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to whom it may concern

Letter of reference - Rosshaupten Dam (Germany)
Foundation Works Executed by BAUER Spezialtiefbau GmbH
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Dear Sirs and Madam,

following the successful completion of BAUER's part of the project, I would like to express my appreciation for the means and methods in which BAUER has performed on the project.

BAUER Spezialtiefbau GmbH, whose office is located at BAUER Straße 1, 86529 Schrobenhausen, Germany has been engaged by the Owner Uniper Kraftwerke GmbH for the construction of foundation works at Rosshaupten Dam project.

The dam structure is an approximately 40 m (131 feet) high, earth-filled dam with a supporting body of gravel and debris and a central sealing core, which consists of material having a high cohesive clay content. As part of the rehabilitation, it was decided to install a 1 m (39.37 inch) thick and up to 70 m (230 feet) deep cut-off wall.

BAUER Spezialtiefbau GmbH was awarded the construction of not only the cut-off wall but also with the implementation of a soil stabilization prior to the cut-off wall installation. Percussion drilling and Tube-à-Manchette (TaM) injections were executed – in total a scope of 2,100 linear m (6,890 feet). The data monitored during all drilling works were digitalized and a 3D model was produced step by step for way of real time documentation and visualization using Bauer's specialist digitization B-project model.

Description of the executed drilling and grouting works campaign: Sonic drilling of the actual dam body and rock drilling with Wassara drilling method. Sealing of the actual dam clay core with Tube-à-Manchette method and the lower bedrock layer with standard rock injection (combination of descending and ascending injection method); in total 24 numbers of boreholes with a maximum depth of 85 m (279 feet) and an inclination of 20° to the vertical.

A unique application was the installation of a BAUER Mixed-In-Place (MIP) structural retaining wall aligned either side of the later cut-off wall trench as a supplementary stabilization of the guide wall.

The cut-off wall was executed without widening the crest of the dam. The base machine BAUER MC 96 was equipped with the turnable BAUER HDS-T hose drum system,

enabling the BC 40 trench cutter to rotate on its own axis and making it possible to execute all panel locations.

The cut-off wall was constructed in single-bite elements. Two independent methods for surveying the trench during the excavation were used, which monitor each other. Inclinometers were installed both in the hydraulic grab and in the trench cutter, which indicated initial reference points for the verticality deviation of the excavation tools. In addition, the Cutter Indication System (CIS) and GIS Grab Inclination System (GIS), developed by Bauer, were used. The inclination of the wire ropes to which the grab or cutter were attached provided information about their exact position in the trench. A tachymeter recorded the position of the aboveground section of the wire ropes three-dimensionally in space.

Details of the Contract
Execution period: March 2018 to April 2019. In order to meet the specified construction schedule, the cut-off wall works had to be executed through the winter months facing the harsh winter conditions. Temperatures during wall installation were as low as - 10° Celsius (-20° Celsius when considering the wind chill) and this required special winterization set-up for the mixing plants as well as the slurry lines. Both were successfully implemented by BAUER.

Location: The site of the Rosshaupten dam project is located in the southern part of Germany forming the Forggensee, by area Germany's largest water reservoir located close to the famous Neuschwanstein Castle.

In 1954, the construction of the Rosshaupten Dam was finished and has created the lake Forggensee, with a total area of 16 km² (6.2 square miles). The dam structure and reservoir is used for power generation as well as for low water elevation and flood protection for the downstream areas. The area has naturally developed into a popular location for recreation activities.

Quantity:
- Inclined exploratory holes including testing: seven (7)
- Inclined drilling and grouting: 2,100 lm (1,000 lm in rock)
- Piling works: 550 m (shaft removal)
- Mixed-in-Place: 3,500 m² (37.674 square feet)
- Cut-off wall: 13,500 m² (145.313 square feet) in overburden and sound rock

Geological condition: The geology at the site is very difficult. Features like vertical and valley-parallel layers of clay, marl and marl stone with fissures. In the area of the dam the molasse layers are very steep. The molasse below the dam is strongly stratified. The layers often change at intervals of a few centimeters and rarely one layer is several decimeters thick. In parts, voids / fissures of the strata are filled with coal. The fresh rock at the dam shows compressive strengths up to 85 MPa (12.328 psi).

The professional way in which the BAUER team prepared and executed the works was very well received. Trial mixes and generally quality management and control along the detailed method statement secured the highest standards of quality for the product.

BAUER was proactively seeking solutions, addressing issues and were answering questions related to any subjects of the works. I also note that these matters were few and infrequent.

BAUER’s professional approach towards Health Safety Environment (HSE) was excellent. The project was executed within the agreed schedule.

Yours faithfully

Roman Töpler
Head of Asset Support & Outage Excellence
Team Hydro DE