



Four-track extension
between Olten and Aarau
(Eppenbergtunnel),
Switzerland

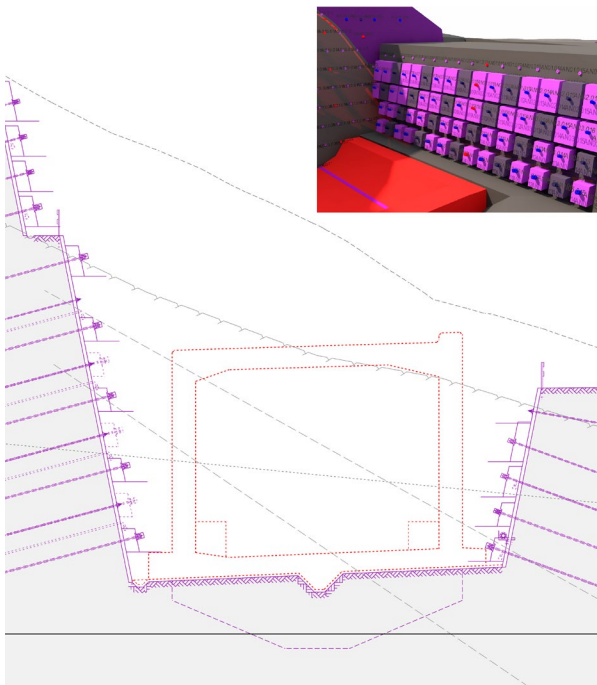
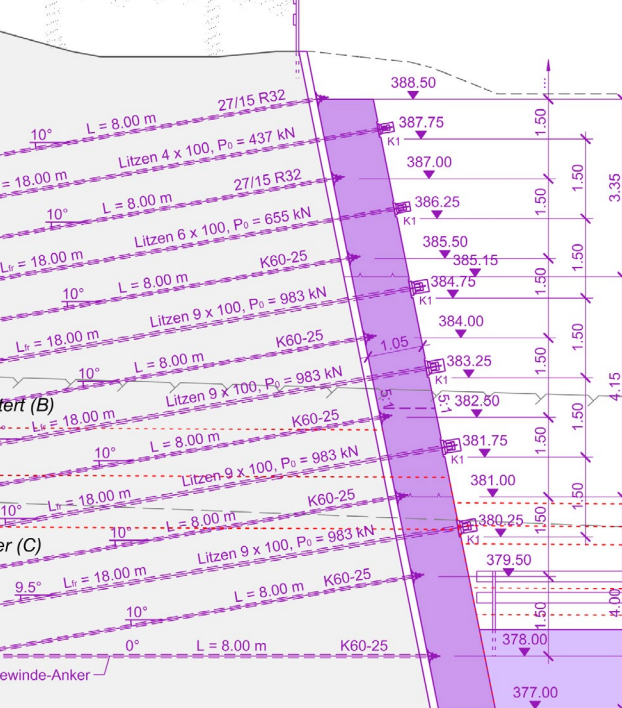
Allplan in practice

GREATER EFFICIENCY THANKS TO 3D PLANNING

“The high requirements of the geometrically complex excavation pit could only be met with spatial planning in 3D.” Rainer Hohermuth, ACS-Partner AG, Zurich

By the end of 2021, the four-track extension of the Olten-Aarau route is expected to relieve one of the most severe bottlenecks on the east-west axis of the Swiss rail network. The project, costing CHF 855 million, includes expansions in the east of Olten, a fourth 2.5-kilometer-long track between Dulliken and Däniken and – as the core element – the double-track, three-kilometer-long Eppenbergtunnel and comprehensive measures for its connection. Federal Councilor Doris Leuthard and SBB CEO Andreas Meyer appeared very pleased to have received the green light to relieve one of the most

severe bottlenecks on the east-west axis of the SBB rail network at the groundbreaking ceremony on May 2, 2015. The four-track extension is a key project for more efficient passenger transport and provides sufficient capacity for freight transport in the long term. In the meantime, construction work has progressed further and is evident, especially in Wöschnau and Gretzenbach, where the access routes and portals for the Eppenbergtunnel are being created. The first parts of the tunnel boring machine started at the beginning of September 2016. The Eppenbergtunnel, which is over three



