries.

Unlike mechanically machined plates, MM1018 does not require prefabrication and conforms precisely to the actual surface geometry - without the need for extensive rework.

Figure 3: The refurbishment work began in 2013

MM1018 IN ACTION: APPLICATION ON THE MÜNGSTEN BRIDGE

A major advantage of the metal polymer MM1018 during the Müngsten Bridge refurbishment was its versatile application: the material could be processed both as a paste and as a liquid, allowing it to be optimally adapted to the structural requirements.

For the gusset plate connections to the supporting structure and for gap compensation when installing a total of 28 new roller bearings, the liquid variant of MM1018 was used.

Thanks to its superior flow behaviour, the material could be injected into the cavity through designated injection points, displacing air through ventilation ports to ensure complete, void-free gap filling. The result was a full-surface and force-fit connection across the entire contact area.

In contrast, the putty variant of the metal polymer was used to connect the base plates of the 126 new deck bearings to the gusset plates. Applied with a trowel onto the contact area, the paste provided precise gap compensation, even on uneven or inclined surfaces.

Both variants cure within 24 hours, are resistant to chemicals, non-conductive and corrosion-resistant.

The time component also posed a considerable challenge during the renovation of the Müngsten Bridge. The replacement of all roller bearings had to be completed within a tight 21-day window - an enormous logistical challenge.

Without the rapid and efficient application of MM1018, this ambitious schedule would have been almost impossible to meet.

The smooth processing on site, the high material safety and the immediate load-bearing capacity after curing made the material a real success factor in this historic refurbishing project.

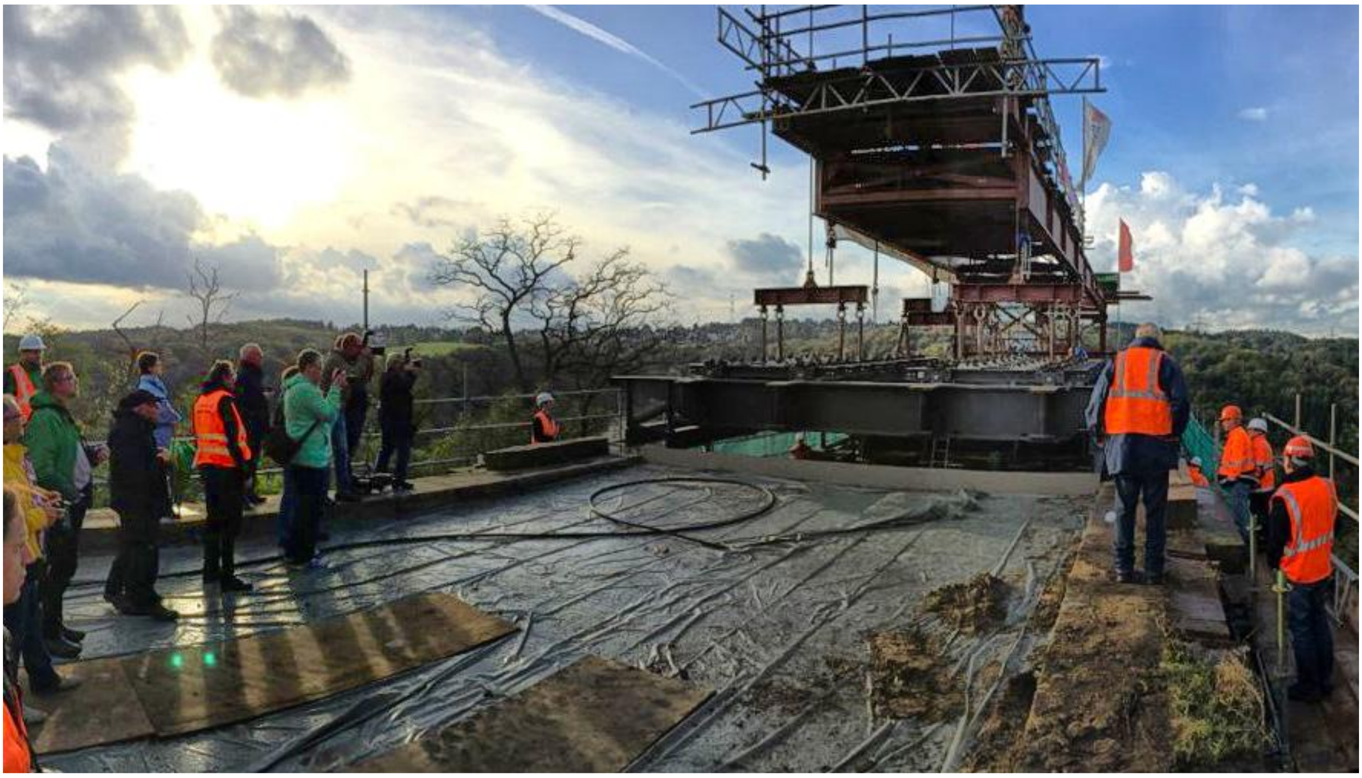


Figure 4: MM1018 was used for the connection and installation of newly designed bearings and reinforcement profiles

