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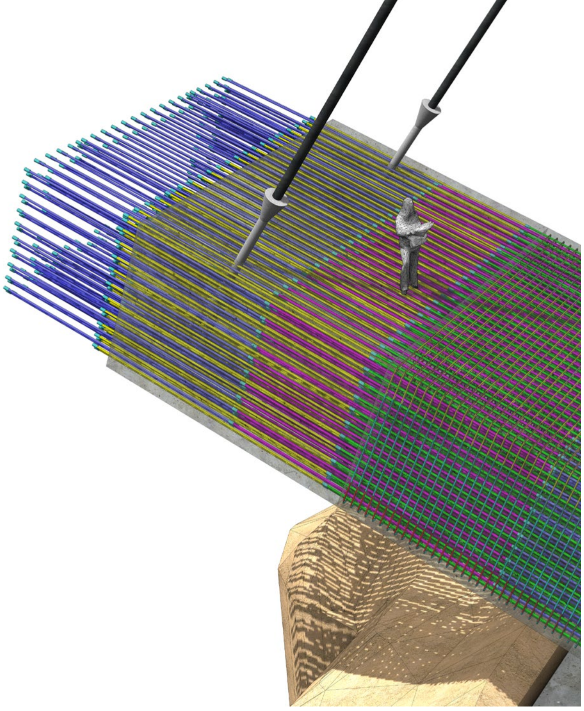
Tamina Bridge, Pfäfers
Engineering office Leonhardt, Andrä und Partner,
© Photo: Bastian Kratzke

Allplan in practice

AN EXCITING PATH ACROSS THE GORGE: THE TAMINA BRIDGE IN THE CANTON OF ST. GALLEN

With an arched span of 265 meters, a superstructure length of 417 meters and a height of 220 meters above the valley floor, the Tamina Bridge is the largest arched bridge in Switzerland. In 2007, an official competition was advertised for the Tamina Bridge project, which was won by the engineering office Leonhardt, Andrä und Partner (LAP). LAP used Allplan Engineering when preparing their entry for the competition. The engineering office was commissioned with the structural design after they won the competition. Numerous stresses had to be tested, including stresses from wind and earthquakes during construction and operation, and the failure of a tension cable. The dimensions of the competition design were confirmed and optimized further during detailed design. Allplan Engineering was again used to create the draft and tender documents. 3D modeling was particularly useful when incorporating the piers into the superstructure, which was critical. Markus Förster, department head for bridge building at LAP, explains: "Already during the planning phase, extensive designs of pre-stressed element guides and reinforcement were required to demonstrate the constructability of the design on the one hand, and similarly to make the tendering construction companies aware of the challenging framework conditions.



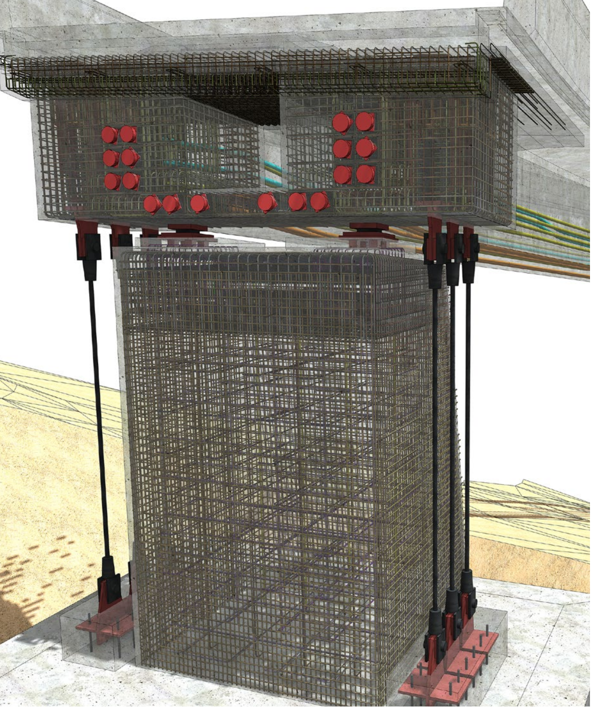
Valens: Reinforcement of the ground level arc; Left: Rendering, © LAP Right: © Photo: Civil engineering office of the canton of St. Gallen

