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# 40 DEGREES UPHILL: GRIPPER TBM COMPLETES SECOND TUNNEL FOR LIMMERN HYDROPOWER PLANT.

**On March 13, 2013 a tunnel boring machine from Herrenknecht successfully completed excavation of the second headrace tunnel for the new pumped storage power plant at Limmern (Switzerland). Equipped with a new safety concept for securing the machine, the Gripper TBM was able to cope with the 40 degree gradient of the two tunnels without incident.**

**Linthal, Switzerland / Schwanau, Germany, April 11, 2013.** A Herrenknecht Gripper TBM (Ø 5,200 mm) bored two 1,030 meter long headrace tunnels through hard rock, connecting the upper reservoir to the machine hall cavern. With the breakthrough of the second tunnel on March 13, 2013 another key milestone in the major project »Linthal 2015« was reached. Linthal is expected to commence operations in 2015 as the currently largest hydroelectric power project in Switzerland. In cooperation with the construction company, Swiss firm Marti Tunnelbau AG, the engineers from Herrenknecht AG developed a solution for safe tunnelling at a gradient of 40 degrees.

The machine drove two 1,030 meter long headrace tunnels from the underground cavern for the pump turbines (1,700 m above sea level) up to the 600 meters higher service chamber on the shores of the Muttsee lake. The tunnel route runs predominantly through Quintner limestone at depths of up to 565 meters. The Gripper TBM had to cut through rock strengths of up to 120 MPa. A route gradient of 40 degrees (equivalent to 84.7 percent) was a special challenge for the machine technology, the workers on site and the planning team. In both tunnels the specialists from Marti Tunnelbau AG had to pass through the Mörtalbruch fault zone. Complex supporting and rock stabilization measures slowed the advance but assured the final success of the project.

## 40 degrees uphill: tunnelling under extreme conditions.

The immense gradient called for an extremely reliable safety concept to hold the machine securely in place during tunnelling. At all costs it had to be ensured that the TBM could not slip back when the grippers were moved. For the Linthal project the construction company Marti Tunnelbau AG and Herrenknecht AG developed a double anti-reverse lock with full back-up redundancy of the available bracing levels for the 130 meter long and 800 tonne TBM. This significantly increased safety for man, machine and structure: in all operating states (advance, standstill or regripping) there were always at least two of three locking systems independently braced against the mountain. The anti-reversing locking systems worked mechanically on the basis of a self-locking toggle lever (automatic mechanical wedging). This meant that even in the case of a failure in the energy supply and the hydraulic systems the necessary bracing of the machine against the mountain was assured.

In November 2010 the Herrenknecht Gripper TBM began driving the first tunnel and completed it in October 2011 after best performances of up to 130 meters per week. Then the TBM cutterhead was disassembled and the back-up pulled back through the pressure shaft and made ready to go again. From February 2012 the TBM bored its way through the

second tube and was still able to achieve a weekly best performance of 133 meters at the end of the tunnel in mid March 2013.

**Pumped storage power plants: gigantic stores for clean energy.**

The Muttsee, Tierfehd and Linthal (Canton of Glarus, Eastern Switzerland) hydroelectric power plants of Kraftwerke Linth-Limmern AG currently generate a total of 480 MW of clean energy. As part of the »Linthal 2015« project, the new Limmern pumped-storage plant will raise the capacity by 1,000 MW. Construction of the new power station is being carried out by the consortium ARGE Kraftwerk Limmern under the leadership of contractor Marti Tunnelbau AG.

Pumped storage power plants act as gigantic energy stores. They compensate for fluctuations in the power grid and ensure security of supply in the expansion of renewable energy sources. Immediately more power is available in the grid than is needed, the pumps of the new Limmern power station will pump water from the lower Limmernsee lake to the upper Muttsee lake. At peak hours, the water flows back to Limmernsee lake through two headrace tunnels to the pump turbines, which then generate environmentally friendly electricity.

**S-575 Limmern**

| **Machine data** | | **Project data** | |
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| Machine type: | Gripper TBM | Tunnel length: | 2 x 1,030 m |
| Diameter: | 5,200 mm | Geology | Quinter limestone |
| Cutting wheel power: | 2,205 kW | Client: | Kraftwerke Linth-Limmern AG |
| Rated torque: | 2,669 kNm | Customer: | Marti Tunnelbau AG |

***Herrenknecht AG***
*Herrenknecht is the only company worldwide to deliver tunnel boring machines for all ground conditions and all diameters – ranging from 0.10 to 19 meters. The product range comprises tailor-made machines for traffic, supply and disposal tunnels as well as additional equipment and service packages. Herrenknecht also manufactures drilling rigs for vertical and inclined shafts as well as deep drilling rigs. The Herrenknecht Group achieved an overall output of 1,104 million euros in 2011. All in all, Herrenknecht machinery has completed around 2,300 kilometers of tunnels in large diameter ranges of over 4.20 meters since the company's establishment in 1977. Around 850 Herrenknecht Utility Tunnelling Machines are in operation around the world constructing or laying water and wastewater systems, gas and oil pipelines, as well as conduits for electricity, internet and telephone lines. The Herrenknecht Group employs around 5,000 people worldwide. These include over 200 trainees and apprentices. With 77 domestic and overseas subsidiaries and associated companies working in related fields Herrenknecht provides comprehensive services close to each project and customer.*

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