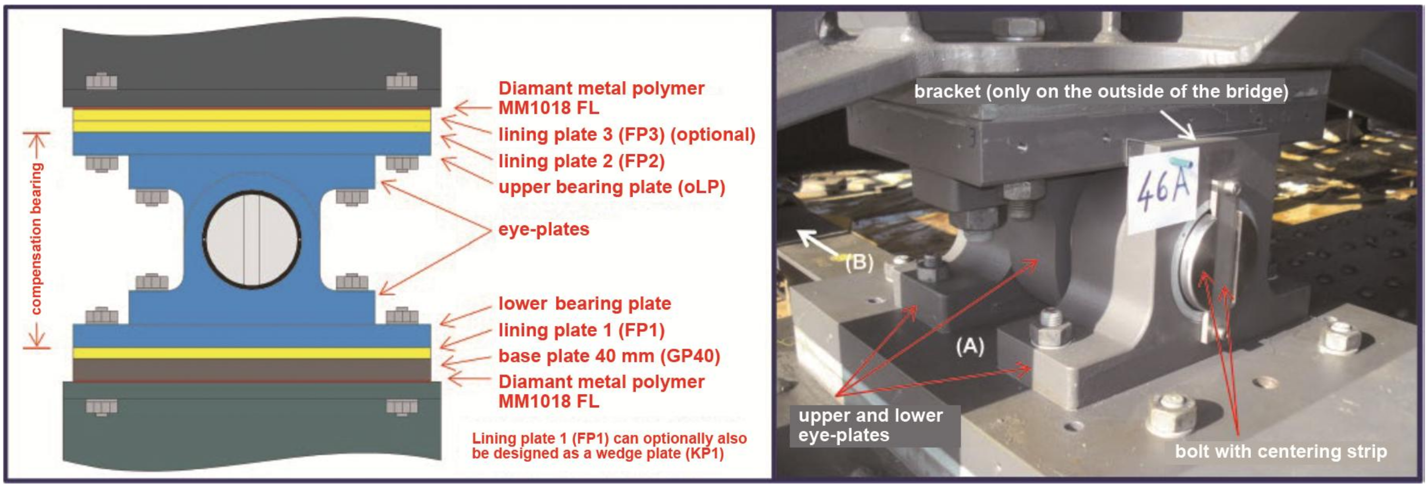


Figure 5: Schematic diagram of a typical connection of the newly designed compensation bearing [1]

4. TECHNICAL EXCURSION: ENGINEERING A NEW BEARING TYPE

The Müngsten Bridge refurbishment required not just replacing existing bearings but developing an entirely new compensation bearing type tailored to the bridge's unique load and movement dynamics.

Due to the complex movement and load conditions, particularly the cyclical forces from railroad operations, conventional elastomer or spherical bearings were out of the question.

Instead, a new type of compensation bearing was developed that was able to meet the high requirements, even in view of the limited space available, while at the same time ensuring the necessary mobility and absorption of tensile forces [1].

A crucial prerequisite for this design's success was a precise and even connection between bearing components and the irregular mounting surfaces of the bridge.

Again, MM1018 played a vital role by enabling complete flatness and inclination compensation. Figure 5 schematically highlights the typical installation process of this custom bearing system.

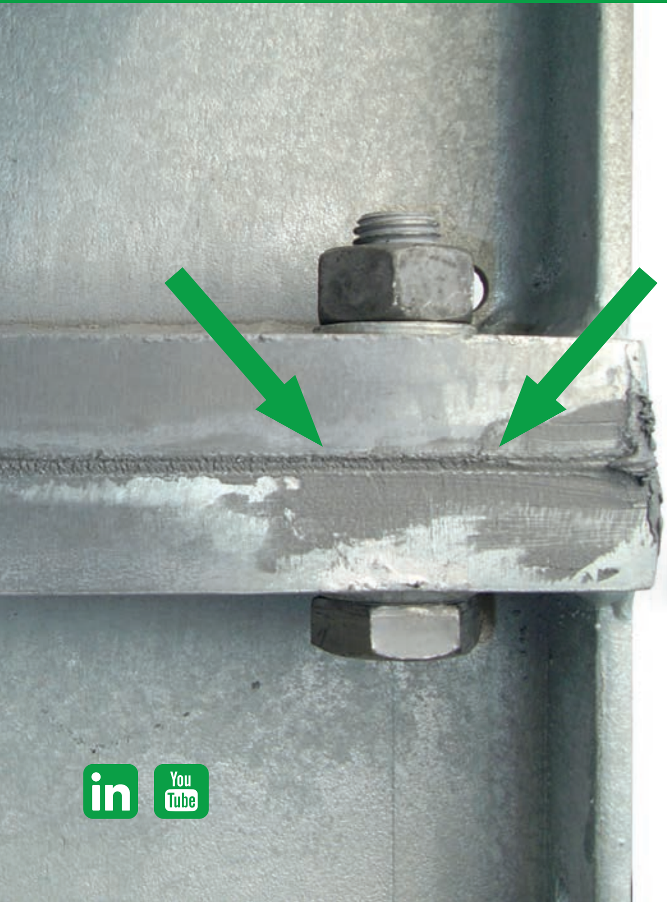
5. CONCLUSION: MM1018 AS A KEY MATERIAL IN BRIDGE CONSTRUCTION

The use of MM1018 in the refurbishment of the Müngsten Bridge impressively demonstrates the advantages of innovative polymer composite materials in traditional steel construction, especially in the refurbishment of historic engineering structures.