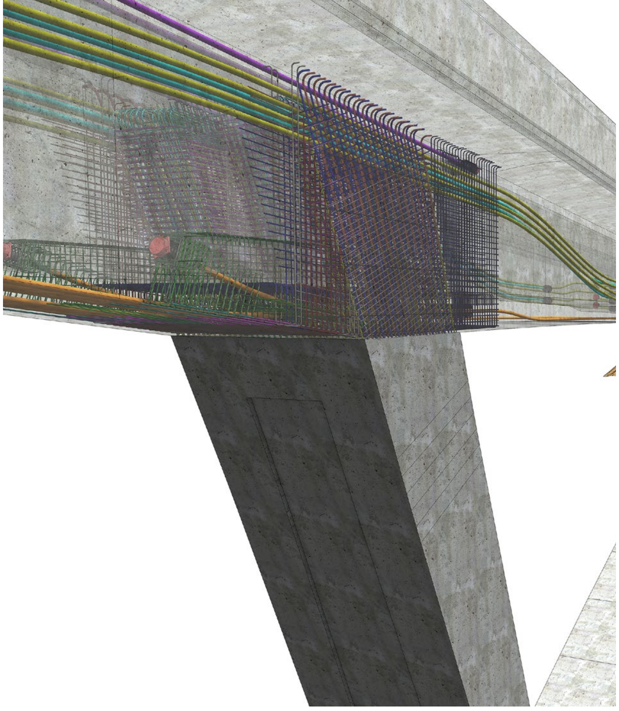
A sophisticated and very powerful tool was available for this purpose with Allplan Engineering." Appropriately for this situation (very steep valley embankments and the large valley depth), the supporting structure is made of an arc and continuous beams monolithically connected via the piers and arched supports. The core of the supporting structure is the arc with a span of 265 meters. The arc is tensioned in the horizontal elements on both sides. The cross-section height varies between 4 meters at the horizontal element in Pfäfers and 2 meters at the arc crest. The width is also reduced from 9 meters at the horizontal element in Pfäfers to 5 meters in the area of the crest. In order to save weight, the arc is designed as a hollow cross-section on over half of its length.

The superstructure is formed by a hollow concrete box. The bridge width of the superstructure was planned as 0.55 meters so that two bridge members can easily be arranged side by side. In order to create space for the tension anchorages, the longitudinal girders are spaced at 1.21 meters at the ends of the building sections. The roadway construction is a maximum of 0.50 meters thick. Its thickness reduces to 0.30 meters between the girders. As with the girders, the slab thickness at the end of the construction sections is also increased to be able to place the tension anchorages. Due to the plan having circular arcs at the ends of the structure, it was necessary to design a variable cross-slope of the roadway, which leads to torsion of the pavement structure in some areas of the bridge. The value of the road cross-slope varies between 5 percent towards the north on the Valens side and up to 5 percent towards the south on the Pfäfers side.

The vertical elements are monolithically connected to the horizontal elements and superstructure, and are essentially designed as a rectangular, walk-on cross-section. In order to shorten the supporting width of the foreshore bridges, the piers are not arranged perpendicularly, but rather vertically to the arc. The pillars on the arc are designed to be solid and have concrete joints at the foot and head. The connection to the arc and superstructure is also monolithic. The superstructure and the piers act like a frame. The pillars act as pendulum supports. Mounting on longitudinally displaceable supports occurs at the abutments. The horizontal elements and abutments are designed with flat foundations.