Left:
Cross-section of the
stop wall

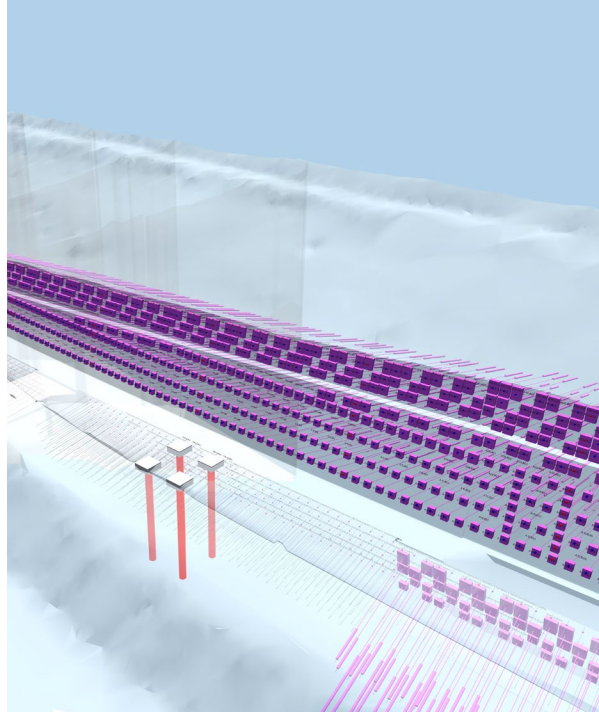
Right:
Cross-section of the
excavation pit

kilometers long, is being excavated from east to west with a tunnel boring machine measuring 100 meters long and 2,400 tons in weight. Tunneling is scheduled to begin at the end of 2016 and the drill head, measuring just under 13 meters in diameter, is expected to see the light at the end of the tunnel near Gretzenbach in spring 2018. A 373-meter-long section of tunnel is being created using open-pit methods to the east of the portal of the tunnel excavated by mining techniques. It is situated in the deep excavation pit, which runs under the Swiss cantonal road and in the hillside. We will discuss this extremely complex excavation pit in more detail below. At the western portal in Gretzenbach, the cut-and-cover tunnel which will pass under the Swiss cantonal road is also under construction. Measuring 128 meters in length, it will be shorter than the one in Wöschau. More than 130 people are currently working on the various building sites of the Olten four-track extension. This will increase to up to 200 people from the start of 2016 to summer 2019. The total costs for this project amount to CHF 855 million. CHF 784.5 million of that total amount come from the loan for the "ZEB", the major Swiss project for the future development of rail infrastructure. A further CHF 70.5 million come from the 2013–2016 service level agreement (SLA) concluded between SBB and the Swiss federal government.

THE PROJECT IS MADE UP OF TEN SUB-PROJECTS

The planned four-track extension between Olten and Aarau is roughly 12.4 kilometers in length. The major project is divided into ten sub-projects, which are grouped into construction lots A and B. In the following explanations, we will concentrate on construction lot A, which includes the following sub-projects:

- > **Sub-project 1:** Eppenbergr Tunnel, measuring 3,114 in length
- > **Sub-project 2:** Wöschau junction with eastern, double-track access to the new Eppenbergr Tunnel
- > **Sub-project 3:** Gretzenbach junction with western, double-track access to the new Eppenbergr Tunnel
- > **Sub-project 8:** Wöschau track crossover with the installation of two new track crossovers with high-speed switches