Its ability to deliver full-surface, load-transferring and form-fitting gap compensation - even in complex irregular gap geometries - ensures long-term structural integrity. Combined with its ease of handling, rapid curing time, and resistance to environmental stressors, MM1018 offers clear time and cost advantages over conventional solutions and makes it a key material for bridge renovations where absolute precision is required.

This case of the Müngsten Bridge exemplifies how traditional engineering expertise and modern materials engineering can work hand-in-hand to create future-proof solutions even for historic structures.

[1] Bewersdorff, S., Kina, J., Liebelt, M., Porsch, M., & Schackenberg, R. (2019). Entwicklung eines neuen Lagertyps für den Eisenbahnbrückenbau. *Stahlbau*, *88*(2), 105-127




DIAMANT
MM1018
Putty - Component A
#1436A
DIAMANT
MM1018
Putty - Component B
#1436B
GERMAN GENERAL BUILDING
AbZ
APPROVAL

COMPLEX BEARING REPLACEMENT AT THE PORT OF HAMBURG

Michael Trzeciok, Project Manager

MAURER SE

Figure 1: The Köhlbrand Bridge in Hamburg

INTRODUCTION

Changing the bearings on the important Köhlbrand Bridge at the port of Hamburg is a major challenge. Through a combination of massive scaffolds, special launching tracks and electric winches inside the bridge deck, MAURER is demonstrating what engineers and installers are capable of.

The Köhlbrand Bridge sits at the heart of the port of Hamburg. Opened in 1974, the asymmetric cable-stayed bridge crosses the Köhlbrand, which is part of the Süderelbe.

It connects the western areas of the port with the island of Wilhelmsburg on the river. It also links the port to the motorways heading towards Flensburg, Kiel, Hanover and Bremen.

The bridge carries large volumes of heavy goods traffic, particularly on weekdays, while its clearance of 53 m allows container ships to pass underneath.

It was this height that posed a challenge when it came to replacing the bridge bearings.

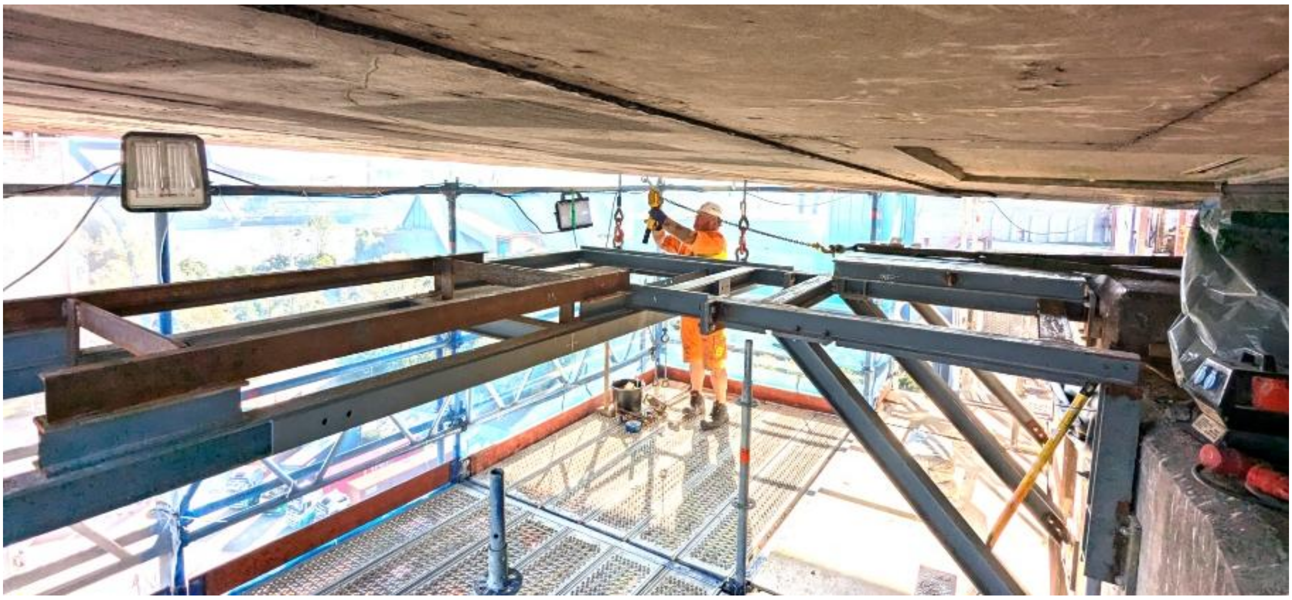


Figure 2: Scaffolding for reaching the bearings

LAUNCHING TRACK AND SCAFFOLD TOWER

The problem when changing the bearings here is not the bearings themselves, but rather the installation and removal.