The design planning was also taken over by Leonhardt, Andrä und Partner. As a result of their experience with many bridge construction projects, Allplan Engineering was also used as planning software from the start. The extensive 3D functionality in particular greatly contributed to the success of the holistic planning of this very complex structure. The successful interaction of planning, software and design is described by Markus Förster as follows: "In coordination with the contractors and taking into account the formwork system used, each of





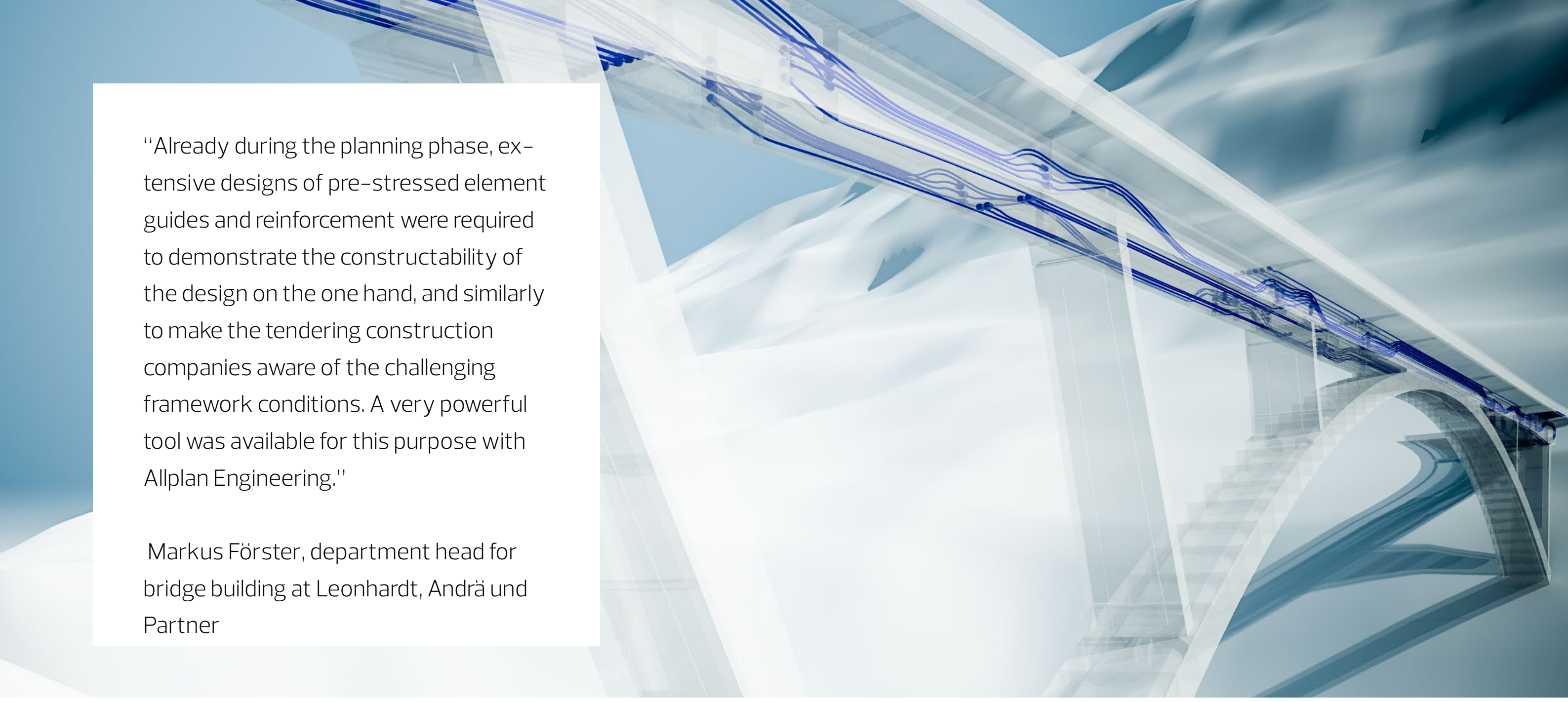
Left: Anchorage of the pre-tensioned cables with reinforcement and fixtures
Right: Incorporation of the pier superstructure in the digital building model.
© LAP

the 55 straight concreting sections of the arc were integrated into the 3D model precisely. This basis could be used to determine the target position of each individual segment and also be used as a basis for the precise measurement of the formwork."