Left:
Excavation pit
overview

Right:
Excavation pit
visualization

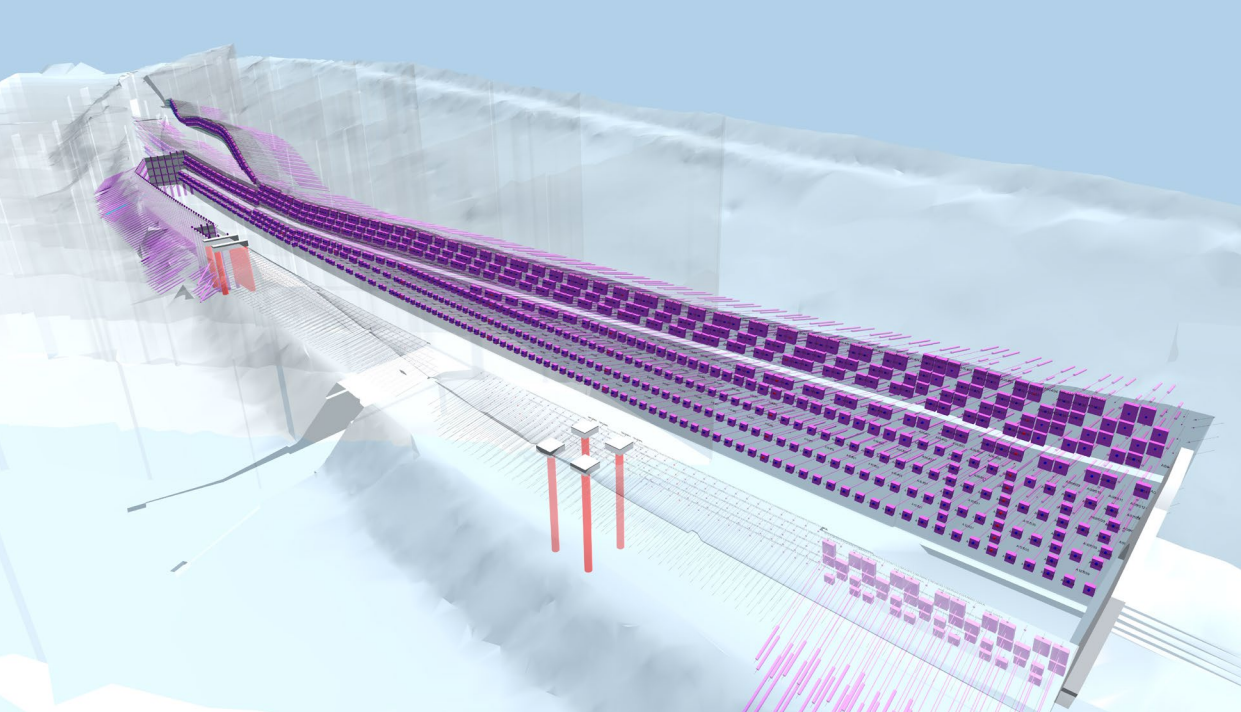
COMPLEX EXCAVATION PIT IN THE WÖSCHNAU HILLSIDE

On the eastern side of the future Eppenbergl Tunnel, in what is known as the Wöschnau hillside, the construction team created an excavation pit around 300 meters long, 20 meters wide and 25 meters deep. The cut-and-cover tunnel is in this pit and, from late summer 2016 onwards, the tunnel boring machine was assembled, and the supporting structure work is being carried out too. The excavation was carried out with heavy crawler excavators in increments of two meters. The pit wall was continuously secured with rock anchors, shotcrete and reinforcement meshes until the depth of the future tunnel was reached. Several thousand anchors were drilled up to 24 meters deep in the hillside. Prefabricated concrete elements are being used as extensive load distribution plates of the pre-stressed anchors on the excavation pit wall. Although it may sound simple in this description, this process has its hidden pitfalls: "The geology is very problematic and the spatially very complex shape of the excavation pit is a major challenge for us," explains Rainer Hohermuth, an ETH-qualified civil engineer who works at ACS-Partner AG in Zurich and is the engineering consortium's project manager responsible for this construction stage in Eppenbergl. The topmost six meters of the excavation pit are made up of slope debris, located above rock with very steep fissures. The comprehensive ex-