Each of the three piers forms its own project phase. After intensive preliminary work, replacing the two bearings on each pier requires the bridge to be closed from Friday evening to Monday morning every time. This is because the bridge deck can only be raised when there is no traffic.

The first two bearings were replaced in October 2023. Pier 101 stands on the island. A scaffold measuring around 40 m in height was built here to reach the bridge bearings.

A special launching track with table was designed, in order to remove an old bearing from the pier and replace it with a new one.

Figure 3: Taking away the old bearing

Figure 4: The cables passing down through the box girder on the left and right

The old bearing was taken away on the table via the launching track and put down, before the table returned with the new bearing.

This required electric winches, which were installed inside the bridge's box girder.

REPLACEMENT OVER WATER

The second phase in September was even more challenging, as pier 102 is located in the water of the Köhlbrand itself.

To replace the bearing here, a temporary bridge was constructed from pieces of the scaffold in order to access the pier from the water.

A total of six pot bearings are being replaced in three phases until 2025.

The bearings each measure 1.5 x 1.5 m, with a weight of 2 t and a load-bearing capacity of up to 30,400 kN.

All photos: MAURER SE

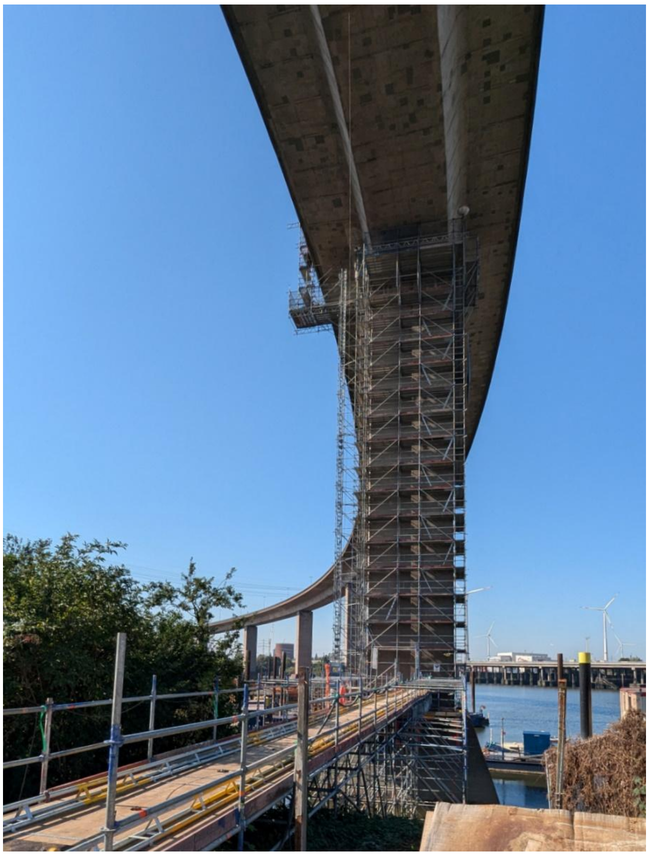


Figure 5: A temporary bridge for accessing the Bridge from the water

Figure 6: New bearing

QUICK FACTS ABOUT MAURER SE

MAURER SE is a leading specialist in mechanical engineering and steel construction, with over 1,500 employees worldwide.

The company is the market leader in structural protection systems (bridge bearings, expansion joints, seismic protection devices, tuned mass dampers and monitoring systems).

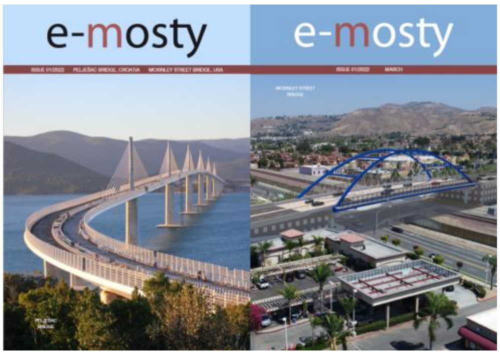
It also develops and produces vibration isolation solutions for structures and machines, rollercoasters and Ferris wheels, as well as special structures in steel construction.

MAURER has been involved in many spectacular large-scale projects. These include the world's largest bridge bearings in Wazirabad, Pakistan, earthquake-resistant expansion joints for the world's longest suspension bridge, the 1915 Çanakkale in Turkey, tuned mass dampers in the Baku and Socar Towers in Azerbaijan, and the unique guided cross-ties with derailing protection on the Champlain railway bridge in Montreal.

Complete structural isolation projects range from the Acropolis Museum in Athens to the new airport in Mexico.

MAURER has also worked on spectacular amusement rides, such as the Umadum Ferris wheel in Munich, BOLT™ – the first rollercoaster on a cruise ship, and the world's first duelling rollercoaster at the Mirabilandia Park in Ravenna, Italy.

You can also read about spherical bearings for the Pelješac Bridge in Croatia in the March 2022 e-mosty:



MAURER

MAURER MSM® Swivel Joist Expansion Joint

OSMAN GAZI BRIDGE, IZMIT, TURKEY | WORLD NO. 4 SUSPENSION BRIDGE WITH HIGH SEISMIC LOAD

Scope of application:
The installation of the MAURER Swivel Joist Expansion Joint shall allow access to and protect the bridge deck from horizontal over load during a seismic event.