The groundbreaking ceremony for the Tamina bridge took place on March 28, 2013. The foreshore bridges were first constructed using ground-supported scaffolds. Conventional scaffolding for the arc and superstructure was eliminated from the outset due to the gorge depth of 200 meters. The structural engineer originally intended the arc and superstructure to be designed as a cantilever.
The proposal of the Tamina bridge consortium commissioned with the design with the companies STRABAG, Meisterbau and Erni, on the other hand, consisted of designing only the arc as a cantilever, but building the superstructure using conventional supports erected on the arc. As a result of this – and by placing the auxiliary pylons required to construct the arc on both sides of the horizontal elements instead of on the foreshore bridge – the sequential construction process could be replaced with a largely parallel construction process. This was a major contribution to reducing the construction time from the originally proposed 5 years to 4 years. By the end of construction, 14,000 cubic meters of concrete, 3,000 tons of reinforcement, 180 tons of pre-tensioned strands and 140 tension member anchorages were installed. The total weight of the bridge is 35,000 tons. The building costs are 37 million Swiss francs.

The Tamina Bridge is part of a long series of prominent bridge structures that were designed using Allplan Engineering. In addition to the Tamina Bridge, the Sava bridge in Serbia, the Queensferry Crossing in Scotland, and the extended Waalbrugg in the Netherlands are examples of bridges with long spans or high complexity.

When working with Allplan Engineering, detailed virtual models are created, which also include pre-tensioned cables, reinforcements and fixtures. In this way, many potential problems can still be solved in the planning phase, especially in critical areas such as intersections with very high reinforcement ratios or in anchoring areas of the pre-tensioned cables. The risk of the deadline being missed and the budget being exceeded due to problems during construction is significantly reduced. At the same time, the productivity increases noticeably during design, due to the automatically generated sections and quantity calculations, amongst other reasons. The virtual bridge model is not only an invaluable aid for the engineers involved in the design and construction, but also helps with the communication with the clients, the public or the personnel on the construction site.



"Already during the planning phase, extensive designs of pre-stressed element guides and reinforcement were required to demonstrate the constructability of the design on the one hand, and similarly to make the tendering construction companies aware of the challenging framework conditions. A very powerful tool was available for this purpose with Allplan Engineering."

Markus Förster, department head for bridge building at Leonhardt, Andrä und Partner

THE CUSTOMER

The international engineering firm Leonhardt, Andrä und Partner (LAP) already specialized in structural engineering during its beginnings under Fritz Leonhardt. This resulted in today's orientation of LAP. Then – as now – one of the main focuses of the firm is the construction of bridges and buildings made of steel and reinforced concrete.

This has resulted in many outstanding engineering projects, including the Stuttgart TV tower (1955), the Olympic roof in Munich (1971), the Galata Bridge in Istanbul (1985) and the Transparent Factory in Dresden (1999). LAP is also committed to the continued development of the construction industry and the associated changes to the requirements for an engineering firm and is actively shaping this future as well.

ABOUT ALLPLAN

ALLPLAN is a global provider of BIM design software for the AEC industry. True to our "Design to Build" claim, we cover the entire process from the first concept to final detailed design for the construction site and for prefabrication. Allplan users create deliverables of the highest quality and level of detail thanks to lean workflows. ALLPLAN offers powerful integrated cloud technology to support interdisciplinary collaboration on building and civil engineering projects. Around the world over 500 dedicated employees continue to write the ALLPLAN success story. Headquartered in Munich, Germany, ALLPLAN is part of the Nemetschek Group which is a pioneer for digital transformation in the construction sector.

ALLPLAN GmbH
Konrad-Zuse-Platz 1
81829 Munich
Germany
info@allplan.com
allplan.com

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