cavation support with anchors ensures that these "vertical rock formations" cannot slip. This also explains the small-scale anchor arrangement with a standard distance of 1.5 meters in both directions. The spatial shape of the excavation pit was the second major challenge, as its lines in the plan have very different radii but are practically never straight. In the cross-section, the different inclination of the slope must be noted, and various parameters in the longitudinal axis must also be considered. For Rainer Hohermuth, this resulted in the following conclusion: "Such a complex excavation pit can only be efficiently processed in the planning stage in 3D." The engineering firm ACS-Partner AG decides whether to work in 3D or 2D depending on the structure. Rainer Hohermuth explains the principle as follows: "When it comes to complicated and extraordinary geometric shapes, we are much more efficient in 3D than in 2D. We also have the great advantage of visual, spatial checks in 3D."

PLANNING THE EXCAVATION PIT IN 3D WITH ALLPLAN

How are several thousand anchors in a geometrically complex excavation pit at a very narrow offset between axes and with holes at many different angles planned in an efficient manner, and how is it ensured that no collisions occur under the holes? And how is it ensured that existing vertical holes are not destroyed by the pipes for the inclinometer



Right:
Excavation pit
visualization

measurements with the anchor and relief holes to be drilled? "These requirements could only be met with spatial planning in 3D," explains Rainer Hohermuth. However, he was still not entirely satisfied with that, as he goes on to explain: "It should also be possible for the anchors to store all the information required for construction as attributes, and to automatically generate a complete list of anchors at the touch of a button with all this information – including all the information for pegging out." The project managers turned to ALLPLAN Schweiz, which developed an individual tool for this purpose, with this idea. This tool included the function of parametric anchors, as the draftsman could use it to assign all the desired data and descriptions to every anchor, and could also use it to spatially position the anchors. In the second step, the tool applied this information to generate the list of anchors, which could be transferred directly to construction without further editing.

GREATER EFFICIENCY AND EXTENSIVE ADDITIONAL BENEFITS THANKS TO PLANNING IN 3D

"If we had planned this complex excavation pit in 2D, it would have been necessary to develop a multitude of cutting plans," says Rainer Hohermuth, before going on to point out: "Even so, we would never have been sure whether two holes would collide." Especially when it comes to recessed