Features:

- Unrestrained absorption of specified movements and simultaneous transmission of traffic loads
- Serviceability of the structure after the earthquake
- Protection of the bridge deck from horizontal overload caused by extreme closing movements during the earthquake
- High life time expectation through use of high performance components
- Longitudinal seismic displacement of ca. 4 m
- Service velocity up to 20 mm/sec (10 times higher than for a regular bridge)
- Watertight across the bridge width
- Maintenance free

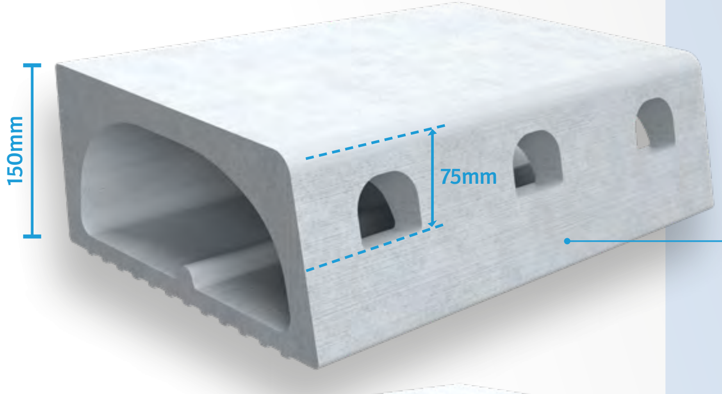
References:

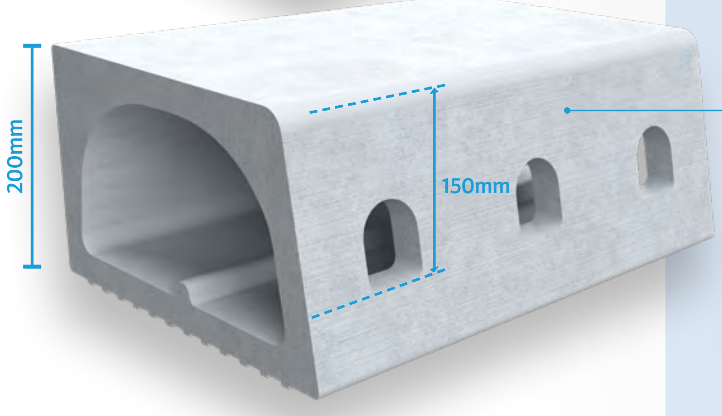
- Bahia de Cadiz, Spain
- Hochmoselübergang, Germany
- Osman Gazi Bridge, Izmit, Turkey
- Mainbrücke Randersacker, Germany
- Millau Viaduct, France
- Rheinbrücke Schierstein, Germany
- Rion Antirion, Greece
- Russky Island Brigde, Vladivostok, Russia
- Tsing Ma, China

Suitable for
75 and 150 mm
Kerb height and
all heights in
between

BRIDGE DRAINAGE UNIT

The bridge drainage channel Type M is designed to collect and discharge surface and structural water from bridges and elevated roads, used by all types of road vehicles.





AVAILABLE HEIGHT OPTIONS

The height of the inlet openings is milled to project-specific dimensions.

BD350x150 = 150mm high element
Top slope 4%
(according to BAST guideline Kap12)

BD350x200 = 200mm high element
Top slope 2%
(according to BAST guideline Kap12)

TECHNICAL FEATURES AND ADVANTAGES

The bridge drain elements are made of one material and are moulded monolithically. In other words, they are manufactured in one piece, which ensures a stable structure with high impact resistance.

CUSTOM SOLUTIONS

We specialize in customization. Depending on your requirements, we determine which element best fits your project. We can utilize various production locations, material types, and manufacturing methods to meet your schedule and needs.

CLICK HERE
For more features, advantages and examples.

Bridge Drainage | Business Park Stein 108 | 6181 MA Elsloo | The Netherlands | T. +31-462 07 70 08 | E. info@bridge-drainage.com

www.bridge-drainage.com

Structural analysis software for structural engineers

Structural analysis software that's fun to work with!

Since 1987, we have been developing intuitive software solutions for structural analysis, dynamics, CFD analysis and structural design. Our goal is to be not only the best known, but also the most user-friendly structural analysis software in the world. Everyone out there should be able to say: We use Dlubal because structural analysis is fun!

Products

RFEM

- Finite element method for analyzing and designing load-bearing structures.
- Enables the creation of complex 3D models.

RSTAB

- Especially for the analysis and design of frame and beam structures.
- Supports various materials such as steel, concrete, wood and aluminum.

RWIND

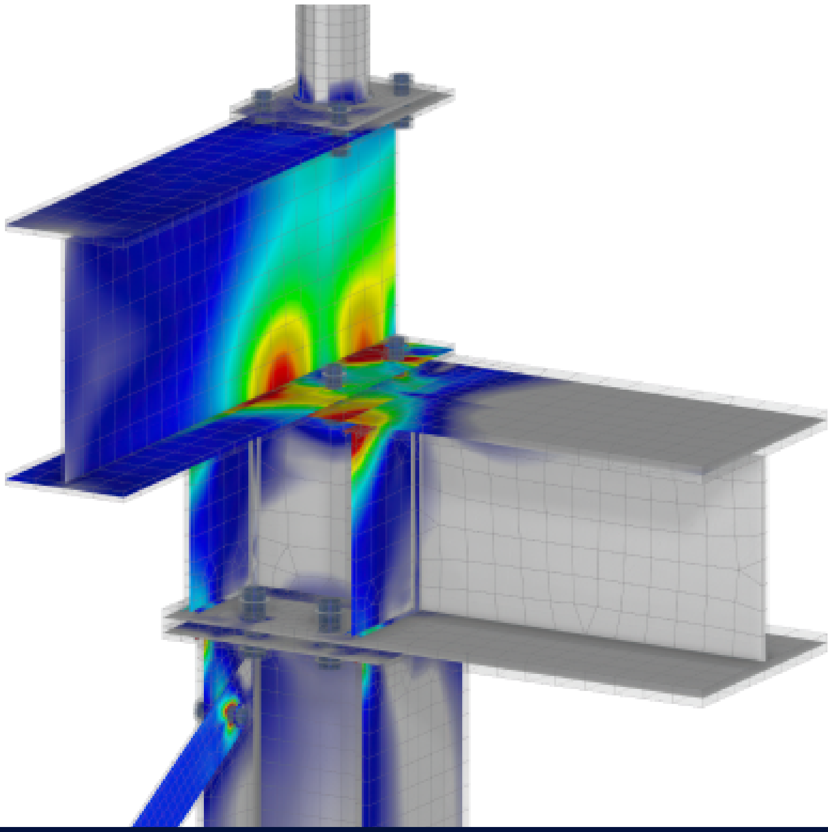
- CFD software for simulating wind flows around buildings and structures.
- Detailed visualization of wind loads and flow patterns.

RSECTION

- Stand-alone program for calculating profile characteristics.
- Execution of stress analyses for various cross-sections.

Dlubal in numbers

35	Years of experience in developing structural analysis software
300	Highly motivated employees around the globe
13.000	Companies work with Dlubal products worldwide
130.000	Users rely on Dlubal software