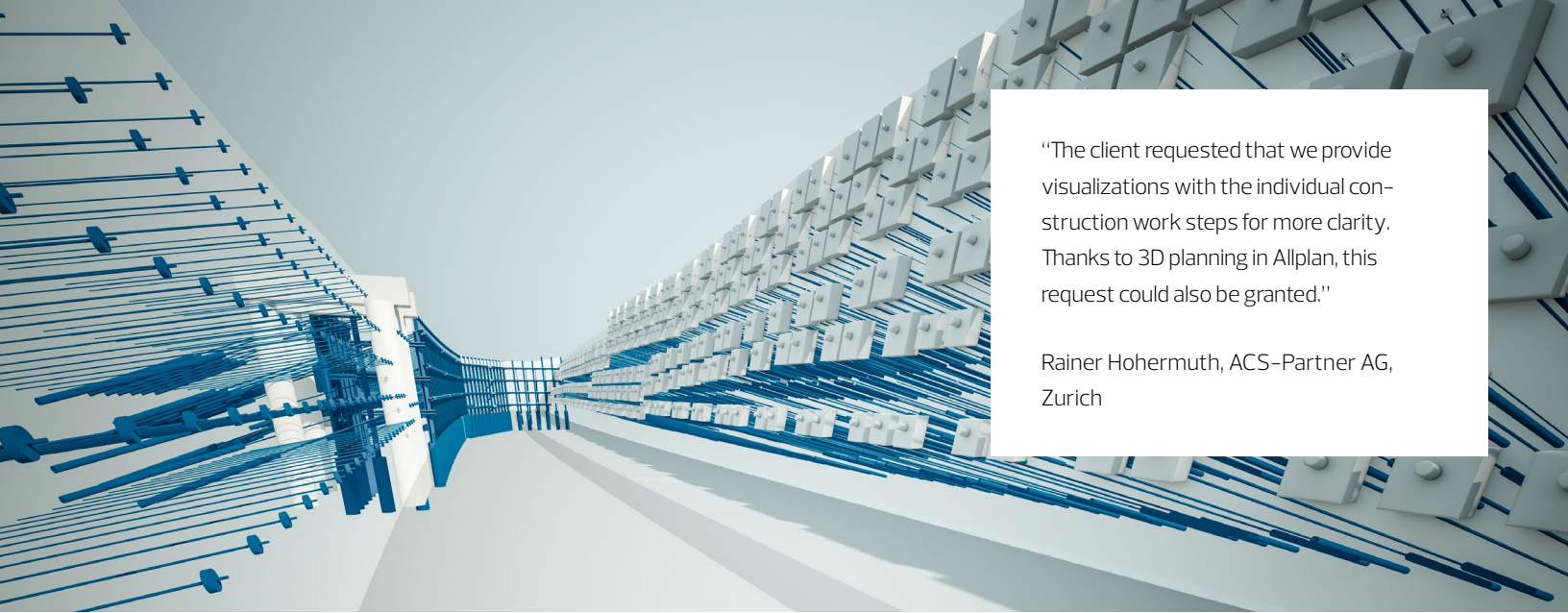
PROJECT INFORMATION AT A GLANCE

- > **Focus:** Planning in 3D
- > **Software used:** Allplan Engineering

EPPENBERG TUNNEL, LOT A (WÖSCHNAU / EPPENBERG TUNNEL / GRETZENBACH)

- > **Client:** Swiss Federal Railways (SBB)
- > **Project design and site management:**
Rapid engineering consortium, made up of ILF Beratende Ingenieure AG based in Zurich, Aegerter & Bosshardt AG based in Basel, ACSPartner AG based in Zurich, and SIGNON Schweiz AG based in Zurich
- > **Construction:** ARGE Marti Eppenberg, Marti Tunnelbau AG based in Moosseedorf, Marti AG, Bauunternehmung based in Zurich, Marti AG based in Solothurn
- > **Building time:** 2015 – 2021
- > **Total costs:** Total project CHF 885 million

corners. The increase in efficiency also shouldn't be underestimated in the development of layouts and anchor lists. It is difficult to make an accurate statement about this, as it is impossible to make a one-to-one comparison. Nevertheless, Rainer Hohermuth believes that the amount of time required could have reduced by a quarter, if not even more. And there are also various additional benefits, for size and invoicing, for example. "But planning in



"The client requested that we provide visualizations with the individual construction work steps for more clarity. Thanks to 3D planning in Allplan, this request could also be granted."

Rainer Hohermuth, ACS-Partner AG,
Zurich

3D also awakens new desires," continues Rainer Hohermuth, giving an example of this: "The client requested that we provide visualizations with the individual construction work steps to be able to show them more clearly. Thanks to 3D planning in Allplan, this request could also be granted."

THE CUSTOMER

The client awarded the general planning contract for the demonstration to execute project phases and the mandate for the local site management to

the engineering consortium Rapid. The engineering consortium is made up of the engineering firms ILF Beratende Ingenieure AG based in Zurich, Aegerter & Bosshardt AG based in Basel, ACS-Partner AG based in Zurich, and SIGNON Schweiz AG based in Zurich. In November 2014, SBB assigned the supporting structure work for the Eppenberger Tunnel and its access routes to "ARGE Marti Eppenberger" for a contract value of just under CHF 300 million.

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.

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