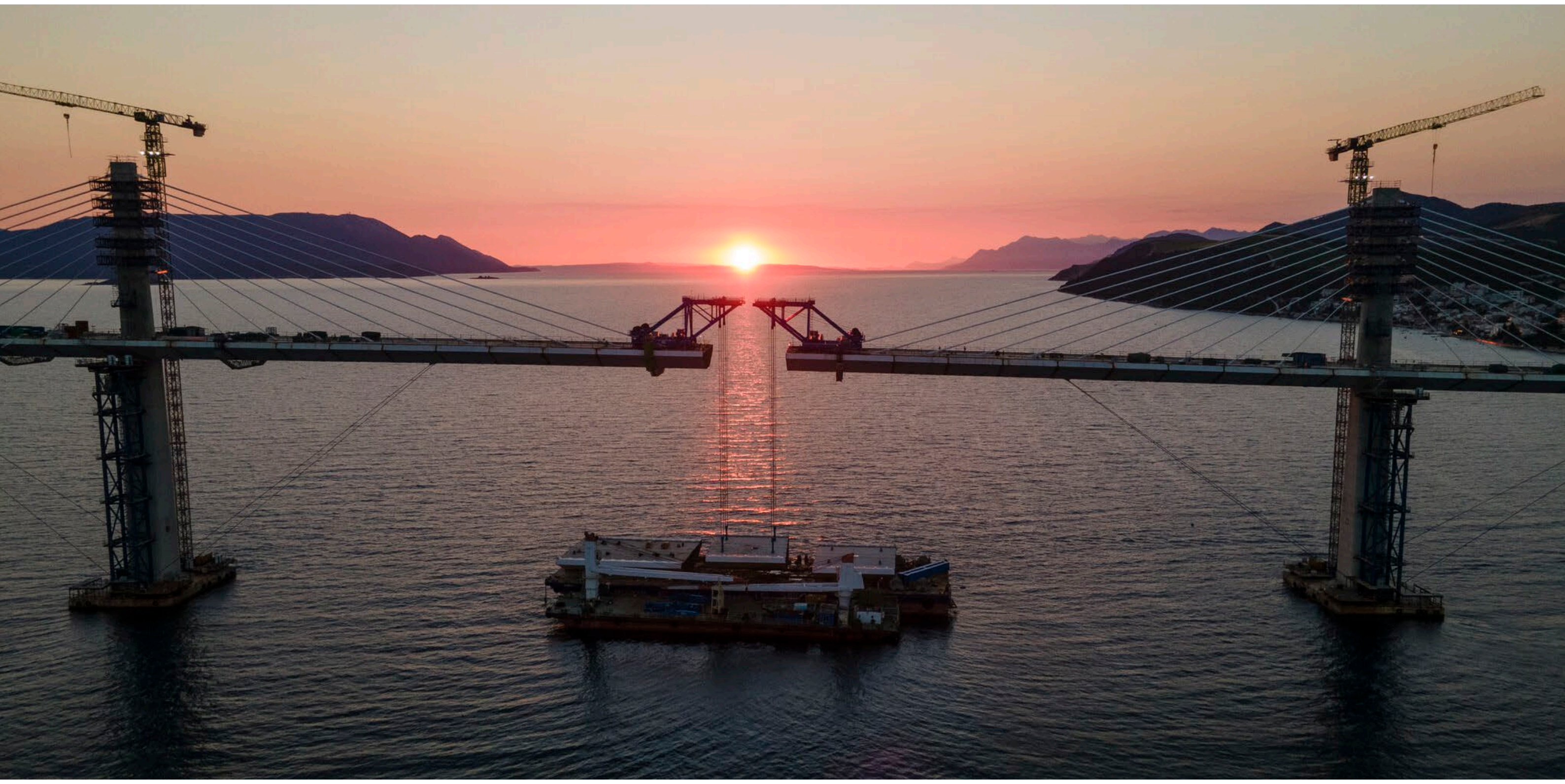
www.dlubal.com/en

dlubal_software

Dlubal Software

We design bridges

ponting
bridges



Pelješac Bridge, Croatia

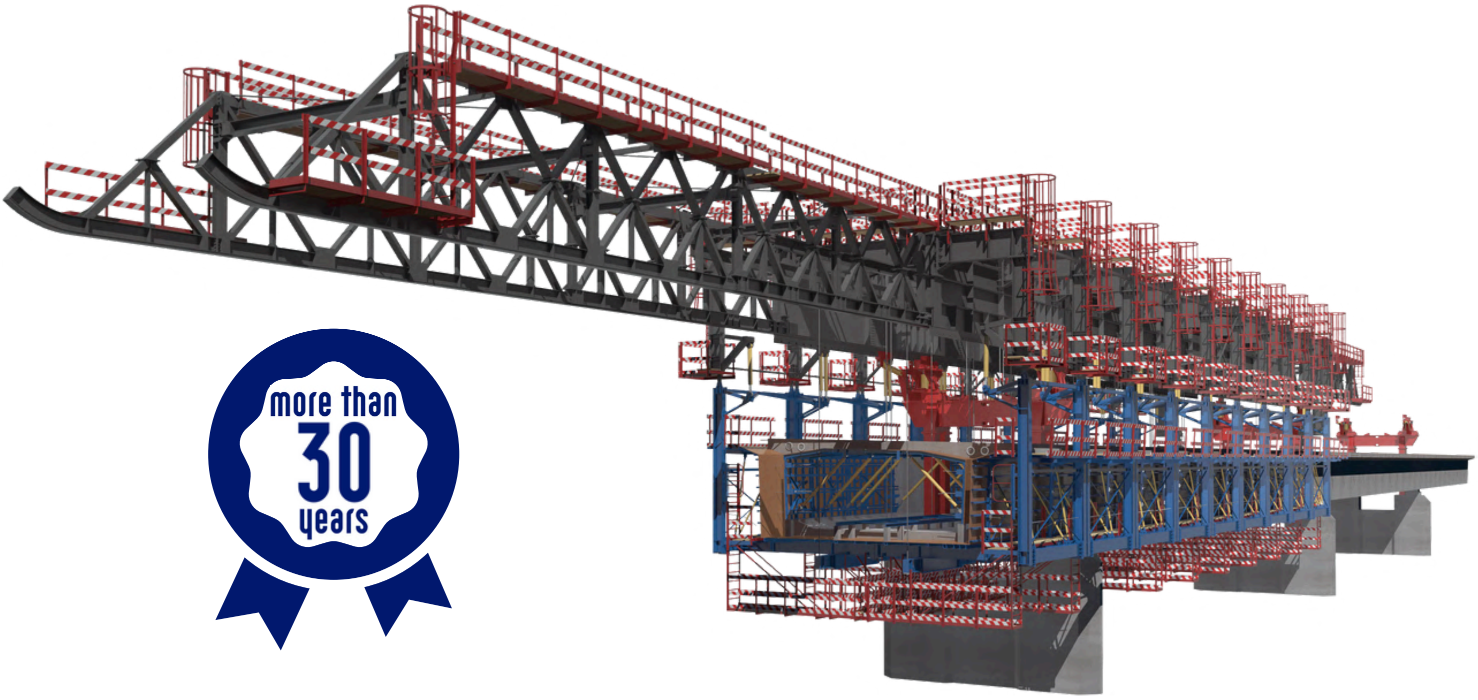
Conceptual/Preliminary/Final design
Joint Venture Faculty of Civil Engineering, University of Zagreb; Ponting; Pipenbaher Consulting Engineers

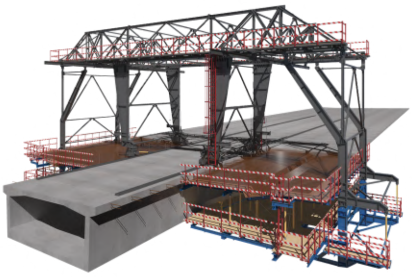
Ada Bridge over Sava in Belgrade, Serbia

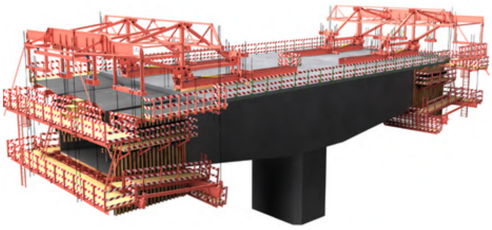
Winning competition design/Preliminary/ICE for final and detailed design

Ponting inženirski biro d.o.o., Strossmayerjeva 28, 2000 Maribor, Slovenia


Gerald Desmond Bridge © Marie Tagudena







American Icon

San Francisco-Oakland Bay Bridge East Span

TYLin

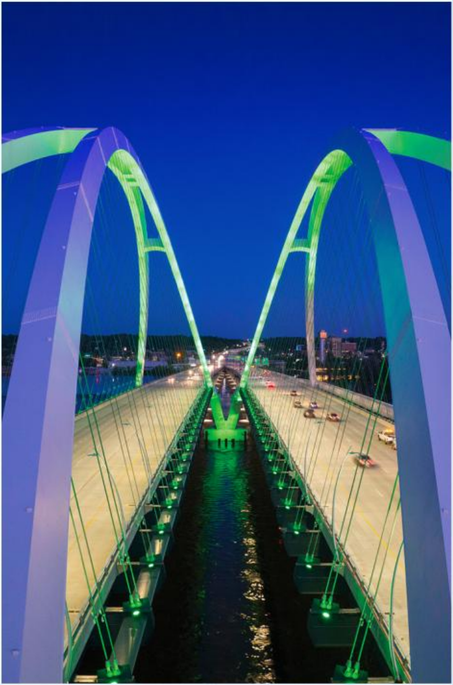
Photo Credit: Thomas Heinser

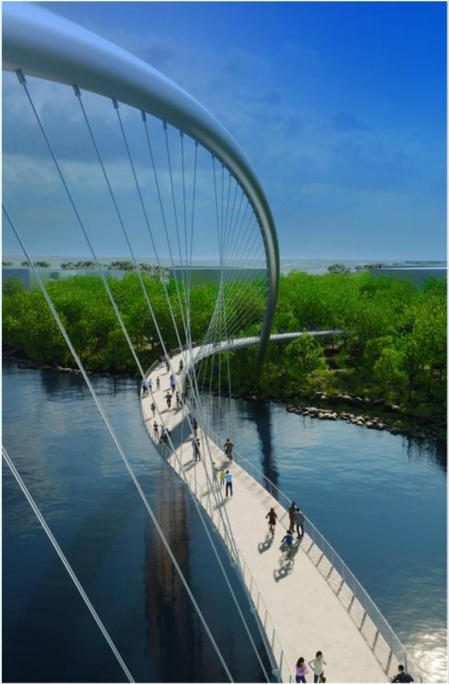
Helgeland Bridge, Norway

Photo : Jules van den Doel

AAS-JAKOBSEN


CCLEX MPTC
acciona
First Balfour






BRIDGES AS
STRUCTURAL ART
MIGUEL ROSALES

ENGINEERSINACTION.ORG

EIA ENGINEERS IN ACTION

BRIDGING COMMUNITIES

Isolation caused by impassable rivers is a root source of poverty all over the world. Fueled by the passion of University Students, our Industry Partners, and the wisdom of our Local Partners, we build footbridges with isolated communities to ensure they have year-round safe access to essential resources such as education, healthcare, and markets.

Engineers in Action

engineersinaction

Engineers in Action

JOIN US!

BE A BRIDGE.

Together we can transform lives.

Everyone can be a bridge to a better world.

A BRIDGE THAT BRINGS SOCIAL CHANGE. A BRIDGE OF HOPE. A BRIDGE OF LOVE.
Bridging the Gap Africa believes everyone deserves access to the basic necessities of life: Better healthcare · Quality education · Robust commerce. We build bridges *with* the communities we serve. This approach enables Kenyan communities to be involved with the building process and empowers them to expand beyond geographies and borders to include corporate and private donors from around the globe.

BtGA is a 501(c)3 in the US that also has Charitable status in Canada. For more information, please visit the Bridging the Gap Africa website at bridgingthegapafrica.org.

BRIDGING THE GAP AFRICA
bridgingthegapafrica.org

Get involved. Be a bridge.

Bridges to Prosperity

We envision a world where poverty caused by rural isolation no longer exists.

Corporate Partners help us make this vision possible.

Each partnership creates a unique experience that promotes teamwork and cross-cultural exchange for our volunteers. Through employee engagement, recruitment and retention, leadership, business development, and marketing, our corporate partners gain a strong return on investment.

Together, we can build more than a bridge; we can build a pathway out of poverty.

bridgestoprosperity.org

/bridgestoprosperity

@bridgestoprosperity

@b2p

PDF BROCHURE

CORPORATE VIDEO

e-mosty

ISSUE 02/2025 JUNE

GERMAN BRIDGES